THURSDAY, JULY 8, 1880

THE TAY BRIDGE

THE Report of the Court of Inquiry appointed to investigate the circumstances of the fall of the Tay Bridge last December has now been made public. There appears to be some difference of opinion amongst the members of the court respecting the scope of the inquiry and the duties placed upon them by the Board of Trade, in consequence of which two separate reports appear together, one by Col. Yolland, Chief Government Inspector of Railways, and Mr. Barlow, President of the Institution of Civil Engineers, and the other by Mr. Rothery, the Wreck Commissioner. The former report describes in detail the design and method of erection adopted in the bridge, giving also a description of the various alterations in the plan which were rendered necessary as the work progressed.

The bridge was 3,465 yards in total length, divided into 86 spans, and it was the central portion, of 3,149 feet in length, which fell on the evening of December 28. As originally designed, this central portion was to consist of lattice girders of 200 feet span, carried by brickwork piers somewhat over 80 feet in height from high-water level, but as the river bottom turned out to be different from what was expected from the borings, and the difficulty of obtaining a secure foundation greater, eleven spans of 245 feet and two of 227 feet were substituted, and braced iron piers were adopted in the place of brickwork, as imposing a less weight on the foundations. It is these piers which at the inquiry chiefly received attention, as there can be little doubt that they were the immediate cause of the catastrophe. The process of floating out and sinking the caissons for these piers has already been described in these columns, and so successfully was this—certainly the most difficult and hazardous part of the undertaking—accomplished, that no suggestion of insufficient strength has been made, and in the Report it is stated that there is nothing to indicate any movement or settlement in the foundations of the piers which fell.

The caissons were lined with brickwork and filled with concrete, on which was built a hexagonal pier of masonry carried up to 5 feet above high-water mark. Upon this pier was built up six cast-iron columns secured by holding-down bolts to the masonry at the angles of the hexagon. The columns were made up of lengths united by flanges and bolts, and connected with each other by horizontal struts and diagonal ties. The up-stream and down-stream columns were each 18 inches in diameter, the remaining four, 15 inches; all were inclined 12 inches inwards at the top. The piers thus formed were from 81 to 83 feet in height from the top of the masonry to the under-side of the girders. The diagonal bracing consisted of flat bars attached to the columns by means of "lugs" cast on them, being secured at one extremity by a screw-bolt passing through the lugs and bar, and at the other by a strap provided with a gib and cotter for tightening up. The horizontal struts consisted of two channel-bars bolted back to back to a single lug on each column.

It will thus be seen that all vertical load must be borne entirely by the columns, and with the exception of the small transverse resistance of the latter the whole of any lateral pressure must be transmitted by the bracing.

Whether as designed the bridge would have been strong enough for its work if the materials and workmanship had been good throughout is very doubtful, but, as carried out, the evidence shows distinctly that it was not sufficiently substantial for the heavy traffic and severe gales to which it was exposed. When everything was tight and in good order the bridge, at the time of its inspection by General Hutchinson in February, 1878, showed great rigidity under the tests imposed by him, but by October of the same year so much slackness had made its appearance in the bracing that, besides the ordinary keying-up by driving the cotters, more than 100 packing-pieces about three-eighths of an inch thick had to be introduced in different parts.

Respecting the immediate cause of the accident the Court states—"In our opinion the weight of evidence points out the cross bracing and its fastening by lugs as the first part to yield." This we believe the calculations of Dr. Pole and Mr. Stewart, taken in connection with the experiments of Mr. Kirkaldy, are quite sufficient to establish. With a wind pressure of 30 lbs. to the square foot on the windward girder and train, and half this amount on the leeward girder, the stress on the tie-bar most severely strained, would be 16·8 tons, or 10·18 tons per square inch; again, with a wind pressure of 40 lbs. to the square foot the stress on the tie-bar would be 22·4 tons. Now, as Mr. Kirkaldy's experiments, made by order of the court on some of the tie-bars removed from the bridge, showed that they broke with a load of from 19 to 23 tons, and the corresponding lugs with a load of 23 to 25 tons, it is pretty certain that the ultimate strength of this part of the structure would be reached by a wind pressure of 40 lbs. to the square foot. And in addition to this more variation is to be expected in the strength of the lugs, as some at least were admitted to be of bad manufacture, and when the pier was most severely strained it would be some of the worst lugs in the lower tiers that would be the first to yield; thus the samples taken for testing would not be likely to embrace specimens of the lowest strength, as these would probably have already given way.

Again, it does not appear necessary to assume a wind pressure of 40 lbs. per square foot to ensure the destruction of the pier; the stresses above mentioned are due merely to the statical pressure, and it can hardly be denied in the face of the evidence respecting the details of the structure that there would be a great deal of motion due to backlash over and above the elastic yielding of the material. Thus a much lower pressure would produce the effects calculated for one of 40 lbs. per square foot.

The principal conclusions arrived at by the court are that there is no indication of settlement in the foundations, that the wrought iron employed was of fair strength, though not of high quality as regards toughness, that the cast iron was fairly good, that the main girders were of sufficient strength, and that the iron piers, though strong enough to sustain the vertical load, were insufficient to resist the lateral action of heavy gales from the weakness of the cross bracing and its fastenings; that the railway company did not enforce the recommendation of General Hutchinson by limiting the speed of trains over the bridge to twenty-five miles per hour, much higher speed being frequently run; that while of opinion that the fall of the bridge was occasioned by the yielding of the cross bracing and fastenings, it might possibly have been due to the fracture of one of the outward leeward columns.

Col. Yolland and Mr. Barlow conclude by stating "that there is no requirement issued by the Board of Trade respecting wind pressure, and there does not appear to be any understood rule in the engineering profession regarding wind pressure in railway structures; and we therefore recommend that the Board of Trade should take such steps as may be necessary for the establishment of rules for that purpose."

Mr. Rothery, in his independent report, while stating that there is an entire agreement between himself and his colleagues in the conclusions arrived at from the evidence, goes further than them, and unhesitatingly apportions the blame among the different parties concerned. On the recommendation that the Board of Trade should establish rules providing for wind pressure, he differs from his colleagues, emphatically stating that it is for the engineering profession to make them, and evidently regards the superficial character of an official inspection as no great evil.

Where French engineers have long adopted 270 kilogrammes per square metre, and many English engineers, on the authority of Rankine, the equivalent 55 lbs. per square foot, while nearly the same figure is used in America, it seems strange that so much difference of opinion should be found to exist; but one thing at least is certain, that the instruments at present in use for measuring wind pressure are exceedingly crude and liable to error, and that until these are improved and much increased in number there is little chance of being on the spot when these excessive pressures occur, or of truthfully recording them when met with.

Respecting the transfer of these responsibilities to a Government Department, we believe that such apronstring policy would be fatal to the profession of the civil engineer; we would rather see the Board of Trade Inspection, which at least is formal and superficial, relaxed than any attempt made to increase its efficiency. The medical profession does not require a fatherly department to watch over its operations or give an opinion on an amputation; why then should the engineering profession? It cannot be too clearly understood that an engineering work cannot be successfully carried out by mere rule of thumb or even by the copious use of "Molesworth" or "Rankine"; each operation is to some extent a physical experiment subject to known laws, but under variable conditions. The physicist and the engineer have already to a great extent established the laws for him, but it remains for the scientific engineer to carefully watch their operation, and thus gain that practical experience which will enable him to deal with each special case as it arises.

The conclusions we draw from the evidence and report are that the design of the piers was most imperfect, cheapness appearing to be the ruling element in every detail, a cheapness too that must have been completely delusive, as any money saved in first cost would soon, in such a rickety structure, have been swallowed up in maintenance. At nearly all points an absence of consideration for small details is most apparent, indicating probably that these were intrusted to some subordinate, who failed to appreciate their importance.

It is very far from our object in this article to hold up any particular individuals to blame for this disaster, but we should like to point out on whom the responsibility should rest if such a thing should occur again.

It would be quite impracticable for the Board of Trade to exercise such supervision over the selection of the material and the execution and erection of a large work throughout its progress, as would render its certificate of any value; we believe, therefore, that the undivided responsibility should rest on the engineer. Any dishonesty on the part of the contractor or his workmen,—and we are sorry to believe this still exists in some cases,—could be easily rendered hazardous by legal penalties.

Doubtless with the keen competition of the present day things must be "cut finer" than they used to be; but while we would remove any arbitrary restrictions imposed by Government on the judgment of those who ought to be best able to appreciate the particular conditions of their own work, we should be very sorry to see the introduction of flimsy structures or reckless traffic arrangements without it being clearly understood on whom the responsibility rested in case of failure.

CAMPS IN THE CARIBBEES

Camps in the Caribbees. The Adventures of a Naturalist in the Lesser Antilles. By F. A. Ober. (Boston, U.S.: Lee and Shepherd; Edinburgh: Douglas, 1880.)

THE author of this lively and very entertaining book of travel undertook in 1876 the exploration of the Caribbees or Lesser Antilles, which islands extend over eight degrees of latitude between Porto Rico and Trinidad, connecting the Greater Antilles with the continent of South America. The islands had been hitherto little visited by naturalists, and the author made his expedition under the auspices of the Smithsonian Institution, with the especial object of collecting the birds of the group.

Around the borders of each island there is a cleared belt of fertile land, and on the coast often large villages and towns, whilst the interior is one vast forest covering wild hills and mountains. It was in the forests that the author's work lay. He took his camera into the mountains with him and photographed everything of interest which he met with, and the book is illustrated by numerous wood engravings of remarkably fine quality taken from the photographs and his sketches. About half the book, which is an octavo of 350 pages, describes adventures in the island of Dominica. Barbuda and Antigua were visited, but are not referred to at length. The account of the islands of St. Vincent, Grenada, Guadeloupe, and Martinique compose the remainder of the work, together with a catalogue of the birds of the group and descriptions of the sixteen new species of birds discovered.

Dominica was so named by Columbus, who happened to hit off the Lesser Antilles on his second voyage, because he sighted the island on a Sunday, November 3rd, 1493. The island is most beautiful. The hills are broken and ragged, seamed, furrowed, and scarred, yet covered with a luxuriant vegetation of every shade of green—purple of mango and cacao, golden of cane and lime—whilst the ridges are crowned with palms, and behind Roseau, the capital, rises Lake Mountain, four thousand feet in height, five miles distant from the town, yet seeming to overshadow it.

Mr. Ober started forthwith for the mountains, and settled himself in a cabin in the midst of the forest amongst the mountaineer population, which is of mixed race, partly negro, partly, Carib, partly European. Here the mountaineers' children waited on him, and brought him beetles and snails and humming-birds, which they caught with birdlime. But he had to dispense with their services, for they brought him far too many things of one kind, and especially huge land-crabs as big as a man's hand. He had incautiously remarked that he should like a specimen of this crab, which abounds in the ravines and rivulet banks. "Each boy and girl in the place resolved to be the first to furnish me with the coveted crab. The consequence was that my place was soon overrun with shell-fish—ugly red and yellow crabs, as large as a man's hand, and from that to the most diminutive. One of the girls in a mischievous mood brought in a crab with a family of little ones, over a hundred, just large enough to be seen, and let them loose on the floor. Through some open window, while I was absent, some giant crab would be dropped on the floor to await my arrival. This was not done in a spirit of mischief, but from an earnest desire to aid me in my labours. For a week I could not stir without coming in contact with a shelly creature. I could not put my foot out of bed without a shudder of apprehension. Of nights I would be awakened by the rattling of ale-bottles, and arising, would discover that some crab had got thirsty in the night and had inserted a claw, which had caught in the neck of a bottle." In the afternoon the author sat looking out through the loophole of this cabin, which served as a window, and surveyed the peaceful Caribbean Sea, with the same vessels to be seen sometimes becalmed under the lee of the Caribbee Islands day after day. The sea is, however, not always placid; in the "hurricane season" it rises in its wrath. It is disturbed, however, only by a hurricane; nothing less. In the mornings and evenings he explored the beautiful forests and stream-beds around his camp, gun on shoulder, and collected all he could find. Sometimes on these excursions he had merry companions, laughing girls combining Carib, French, and negro blood in their veins, and full of life and fun. Let us follow him with Marie and her friend in search of crayfish (we presume a species of Palæmon, the author unfortunately does not state). "The path is slippery, and we shall need a help from 'Marie's' hand, for the way leads up hill and over rocks wet and smooth, whilst wet leaves flap in our faces and creeping ferns and trailing plants hang on our feet as we go.

"We reach the river, the stream that flows out of the mountain lake, broad and with gravelly beach, with immense boulders as islands, and a wall of vegetation on either side that rises straight up a hundred feet. Here the two girls made into the stream in search of crayfish. The stream is broad with deep pools, and in these the crayfish lurked, looking like miniature lobsters in the clear water. We can see only the small ones, but Marie assures us that there are large ones out of sight beneath the cascades.

"Erect upon a rock she stood for a moment, then plunged head foremost into a foaming pool, disappearing from sight. A moment later rising bubbles preceded a round little head, from which hung long limp tresses; a pair of shoulders brown and bare, and round arms and little hands reaching out for a support. She had a crayfish in each hand, and another with wriggling legs in her mouth."

The following is an account of the method in which humming-birds are caught:—"Let us follow little Dan, the oldest and sharpest of the humming-bird hunters, as he goes out for birds. First he goes to a tree called the mountain-palm, which replaces the cocoa-palm in the mountains, the latter growing only along the coast. Beneath the tree are some fallen leaves fifteen feet in length; these he seizes and strips, leaving the midrib bare, a long slender stem tapering to a point. Upon this tip he places a lump of bird-lime, to make which he had collected the inspissated juice of the bread fruit and chewed it to the consistency of soft wax. Scattered over the Savanna are many clumps of flowering bushes, over whose crimson and snowy blossoms humming-birds are dashing, inserting their beaks in the honeyed corollas, after active forays resting upon some bare twig, pruning and preening their feathers. Cautiously creeping toward a bush upon which one of these little beauties is resting, the hunter extends the palm-rib with its treacherous coating of gum. The bird eyes it curiously but fearlessly as it approaches his resting-place, even pecking at it; but the next moment he is dangling helplessly, beating the air with buzzing wings in vain efforts to escape the clutches of that treacherous gum."

Mr. Ober tried hard to keep humming-birds alive, but, as usual, without success. They never survived many days. If exposed to the light they kept up a constant fluttering, until the muscles of their wings became so stiff they could not close them, but expired with the wings widely outstretched. "Every morning I would introduce into the cage a bough of fragrant lime-blossoms, at which they would all dash instantly, diving into the flowers with great eagerness. Sugar dissolved in water and diluted honey was their favourite food, and they would sip it greedily. Holding them by their feet I would place their beaks in a bottle of syrup, when they would rapidly eject their tongues and withdraw them, repeating this operation until satisfied. They never displayed fear, but would readily alight on my finger and glance fearlessly up at me, watching an opportunity, however, for escape."

The boiling lake of Dominica was visited and photographed by the author. It was remarkably quiet during his visit, showing only a slight movement in the centre. The margin showed traces of the recent subsidence of the water-level, and on the following day the water had risen again somewhat, and was more active. It appears that the ebullition must be intermittent, but Mr. Ober did not see it in full action, though the water rose further, and the disturbance and noises continued to increase. The temperature of the water was only 96° F., though Dr. Nicholls, one of the party who discovered the lake, found it at 196° F., and Mr. Prestoe, of the Botanic Gardens of Trinidad, from 180° to 190°. The author follows Mr. Prestoe in the expectation that by the widening and deepening of the outlet the lake will disappear in time, and a geyser alone remain. In a boiling spring hard by the author and his guides cooked their supper of wild yams and eggs, and, as usual, cold water for drinking was found also close at hand.

An interesting account of the Caribs of Dominica follows. They have allotted to them a reservation extending from Mahoe River to Crayfish River, a distance of about three miles along the Atlantic coast and away back into the mountains as far as they please to cultivate. Though each family has a little garden near the house, all the "provision grounds," where staple articles of food are grown—yams, sweet potatoes, cassava, bananas, and taro—are at a distance from the houses, some even two miles away—solitary openings made in the depths of the high woods. The Caribs are especially interesting as being the earliest American savages met with by Columbus, the original "cannibals," and the race to which Caliban and Man Friday belonged. They seem somewhat addicted to drinking now, for the author describes the old King George the Third as seen tottering towards the plantation with a sovereign he had earned in his hand to spend it in rum. A lot of drunken Caribs tried to break into the author's house one night for amusement, and not being able to do that, poked a lot of fireflies in at the cracks to light up the inside, and see for certain whether he was at home—a very neat way of lighting up an interior. The general account of the Caribs is well worth reading.

We cannot follow the author in his exciting hunt after the souffrière bird, which lives only about the crater of the island of St. Vincent. The wary bird when at last procured proved to be of a new species, *Myadestes sibilans*. In Antigua he was victimised by the well-known "jigger." "I awoke one morning with an itching of my toes, which frequent rubbing failed to allay, and examination revealed four white tumours. They were as large as peas, and in the centre of each was a little black speck. I called my boy William, who at once pronounced them jiggers." The first old negress passing was called in, and turned them out of their nests with an adroitness which showed long practice. "A few hours are sufficient to give the jigger a hiding-place, and as the sensation he causes is a rather pleasant itching only for a time, he is sometimes not discovered till a painful sore is formed."

At Dominica the author met with Dr. Miroy, a friend and correspondent of Sir Joseph Hooker, and who is endeavouring, through the aid of the Kew establishment, to re-introduce the cultivation of coffee into the island. He is cultivating Liberian coffee, in the hope that it will prove able to withstand the attacks of blight which ruined the former crops forty years ago.

In Grenada the author hunted the monkeys which abound there as at St. Kitts, having been of course introduced, and having run wild, as explained in a series of letters in NATURE some months ago. He could not, however, make up his mind to shoot one when it came to the point. The monkeys are a great pest, and do great damage to the cultivator, just as in St. Iago, Cape Verde Islands, on the other side of the Atlantic, where also they were doubtless introduced, though it is not as yet known what the species is.

The book ends with an account of an ascent of the Guadeloupe Souffrière. It is throughout entertaining and highly amusing, but the author is evidently not very deeply versed in natural history, and there is often to be noted a lack of precise information, as in the case, for example, of the crayfish, cited above. The account of the land-crabs is somewhat conflicting. At one place we read of a mother-crab, with 100 tiny young, found far up in the mountains, at another, where the author falls in with an army of land-crabs on their combined march to the sea; he tells us that they bury their eggs under the sand, where they are hatched, and soon after millions of the new-born crabs are seen quitting the shore and slowly travelling up the mountains.

The story which he tells of the habits of the huge Hercules beetle, *Dynastes hercules*, can hardly be accepted as it is by the author on the authority of his dusky guide. It is that the male beetle seizes a small branch of a tree between its enormously long nippers and buzzes round and round the branch till this is cut off, producing a knife-grinding sound, supposed by the author to be a sexual call. He heard a knife-grinding noise indeed, but he did not see the rotating beetle. We recommend the book to all our readers.

A NEW ENGLISH TEXT-BOOK OF BOTANY

An Elementary Text-book of Botany. Translated from the German of Prof. K. Prantl. Revised by S. H. Vines, M.A., D.Sc., F.L.S. (London: Sonnenschein and Allen, 1880.)

THIS text-book, we are informed in the English preface, "was written by Prof. Prantl, to meet a growing demand for a work on botany, which, while less voluminous than the well-known work of Sachs, should resemble it in its mode of treatment of the subject, and serve as an introduction to it." While we already have in English many text-books for students, one indeed almost professedly taking the same line as this, every teacher must have felt how inadequately they supply the needs of the class for which they have been written. Most are new editions of books written first twenty years ago or more, and suffer from the impossibility of introducing those new facts which have so deeply modified our present standpoint, without damaging the symmetry and unity of a well-written work; and others, of more recent origin, are badly compiled or over-concentrated. The book before us, avoiding these faults, will unquestionably take a high place at once; for though using Sachs as his storehouse, the author has digested the strong meat of the big book, and here provides his readers with the milk suited to their years. Moreover, the book is singularly well-balanced in all its parts, and clearly-written throughout. The translation is so flowing that no reader uninformed of the fact would guess that German was the original dress; and Mr. Vines has added to the value of the work by appending a table, in which the classification there adopted is compared with that of Bentham and Hooker.

A reference to those knotty points to which one always looks at once as tests of successful treatment has proved so satisfactory that it is with regret that we turn to the ungracious task of pointing out the deficiencies that will somehow creep into the most carefully-written books. In several points Prantl has followed Sachs too closely, so that the accounts of cell-division, of the morphology of the pollen-grain and ovule, of the growing-point of Phanerogams, are all far behind our present knowledge. Again, in the treatment of "Modes of Branching," Sachs has been followed rather than Hofmeister, who, despite his complex sentences, gives a much clearer exposition.

Thus Sachs is copied even to including the cyme in *monopodial* systems. Surely this is a contradiction in terms, and might be avoided by the use of "lateral," in contradistinction to "dichotomous." In the figures (17, 19) of uniparous cymes, Sachs, and with him Prantl, omit to mention that the diagram is taken in *plan*, a point the more important that in French and English text-books it has been usual to give such diagrams of inflorescence in *elevation*. Without noticing this, a trap is laid through which not students alone have fallen into the error of thinking that the Germans use "scorpioid" and "helicoid" in senses inverse to the usage of other botanists. Under inflorescence no mention is made of the very useful French "Cymobotrya" terminology, possibly through feelings of patriotism, with which, however, Englishmen are not concerned. The Elder is given as the example of a corymb; which term is, however, restricted by the best botanists to the corymbose *raceme*, of which the elder is not an example.

In the histology there are several not unimportant errors, probably Prantl's own. He says that the phloem contains both "phloem parenchyma" and "cambiform tissue"—is not phloem parenchyma always (primitively at least) cambiform? We are told (p. 51) that the vessels of secondary wood are "*invariably* provided with *bordered* pits;" this is far too absolute. Under collenchyma no mention is made of its commoner form, distinguished as "concave" by Vesque. Endoderm is defined as peculiar to Dicotyledons! Under "stomata" no mention is made of water-pores. The account of the structure of roots and the development of their secondary wood in Dicotyledons is hardly explicit enough, and almost demands the introduction of one or two pure diagrams; and when it is stated that rootlets arise in front of the xylem bundles of the root, mention should be made of such important exceptions as Umbellifers and Grasses.

The physiology proper is singularly well treated, though perhaps with too great a fear of detail. Thus no sufficient account is given of the *vis a fronte* and the *vis a tergo*, which lead to the movements of the rising sap.

A few little mistakes have been left uncorrected in the systematic part. The legume is stated on p. 197 to occur in "all the Leguminosæ;" and while this is modified in the account of the order on pp. 278-280, a true legume is here implicitly denied to the Cæsalpinieæ! "Replum" is given as meaning a false-dissepiment of the Crucifers, a use unauthorised by the best systematists, and inconsistent alike with its application to the lomentaceous Leguminosæ and to its Latin signification.

The figures are good, but, as usual in English editions of foreign works, poorly printed. The worse fault of separating them widely from the text they illustrate has been avoided.

Finally, despite all trouble taken by the editor, oversights will occur in a translation. Thus *Tüllen* is given in italics without its English (?) equivalent, "tyloses," and "bracteole" is given instead of the more familiar "bractlet." But these blemishes show how good is the book in which they are the worst to be found; they have been here put forward chiefly in the hope of helping the editor in the new edition which will soon be demanded; and it is with a safe conscience that we would recommend this book as the best of its kind in the English language.

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.*]

Ocean Circulation

THE notice in NATURE (vol. xxii. p. 207) of the experimental researches of Professors Haughton and E. Reynolds on the coefficient of friction of water upon water, having concluded with the statement that "the authors of this research point out that these results tend to negative the theory of Dr. Carpenter that the phenomena of ocean-circulation are due to the greater height of the water at the equator as compared with that at the poles," I must be allowed to protest against being credited (or rather *dis*credited) with a doctrine which is neither expressed nor implied in anything I have written on the subject.

The doctrine which I *have* advocated is no other than that first distinctly promulgated by Lenz in 1847, and now accepted by numerous Physicists of the highest eminence, both British and Continental; viz., that besides the *horizontal* circulation produced by the action of winds on the ocean-surface, there is a *vertical* circulation of which Polar cold is the *primum mobile*, consisting of an *under*flow of Polar water (chiefly from the Antarctic area) towards and even beyond the Equatorial zone, and a complementary *upper*-flow of Equatorial water towards the Poles.

That every part of the vast Oceanic basin in free communication with either of the Polar areas is occupied, to within the range of the surface-heating produced by insolation,[1] by water which has been cooled down in one of those areas, is now one of the best-established facts of Terrestrial Physics. And those who cannot find in the excess of specific gravity imparted to sea-water by Polar cold, an adequate cause for this movement of translation, are bound to account for it in some other way.

I venture to submit to the accomplished professors of Trinity College, that laboratory experiments made to determine the friction of water upon water *at sensible velocities* can scarcely prove that when the equilibrium of a great mass of water has been disturbed, there will *not* be *any* movement of translation (however slow) for its recovery. And I would suggest to them that they should rather investigate the conditions of one of those "experiments ready prepared for us by Nature," which is constantly going on in the Baltic Straits, and of which the results have been for many years past most carefully recorded by Dr. Meyer of Kiel and his associates. Four factors are there in continually varying action, viz. (1) difference of *level* between Baltic and North Sea water; (2) difference of *salinity*; (3) difference of *temperature*, mainly due to an importation of Polar water into the Skager-rack; and (4) *surface-movement* produced by wind, which may also modify the relative levels.

I am assured by Dr. Meyer that the action of each of these factors has now been so fully determined, that the effect of any combination of them can be predicted as certainly as ordinary tidal phenomena. And of the competence of small differences in specific gravity to produce movement in great bodies of water, no one who has investigated the question on the great scale seems to have the smallest doubt. This was the unhesitating conviction of the late Mr. Froude, as the result of his numerous observations on harbours, lochs, and fiords, communicating with the sea at their mouths: for he assured me that wherever the salinity of the water at their upper end is lowered by the descent of fresh water from the land, producing a slight

[1] The researches of Prof. Forel and his associates on the Swiss lakes clearly show that in *fresh* water the heating effect of insolation is limited to about 100 feet. In *salt* water, on the other hand—as I pointed out in my Mediterranean Report—there is a *downward convection* of heat produced by the sinking of the water made heavier at the surface by saline concentration. In the Mediterranean, where this effect is limited to a part of the year, it scarcely shows itself below 100 fathoms (600 feet); but under the Equator, where it is constant, the surface-heated stratum ranges downwards to from 300 to 400 fathoms. Beneath this depth the thermometer progressively sinks in the ocean-basin generally (the thermal condition of the North Atlantic being altogether exceptional) from 40° to 33° or thereabouts; whilst in the Mediterranean, to the deeper part of whose basin the Polar underflow has no access, the thermometer shows a uniform temperature of from 54° to 56° (according to the locality) from the surface-heated stratum to the deepest bottom (2,000 fathoms).

surface outflow, he could trace an underflow of sea-water up the channel; and this he could attribute to nothing else than the slight excess of *downward* and therefore *lateral* pressure in the *outside* column, depending on the continually-maintained reduction in the mean salinity of the *inside* column, which more than compensated for any slight excess in its level.

WILLIAM B. CARPENTER

56, Regent's Park Road, London, N.W.

The Freshwater Medusa

IN NATURE (vol. xxii. p. 190) Prof. Lankester refers to a statement of mine in the preceding number, that I had arranged with Mr. Sowerby some methods of observation from which I hoped to obtain data for the determination of important points regarding the development of the freshwater Medusa, and expresses a desire to be informed as to the nature of the proposed methods.

The obvious and only practicable course to be adopted with this view was arranged with Mr. Sowerby by Mr. Busk and myself, and consisted in the separation of specimens from the Victoria tank and their confinement in glass jars, which, in order to secure a continuance of the necessary temperature conditions, were to be retained in the same house with the tank in which the Medusa had shown itself. The examination from time to time of these jars would probably bring to light facts having a direct bearing on the development of the animal. This method of observation, indeed, is so obvious that it must have occurred to any one engaged in the investigation it was designed to aid.

Prof. Lankester now says that Mr. Sowerby informs him that he had undertaken no experiments except such as had been carried out at his request; but as it seems that these are identical with those proposed by Mr. Busk and myself, nothing has been thereby lost.

Residing at a distance from London, my opportunities of studying the life-history of the Medusa are at this moment comparatively few. Prof. Lankester, however, being on the spot, and having an unlimited supply of subjects for investigation, will doubtless avail himself of the advantage thus afforded, and will render our knowledge of this remarkable little animal more complete than would otherwise have been possible.

Prof. Lankester refers to the difference of opinion between himself and me, and promises to bring proofs of his own views. When these proofs are offered I shall gladly accept them. My desire is that no previous expression of opinion shall blind me to evidence in favour of a contrary position. The only important points, however, on which my conclusions have been absolutely at variance with those of Prof. Lankester are the presence of a circular canal and the perviousness of the distal extremities of the radial canals. With regard to these there cannot in my opinion be the slightest doubt.

The nature of the marginal bodies is also a point of much importance in this investigation, but I have expressed only a conditional opinion with regard to it. While Prof. Lankester considered these bodies as undoubtedly tentacular, I held that the evidence afforded by adult and by comparatively young specimens is in favour of their velar origin; but at the same time I stated that this point cannot be decided without the evidence obtained from development.

I also drew attention to the remarkable attachment of the tentacles, whose adnate basal portion occupies exactly the position of the *peronia* in the Narcomedusæ and Trachomedusæ, but I failed to find evidence of the presence of true peronia as described by Prof. Lankester, who now admits that the peronia while present are rudimental.

The other points, namely those which concern the systematic position of the Medusa, are necessarily only hypothetical. It appeared to me that while there are certain features in the structure of the adult Medusa which point towards the Trachomedusæ, there are others which connect it with the Leptomedusæ, to which on the whole it seemed to be more closely allied, though holding a position intermediate between the two; but I regarded the data in our possession as insufficient for the final determination of this point, which can be absolutely settled by the study of development alone.

Prof. Lankester promises details of his observations in this month's number of the *Quarterly Journal of Microscopic Science*, and I look forward to what I doubt not will be a valuable contribution to hydroid zoology.

As to the name of the Medusa, Prof. Lankester, while abandoning his generic name in favour of mine, declares it to be his intention to retain his own specific name for the animal. This is to me a matter of complete indifference. Science can gain nothing from personal contention about names, and the time so occupied might with far greater advantage be devoted to more useful and lasting work.

J. ALLMAN

On the Simplest Continuous Manifold of Two Dimensions and of Finite Extent

SO far as I am concerned Mr. Frankland answers too soon (p. 170), for I am sorry to say I have not read Klein in the meantime. Therefore my reply is provisional. A hint was given of Mr. Frankland's explanation by Mr. Newcomb in a phrase quoted by Mr. Halsted (*American Journ. of Math.*, I. iii. 275, paper on the bibliography of hyperspace, &c.): "The first elements of complex functions imply that a line can change direction without passing through infinity or zero." We do not require even the first elements of complex functions to tell us that we can get to the other side of a point without passing through it, provided we can go round it. But the question was not whether "a line" simply could be thus reversed, but whether it could be so with the geodetic perpendicular in question described in a uniform continuous manifold of two dimensions. Mr. Frankland's explanation expressly takes account of a third dimension. It supposes the moving line to generate a sort of skew helicoid about the fixed line to which it is perpendicular. But how can even initial portions of successive generators be in the same plane, Euclidean or other? This point may seem incidental, but I think it is essential, so I omit further questions.

Somewhere in his "Dynamic" Clifford says that Klein's double surface is a sphere in which opposite points are considered as one. In this light the mystery disappears. There are two perpendiculars: considered as one they never change sign; because, considered as two, they periodically exchange signs. But if opposite points do not coincide, they may be "one," but they are not one point; if they do, is the manifold they compose a surface? Mr. Frankland has not called it a surface: but is it continuous?

There is a very well-known manifold which obviously obeys the laws worked out by Mr. Frankland and Mr. Newcomb, a system of straight lines, not vectors, through a common point; or, reciprocally, a system of planes. To measure of curvature answers density; if this is constant, the geodetic distance from a point to a geodetic line is represented by the angle between a straight line and a plane.

It may be worth while to note one or two oversights in the writing or printing of Mr. Frankland's letter. For $\frac{1}{2}l\sqrt{-1}$ we ought to have an expression involving the angle between the geodetics. The sentence "If a being," &c., is a quotation, and the last word should be "position," not "poise."

Both Mr. Newcomb and Mr. Frankland understand my intention as more negative than it was. I said (xv. 547) "it could hardly fail to be instructive if Mr. Frankland would explain," &c. Probably I underrated the difficulty, in this Euclidean world, of making it clear that one means just what one says.

C. J. MONRO

Hadley, June 29

A Fourth State of Matter

IT seems to me that Mr. Tolver Preston in his letter on the above to NATURE (vol. xxii. p. 192) has somewhat overlooked the context in the objections he urges against Mr. Crookes's remark that "an isolated molecule is an inconceivable entity." It is plain that Mr. Crookes meant this statement to apply to the *quality*, not the *existence* of a molecule, and granting Mr. Crookes's premisses regarding the constitution of matter, it appears a very fair deduction; since if the three states of matter (as we know it), viz., solid, liquid, and gas, owe their different *qualities* merely to different modes of motion of the ultimate molecules, it is quite conceivable as well as logical to suppose that the latter have a nature totally unlike that of the effects of their motion, and therefore inconceivable to us by reason of its dissimilarity to anything of which we at present possess any knowledge.

Again, with reference to the remark, "solid it cannot be," which Mr. Preston calls in question, it would be manifestly illogical on his premisses for Mr. Crookes to regard the isolated molecule as a solid, even though, according to Mr. Preston, it may possibly possess certain properties in common with what we call solids, for solidity, according to Mr. Crookes, being "merely the effect on our senses of the motion of the discrete molecules among themselves," it would be exceedingly arbitrary to ascribe to the molecules themselves a quality which, as we *commonly* know it, is simply an *effect* of their motion. We might just as well identify a *gas* with *pressure*.

July 3 E. DOUGLAS ARCHIBALD

Minerva Ornaments

I NOTICE that a correspondent writing from America expresses his scepticism as to the figural character of certain stone objects in Dr. Schliemann's collection at South Kensington. Judging from the analogy of similar objects found in America, he pronounces them to be "net-sinkers" and not idols. Whatever, however, may be the nature of the American objects, I think there can be but little doubt that Dr. Schliemann is right in considering the objects discovered by him at Hissarlik to be rude representations of a deity. At first sight they certainly have but little resemblance to anything of the sort, but a careful examination shows that several are marked with the rude delineation of a human face—or, as Dr. Schliemann believes, of an owl's face—as well as of a triple necklace, and sometimes also the characteristics of a woman. Occasionally the hair is represented on the back of the head by straight lines. The delineation is sometimes incised, sometimes painted, though the paint is mostly worn off. As the marked objects are of the same shape as the unmarked ones, we can have no hesitation in inferring that both were intended for the same purpose. A. H. SAYCE

July 4

Arthur Young's Travels in France

A FEW months ago my friend Mr. F. F. Tuckett, of Bristol, drew my attention to a passage in Arthur Young's Travels in France, published in 1792, narrating a visit to Lavoisier and to a certain M. Lomond, the inventor of an electric telegraph, which in some points anticipated that of Ronalds. The mention of Lomond's name in a historical list of telegraphic inventors recently published by your contemporary, the *Scientific American*, induces me to send you the inclosed extract as likely to be of interest to the readers of NATURE. S. P. THOMPSON

Univ. Coll., Bristol, June 18

"The 16th.—To M. Lavoisier by appointment. Madame Lavoisier, a lively, sensible, scientific lady, had prepared a *déjeuné Anglois* of tea and coffee, but her conversation on Mr. Kirwan's Essay on Phlogiston, which she is translating from the English, and on other subjects which a woman of understanding, that works with her husband in his laboratory, knows how to adorn, was the best repast. That apartment, the operations of which have been rendered so interesting to the philosophical world, I had pleasure in viewing. In the apparatus for aërial experiments nothing makes so great a figure as the machine for burning inflammable and vital air, to make or deposit water; it is a splendid machine.

"Three vessels are held in suspension with indexes for marking the immediate variations of their weights; two, that are as large as half-hogsheads, contain the one inflammable, the other the vital air, and a tube of communication passes to the third, where the two airs unite and burn; by contrivances, too complex to describe without plates, the loss of weight of the two airs, as indicated by their respective balances, equal at every moment to the gain in the third vessel from the formation or deposition of water, it not being yet ascertained whether the water be actually made or deposited. If accurate (of which I must confess I have little conception) it is a noble machine. Mons. Lavoisier, when the structure of it was commenced, said, 'Mais oui, monsieur, et même par un artiste François!' with an accent of voice that admitted their general inferiority to ours. It is well known that we have a considerable exportation of mathematical and other curious instruments to every part of Europe, and to France among the rest. Nor is this new, for the apparatus with which the French Academicians measured a degree in the polar circle was made by Mr. George Graham. Another engine Mons. Lavoisier showed us was an electrical apparatus inclosed in a balloon, for trying electrical experiments in any sort of air. His pond of quicksilver is considerable, containing 250 lbs., and his water apparatus is great, but his furnace did not seem so well calculated for the higher degrees of heat as some others I have seen. I was glad to find this gentleman splendidly lodged and with every appearance of a man of considerable fortune. This ever gives one pleasure: the employments of a state can never be in better hands than of men who thus apply the superfluity of their wealth. From the use that is generally made of money, one would think it the assistance of all others of the least consequence in affecting any business truly useful to mankind, many of the great discoveries that have enlarged the horizon of science having been in this respect the result of means seemingly inadequate to the end: the energetic exertions of ardent minds, bursting from obscurity, and breaking the bonds inflicted by poverty, perhaps by distress.

"To the 'Hotel des Invalids,' the major of which establishment had the goodness to show the whole of it. In the evening to Mons. Lomond, a very ingenious and inventive mechanic, who has made an improvement of the jenny for spinning cotton. Common machines are said to make too hard a thread for certain fabrics, but this forms it loose and spongy.

"In electricity he has made a remarkable discovery: you write two or three words on a paper, he takes it into a room and turns a machine inclosed in a cylindrical case, at the top of which is an electrometer, a fine small pith ball; a wire connects with a similar cylinder and electrometer in a distant apartment; and his wife, by remarking the corresponding motions of the ball, writes down the words they indicate: from which it appears he has found an alphabet of motions. As the length of the wire makes no difference in the effect, a correspondence might be carried on at a distance—within and without a besieged town, for instance, or for a purpose much more worthy, and a thousand times more harmless, between two lovers prohibited or prevented from any better connection.

"Whatever the use may be, the invention is beautiful. Mons. Lomond has many other curious machines, all the entire work of his own hands. Mechanical invention seems to be in him a natural propensity." ("Travels during the Years 1787, 1788, and 1789," by Arthur Young, Esq., F.R.S. Vol. i. p. 64.)

"Saxifraga umbrosa" adorned with Brilliant Colours by the Selection of Syrphidæ

AMONG Diptera the most assiduous visitors of flowers are certain Syrphidæ, which, elegantly coloured themselves, are fond of splendid flower-colours, and, before eating pollen or sucking nectar, like to stop a while, hovering free in the air, in front of their favourites, apparently fascinated, or at least delighted, by the brilliancy of their colours. Thus I repeatedly observed *Syrphus balteatus* hovering before the flowers of *Verbascum nigrum*, often *Melanostoma mellina*, and *Ascia podagrica* before *Veronica chamædrys*; in the Alps the lank *Sphegina clunipes* before *Saxifraga rotundifolia*, and in my garden *Ascia podagrica* before *Saxifraga umbrosa*.

Of *Verbascum nigrum* the main fertilisers are humble-bees, Diptera co-operating only in a subordinate degree; in the case of the three other species, on the contrary, the above-named Syrphidæ are such frequent visitors and cross-fertilisers that we may safely conclude that it is by their selection of elegantly-coloured varieties that these flowers have acquired their beautiful peculiarity. Hence, in order to estimate the colour-sense of these Syrphidæ, it is worth while to consider what colour-combinations they have been able to produce by their selection.

Saxifraga umbrosa being, as far as hitherto known, their finest masterpiece, we may in the first place look at the variegated decoration of this species. Its snow-white petals are adorned with coloured spots, which in size and intensity of light gradually decrease from the base of the petals towards their extremity. Indeed, nearest to their base, within the first third of their length, there is a large irregular spot of an intense yellow; about the middle of their length there follows a narrower cross band of red colour, vermilion towards the base, intensely pink towards the outside, not reaching the margins of the petals, sometimes dissolved into several separate spots; lastly, beyond the middle of the length of the petals there are three to eight smaller roundish spots of a paler violet-pink colour.

The flowers of *Veronica chamædrys* prove that also gay blue colours are perceived and selected by Ascia.

Lippstadt, Germany HERMANN MÜLLER

Dilatation of the Iris

In addition to the method of observation mentioned by Mr. Ackroyd in his photometric proposal (Nature, vol. xxi. p. 627) I may mention that the variations of the diameter of the pupil are very beautifully observed by a pair of punctures in a screen over the eye. In fact long ago I used this as a means of observing the absolute diameter of the pupil, subject to a small unexamined constant error.

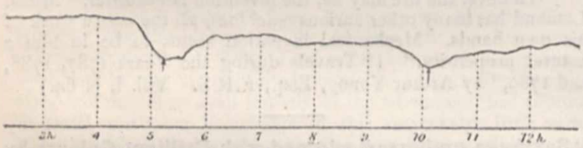
By pricking a row of holes in a card at distances of ·06, ·07, ·08 . . . . ·25 inch, and placing this close over the eye, the diameter is observed by sliding the card until two of the holes are found at such a distance that their edges appear to touch. The opening of the other eye, or the slightest disturbance of light, produces an apparent alteration in the sizes of the disks of light, so that their edges recede or overlap; and a fresh pair of holes may be found showing the altered diameter of the pupil.

Thus (1) the extreme diameters of the pupil were found to be ·07 (? ·06) and ·25 inch; (2) the diameter is rapidly variable at will, *without any alteration of stimulus*, even as much as from ·13 to ·19 inch; (3) the sympathetic motion takes ·4 or ·5 second to be produced when the other eye is exposed to light. Many similar interesting questions may be examined by this simple instrument; for which purpose I inclose a sample card for editorial trial. W. M. F. P.

Comparative Curves in Terrestrial Magnetism

Monsieur,—En séquence à la intéressante communication de Rev. S. J. Perry de l'Observatoire de Stonyhurst, je vous prie d'additioner les suivants renseignements sur la même perturbation magnétique de 17 mars passé, d'après la courbe du déclinographe de l'Observatoire du Infant D. Luiz, à Lisbonne.

La différence entre le maximum et le premier minimum à 5h. 49,5m. G.M.T. est de 13′,9 (un tiers du mouvement à Stonyhurst), et entre le même maximum et le 2e minimum à



Declinographe 17 Mars, 1880 (Lisbonne M.T.).

10h. 45m. G.M.T. est un peu plus grande 16′,2, le contraire qu'on voit à Vienne et Stonyhurst.

Il est digne aussi de remarque que le temps du 1er minimum ne s'accorde avec le temps à Stonyhurst et Vienne, pendant que le temps du second est de parfait accord.

La longitude de cet Observatoire est + 36m. 35s. G. Je vous envoie la copie de la courbe.

Agréez, Monsieur, l'assurance de ma haute considération.

Lisbonne, 21 juin 1880 J. Capello

Effects of Lightning on Trees

Your note in Nature, vol. xxii. p. 204, on the recent thunderstorm at Geneva induces me to send you a note on a tree struck by lightning in Stoneleigh Park during a severe storm on last Thursday week (June 24). The tree was a fine oak about forty feet high, and the lightning seemed to have struck not among the smaller branches at the top, but about two-thirds of the way up the main trunk, just where several of the larger branches came off from the stem. From this point to the ground the bark had been rent off along a strip about three inches wide, and through the whole length the wood beneath the bark had been gauged out as if by a carpenter's tool, the groove made being about an inch wide and deep. The curious fact of the tree being struck apparently among the branches at once suggested to me that the electricity must have travelled, without visible effect, through the upper branches, and only produced disruption of the wood when the current was strengthened by the combination of a great number of separate streams. I had forgotten that this was Prof. Colladon's theory of electric discharge, but am glad to be able to give it the support of this observation.

Rugby, July 3 L. Cumming

Iron and Hydrogen

In the description given a few weeks back of the experiments of Prof. Hughes, the fact was demonstrated that iron wire in contact with dilute acids becomes brittle, and at the same time takes up hydrogen.

There are one or two points of great interest that many, perhaps, besides myself, would like to know more about.

Thus, at the same time the iron becomes brittle, does it also become harder?

This leads one to speculate on the facts illustrated in the hardening and tempering processes of steel.

We know that such liquids as water, weak acid, oil, &c., which are used as baths in which the heated metal is quenched, are all decomposable by iron and other metals at a high temperature, the result being the liberation of hydrogen, &c. Now is it not probable that this liberation of hydrogen is really the essential element in the physical change produced in the hardened steel?—that is to say, that the steel absorbs, or perhaps becomes alloyed with the nascent hydrogen in contact with its surface, thus rendering it intensely hard?

Prof. Hughes has pointed out that a red heat entirely dissipates the hydrogen from the iron wire, which returns to its normal state.

This perhaps will explain the process of tempering by supposing that a certain proportion of the (hardness-rendering) hydrogen is driven off according to the temperature reached, as shown in the well-known shades of colour seen on the surface—that is to say, the hardness is proportionate to the contained hydrogen, such as that many other metals become very hard or soft by being alloyed as zinc and copper in brass, tin and copper in bronze, &c.

This is supported by the fact that one of the most successful processes of hardening depends on the use of a quenching-bath of dilute sulphuric acid. This would be explained by the greater ease with which acidulated water is decomposed by iron, and therefore a larger bulk of the nascent hydrogen liberated on its surface could be absorbed by the metal.

The carbon in steel probably only plays the part of a go-between in rendering the absorption of hydrogen more facile. There is a fact that also supports this, namely, if unhardened steel is dissolved in HCl the carbon is left in the form of graphite scales, whereas after hardening, if treated with the acid in the same manner, the residue is found to consist of a liquid hydrocarbon, thus showing the presence of hydrogen in the metal.

These points I should like to have been able to confirm or refute for myself; but not having the required time or apparatus, I leave it with the hope that some one possessing those advantages will settle these questions. H. J. Johnston-Lavis

Naples

"Coronella lævis"

In Nature, vol. xxii. p. 156, the presentation is announced of two specimens of *Coronella lævis* (British) to the Zoological Society. I have known so many persons doubt the existence of the *Coronella* in the New Forest that I should feel greatly obliged to any of your correspondents who would give me some information as to its history, whether it has been introduced, or is really indigenous. H. King

[Mr. Sclater tells us that he has no doubt that the smooth snake is indigenous to the British Islands, although it was overlooked for many years. The first living example received by the Zoological Society was in August, 1862, presented by Mr. Fenton, having been obtained in the neighbourhood of Sandhurst. Since then nearly twenty specimens have been received, chiefly from the New Forest and neighbourhood of Bournemouth. See Mr. Cooke's excellent little volume, "Our Reptiles" (London, 1865), for a full account of this species of snake. —Ed.]

Recall of Appearance of Books, &c.

I have only to-day been able to read the back numbers of Nature for the past two or three months, and hence have only now seen Mr. Ernst's letter in your issue of April 29 last.

His power of recalling the appearance of books I know is possessed by others. I have a very large and still increasing library, but there is hardly a volume, or indeed a tract, the appearance and condition of which does not at once present itself to my mind if occasion to use it should arise. Further, being engaged in the compilation of a work some years since, wherein many references to other books were necessary, I used, when away from home (as was frequently the case) to write and indicate not simply in what part of the library the book would be found, but in what portion of the volume, and almost always whether on the left or right hand page, any given passage required would be found.

Of late years I have found it desirable to rebind my tracts in something of a uniform manner. Their external individuality is thus destroyed, but the aspect of their title-pages and the location of particular passages of the contents remain as fresh as ever. CORNELIUS WALFORD

London, June 24

Stags' Horns

WITH further reference to the above question I have pleasure in inclosing a letter received to-day from the head keeper at Bradgate Park, near Leicester, where both red and fallow deer are kept.

I may add that I saw at the end of July last, near the head of Loch Eribol, in Sunderland, a quantity of stags' horns in a gipsy encampment, which I supposed had been collected for sale by that curious fraternity. HERBERT ELLIS

62, New Walk, Leicester

"*To* HERBERT ELLIS, ESQ.

"*Bradgate Park, 22nd June*, 1880

"DEAR SIR,—In answer to yours of the 19th inst. respecting what becomes of the stags' horns after being shed, I beg to say they are regularly collected and sold. But there is not the slightest doubt of their eating each other's horns. I have myself seen several cases where both brow antlers and the top points have been gnawed off. I have also seen Scotch heads that have been quite spoiled by the tines having been gnawed, which must have been done after the horn had become hard, and whilst the animal was living. I am, sir, yours respectfully,

"C. OVERTON"

Cup and Ring Stones

MANY of the markings mentioned by Mr. Middleton are hollows made by rain, or rather deepened by rain-water holding many low organisms in hollows, on the upper surfaces of exposed grit stones; overflow from these accounts for the groove or spout noticed at the margin of some of them. They are to be seen on the stones erected near Boroughbridge, and speak to the length of time these stones must have been raised into their present position. W. S.

June 21

Diatoms in the London-Clay

To enable me to determine the exact extent of the diatomaceous band in the London clay, I am anxious to obtain information of any wells in progress, or in contemplation, anywhere in the London Basins, *west* and *north* of London. With the help of some of your readers I have no doubt that I shall shortly be able to show that the one referred to is co-extensive with the London clay. The details I wish for are:—

1. Locality of well.
2. If begun, the depth attained.

I shall also be glad to hear of any railway cuttings now being made in the same area. W. H. SHRUBSOLE

WATER SUPPLY

AMONG the improvements in sanitary matters that this generation has witnessed not one ranks higher than the settled and still growing conviction of the importance of a pure water supply, and nowhere are the various aspects of the question more keenly debated and considered than in the Metropolis at the present time.

At a discussion at a recent meeting of the Chemical Society there seems to have been some doubt thrown on the conclusions arrived at by chemists in determining the wholesomeness of a water by no less an authority than Prof. Huxley, and it may be well to inquire how far his allegations are borne out by facts.

In the earlier days of the history of chemistry, as was to be expected, the processes adopted in the analysis of water were crude in the extreme, and the quaint ideas promulgated in the treatises then published are not a little amusing. Gradually, however, and especially during the last few years, the methods of analysis have improved, and although, judging by the wide diversities of opinion that exist as to what may or may not be pronounced a water sufficiently pure for drinking purposes, the subject cannot yet be said to have arrived at a stage completely satisfactory; still, so far as the purely chemical evidence is concerned, it would seem to be able to furnish results which are sufficiently exact for all practical purposes. The operations involved are among the simplest and easiest the chemist has to perform, and consequently it is not the data furnished by analysis that are called in question, but the conclusions drawn from them.

Persons interested in sanitary questions, but who have no special knowledge of the difficulties that beset the forming a correct judgment as to the wholesomeness of water, are apt to express themselves as scandalised, and it must be confessed with some show of reason, that it should be possible there should be so little agreement amongst those who are looked up to as authorities on such matters.

This disagreement, however, is more or less inevitable in the present state of our knowledge, and is largely due to the intricacy of some of the problems involved in the question, which is by no means a simple chemical one.

The debatable ground is the nature and estimation of organic matter and the amount of significance that should be attached to the presence of oxidised nitrogen compounds.

Organic matter may be of animal or vegetable origin, the former being dangerous and the latter much less so, if indeed it be not altogether innocuous. To distinguish between the two kinds is therefore all important; but unfortunately it is impossible directly to do this, as both animals and vegetables yield albuminoïd matters, which are, chemically speaking, practically identical in composition.

Of the various processes for the estimation of organic matter there are three that are in general use. One, the oldest, known as the permanganate process, finds its advocate in the present day in Dr. Tidy, and consists in measuring the organic matter by the quantity of oxygen required to oxidise it. Another, originated by Prof. Wanklyn, and which he calls the albuminoid-ammonia process, consists in decomposing the organic matter by an alkaline solution of potassium permanganate, and taking the resulting ammonia as the measure of the organic matter. The third process, the one employed in the laboratory of the Rivers Pollution Commissioners and advocated by Dr. Frankland, its originator, estimates the organic carbon and nitrogen separately.

A good deal may be said in favour of all these processes, as affording a rough estimation of the quantity of organic matter, but none of them can be relied upon as giving any indication of its nature, *i.e.*, as to whether it is dangerous or not; and yet it is the almost invariable custom to judge of a water by the quantity of organic matter it contains, no matter what its origin, and a variation of two or three times a given amount is held to make the difference between a good and bad water.

It was to this point that Prof. Huxley especially addressed himself in his remarks already referred to. He gave it as his opinion, speaking as a biologist, "that a water may be as pure as can be as regards chemical analysis, and yet, as regards the human body, be as deadly as prussic acid, and on the other hand may be chemically gross and yet do no harm to any one." "I am aware," said he, "that chemists may consider this as a terrible conclusion, but it is true, and if the public are guided by percentages alone they may often be led astray. The real value of a determination of the quantity of organic impurity in a water is, that by it a very shrewd notion can be obtained as to what has had access to that water."

However startling these statements may be to those who judge of the wholesomeness of a water by the amount of organic matter it may contain, we believe it to be none the less an accurate description of facts. It is within our knowledge that some of our most wholesome supplies sometimes contain an excess of organic matter, and that the waters which give rise to typhoid fever and other hardly less serious disorders are frequently just those which contain the least, the difference of course being that in the one case the organic matter is innocuous, in the other deadly.

Since, then, chemical analysis fails entirely to distinguish between these two kinds of matter, it may be thought to be a work of supererogation to have recourse to it at all. Not so, however, for what analysis fails to do directly it can to a large extent do indirectly. Organic matter in solution in water is more or less prone to oxidation, the highly putrescible matter of sewage being most so, and that derived from vegetation very much less so. Hence it follows that one would expect to find the oxidised nitrogen compounds in greater excess in the one case than in the other, and as a matter of fact that is just what we do find. Almost invariably, in all waters of acknowledged wholesomeness, the quantity of nitrates never exceeds a certain small amount, whereas in waters, such as polluted well and spring waters, that have given rise to illness, the oxidised nitrogen compounds, with other accompaniments of sewage, are to be found in excess. By means then of these oxidised nitrogen compounds we get collateral evidence throwing light on the nature and probable source of the contamination of which a mere percentage estimation of organic matter would fail to give the slightest indication.

The mistake has been hitherto that the discussion has been narrowed by looking at the question almost entirely from a chemist's point of view. It is, however, to the biologist that we must look chiefly for the future elucidation of the subject, and he has a field of the widest range, embracing much untrodden ground, for his investigations.

Putting on one side the specific poisons which through the medium of water are able each to generate, after its kind, diseases such as typhoid fever, it is highly probable, judging from what has already been proved to take place in analogous cases, that dangerous organic matter is not poisonous as such, but acts by affording the pabulum for organisms which are able to set up putrefactive changes in the blood of the person drinking polluted water. Even the conversion of organic matter into nitrates is not a mere chemical process of oxidation, since we now know that the oxidation only takes place by the help of a distinct ferment.

In the inquiry as to how far organic matter is destroyed in rivers, it is clearly insufficient to rely upon laboratory experiments in which diluted sewage is exposed only to the oxidising influence of air. This is entirely to ignore the agency of vegetation and of the vast army of organisms, identical with or allied to bacteria, which, being endowed with various functions of reorganisation, convert the carbon and nitrogen of organic matter into simpler inorganic compounds, these in turn to become the food of the more highly organised aquatic vegetation.

Whilst therefore duly recognising the practical help that chemistry can afford in the more limited scope that properly belongs to it, we trust, in the interest of sanitary science, that the enunciation of the views of so distinguished a biologist as Prof. Huxley may have their due weight with those to whom these questions are ordinarily referred, and will tend to promote a better understanding and more solid ground for agreement than has up to the present seemed possible.

CHARLES EKIN

THREE YEARS' EXPERIMENTING IN MENSURATIONAL SPECTROSCOPY[1]

BY A NEW HAND THEREAT

II.

The Whole Solar Spectrum.—Could an observer, who had once made close acquaintance with the glories of symmetry resident in great A of the solar spectrum, when seen in the brightness of a southern noon-day, under a dispersion of 33° and magnifying power of 10, ever remain content therewith?

Never! if a particle of soul belonged to him! for he would be imperiously constrained from that moment to feel that he must see the whole solar spectrum as it is given forth effulgently to the denizens of the south by a nearly zenith sun, before he died; or to what purpose would he have lived in a sun-illumined world?

Out, therefore, once more to Lisbon the experimenter and his Wife went in 1878, with the important assistance again of the Pacific Steam Navigation Company of Liverpool; but now, armed with a rather different apparatus. There was indeed the same heliostat and there were all the prisms belonging to the aurora spectroscope; but instead of each of them being looked through singly and successively, they were now used all together, set out in a curvilinear line several feet long on a large table, and looked through all at once; with telescope and collimator each 32 inches in focal length; with magnifying power of 20, and a further prismatic method supplanting the usual employment of coloured glasses to prevent false glare in the field of view; and then what a new world was opened up to behold and admire!

Lines multiplied on lines and in a perfection of finish and refinement, sometimes of infinite thinness, sometimes remarkable power; and the classic fields of those more refrangible portions of the spectrum where the great spectroscopists of the age, Kirchhoff and Secchi, Lockyer and Janssen, Huggins and Young, have chiefly gained their laurels, as expounders of the constitution of the sun, were surveyed with respect and all admiration; but first, foremost, and beyond everything else, were the glories of the illimitable depths of solar colour; colour, the best leading index that has ever been invented yet, to simplify and facilitate the description of all spectrum place.

After having got completely rid of those usual attendant impurities in solar spectroscoping, viz., chemically coloured glasses used as shades, the large dispersions now employed enhanced rather than dulled the solar colours; raised one's ideal of what colour in light can be, and gave, through near fifty gradations, a definite and ever-memorable colour-characterisation to as many portions of the whole spectrum.

In presence of *such* solar colours, it seemed to be a wilful ignoring of one's best and plainest faculties to speak of the spectrum colours as being only 3, or 5, or even 7. They might indeed be rather spoken of as next to infinite in number; or rather still, as being just so many as there are easily perceptible differences of spectral place; *but* for that law of locomotion of colour-bands within certain limits, already discovered by the experimenter in his absorption spectra, and found equally applicable to the solar spectrum. Confining therefore the number of colours to something which should give each of them a breadth, not likely to be overpassed by the locomotive effects + and − on their boundaries, the following table of fifteen spectral colours was prepared after much discussion and criticism of each individual member of it:—

[1] Continued from p. 195.

General Distinctions.	Particular Colours.	Wave-Number Spectral Place, normally.		Solar Lines within those Limits of Place.	Chemical Flame, and Electric Spark, Lines within the same Limits.
		Extends from	Reaches to		
Red end of Spectrum.	Ultra-Red.	25,000	30,000	X.	—
	Crimson-Red.	30,000	34,000	Y and A.	Rubidium *x* and Potassium *α*.
	RED.	34,000	37,000	Little *a* and great B.	Lithium *α*, nearly.
	Scarlet-Red.	37,000	39,000	Great C.	Scarlet Hydrogen Line.
	Light-Red.	39,000	40,000	*c'* and *α* Band.	Light-Red Oxygen.
Middle of Spectrum.	Orange.	40,000	42,000	*α* Band and Rain-Band.	Carbo-Hydrogen's Orange Band, and chief Oxygen Line.
	Yellow.	42,000	44,000	D.	Sodium *α*.
	CITRON.	44,000	47,000	Aurora's chief Line.	Carbo-Hydrogen's Citron Band of Lines.
	Green.	47,000	51,000	E and little *b*.	Thallium *α* and C.-h.'s Green-Giant Line.
	Glaucous.	51,000	55,000	Little *c* and F.	Glaucous Hydrogen.
Violet end of Spectrum.	Blue.	55,000	57,000	Little *d*.	Cæsium *α* and *β*.
	Indigo.	57,000	58,000	Little *e* and little *f*.	Indigo Nitrogen Band.
	VIOLET.	58,000	61,000	Great G and little *g*.	Violet-Hydrogen Line.
	Lavender.	61,000	65,000	Little *h* and great H¹ and H².	Lavender-Hydrogen Line.
	Gray.	65,000	70,000	—	—

The colour question settled, then came the measurement of the places of the lines seen therein and amongst. Each day the rather ragged train of some simple, some compound, prisms was set to minimum deviation for each of them in the part of the spectrum concerned, and from 100 to 200 or more lines per day were securely recorded day after day; until at last, after that long and laborious journey through all the colours and all the lines, not omitting to chronicle in appearance, as well as measured place, a single one amongst 2,000, at last, like huge volcanoes throwing out pillars of black smoke streaked with vertical lines, the overpowering forms of H¹ and H² hove in sight, and formed a fitting balance as well as contrast in the violet to great A and its rhythmical predecessors in the red.

But long, long before soundings were touched in the appearance of these two smoky giants, certain questions had to be wrestled with touching the terms in which all spectral places should be measured and published.

Full of desire to contribute data for theorists, the experimenter had indulged in the prospect of recording all line-places in terms of wave-lengths; and had even made his versatile, Robinson Crusoe sort of solar spectroscope, read its scales in numbers increasing as the wave-lengths of light do, from the violet towards the red end of the spectrum; and also caused it to present the violet end towards the left, and the red towards the right hand, as with most of his predecessor's maps employing wave-lengths. Further still, as he found it expedient to compare the solar spectral lines he was observing each day with the best maps and photographs he could collect, he applied a wave-length scale to each of them, made them all turn their violet ends leftward, and then tried to trace each line visible in the telescope through all its previous renderings or omissions by previous observers.

But oh! the difficulty of carrying that principle out fully, with anything more than a very few leading lines. The difference of the differences of a diffraction or wave-length scale, between one part of the spectrum and another, as compared with an average refraction or prism representation, viz., some sixteen times, was found to defy all accuracy by any ordinary pen or pencil, and to mislead or confound the eye, as to the mere physiognomy of groupings of the lines. Then, worse still, nature herself, and spectrum-forming nature too, was being fought against, in having scales increasing their numbers for dispersion one way, when the prismatic deviations which produced these dispersions were going the other way. So at last it was determined that whatever the scale a pure theorist may eventually prefer to put a few spectrum places in at last, for his own purposes, the spectrum observer, in order to observe well, quickly, and safely throughout the whole spectrum must have :—

1. A scale according to nature, as to the direction of increase of its numbers.

2. Increasing therefore these numbers from red to violet, both because the prismatic deviations do the same, and because, when the temperature of bodies is gradually raised, from that of the air in which we live up to such point that they begin to be luminous, the first light given off is red; and they only attain to violet light in the latest and most extreme degrees of heat eventually obtained.

3. Red therefore being the natural beginning of the spectrum, and all spectral numbers arranged as above, increasing towards the rest of the spectrum, the said red end requires to be placed on the left hand, so that every spectrum map may be told off as all writing and printing is made to read in all European countries, viz. from left to right, never from right to left.

4. Seeing that prisms will always be employed by some observers of the solar spectrum, and gratings by others, the scale to be used should be one whose general form, in equal parts, should divide the immense difference of physiognomy which exists between the spectra offered by these two instrumental methods; that is, not compressing the red end so much as the prism does, nor compressing the violet so much as the grating does; and this end is obtained most neatly, on an equally absolute foundation with wave-lengths, and in a handy set of whole figures by adopting the number of such waves to the inch, British.

The above points having been all fairly arrived at, after great sacrifices of both time and labour in the other direction, the Edinburgh experimenter proceeded without any further compunction to alter his spectroscope once more, and make it conform in all respects thereto, *i.e.*, to show the red end of spectra towards the left, and to increase spectral readings from left to right; while he further applied new scales to his collection of spectrum maps in terms of wave-numbers. And then came the reward; for not only did the same eye and pencil succeed in applying a wave-number scale more accurately than a wave-length one to prism-observed spectra, and make the correspondences between prism and grating spectra more numerous, perfect, and easily apprehensible, but the wave-number scale was found more suited naturally to the absolute requirements of the solar spectrum in itself. Or, thus, while the wave-length scale, as represented in Ångström's grand normal solar, but diffraction spectrum stretches out the red end to such a degree that the lines there are so few and far between as to waste the very paper on which they are drawn, the wave-number method gently compresses them, or brings them twice as close together; while again, if at the violet end the lines are so numerous, and closed packed in Ångström's map that they have hardly standing room, and can scarcely be separated one from the other—the wave-number method gives them twice as much space there, in a map measuring, on the whole, from red to violet, only the same length as Ångström's.

But there was a still higher reward to the experimenter, who, adopting the scale of wave-number, and finding he had more room for the violet end of the spectrum, began to pay more attention thereto; for he then found that, crowded as were the violet lines in Ångström's diffraction map, they were not half crowded enough; or rather that there were really in that part of the solar spectrum three or four times as many more lines still; far more indeed than could have been inserted on the engraved plates of the Swedish philosopher, and many more than his diffraction grating was probably able to show. While therefore all strong lines throughout Ångström's map are believed to have been most admirably measured, and the far more numerous thin lines are also most truthfully rendered in the earlier and middle parts of the spectrum—the violet termination, what with the imperfect showings of his grating, and the contracted space of the wave-length scale map, has not been done justice to.

Yet this is a very material point in the physics of the sun; for according to the preponderance of violet, over red, light, so may be assumed the intensity of the temperature of that light's origin. Whereabouts then did the increased number of lines in the violet observed by the Edinburgh experimenter with his prisms, over Ångström with his grating, place the photosphere of the sun as to temperature?

This point, described by the experimenter in the *Transactions* of the Royal Society, Edinburgh, vol. xxix., for 1879, was approximated to by him in this manner:—Having collected from various sources several thousands of spectrum place observations, he reduced them all to wave-number scale, and then arranged them according to the temperatures of their sources of origin, or, as Mr. Norman Lockyer has since then termed it, their respective "heat-levels," and the following series was obtained :—

Source of origin of spectral light, when at freezing point as in telluric absorption spectra, has its maximum of lines at W.-N. place	= 39,000
Chamber absorption spectra at temp. 68° F. at ...	41,000
Flame lines at lamp-flame temperatures at	47,000
Gas-vacuum tubes illuminated by 1 inch induction spark	49,000
Chemical lines in 2 inch sparks	49,000
Chemical lines in 6 to 10 inch sparks intensified ...	51,000
And Ångström's diffraction solar spectrum	55,000

But the solar spectrum, as observed on this occasion in Portugal, showed its maximum of lines at 61,000 of the same scale; or indicated that the temperature of the solar photosphere may be as much above the highest temperature yet attained by man, even with assistance of electricity in its condensed form, as that is above the freezing temperature of the upper strata of the earth's atmosphere.

Lastly, *Gaseous Spectra.*—Under this term are included both flames, especially blow-pipe flames, in the open air; and electric illuminations inside so-called gas-vacuum tubes, such as those of Geissler and Plucker combined. But in all these cases the experimenter, finding that faintness of the light was the crying evil, changed the usual *transverse* method of looking at lines, or cones, of light, for an *end-on* view of the same.

Trying this first for the blow-pipe, whose flame of coal-gas urged by a stream of air could then, by a collimating objective applied to the anterior telescope, be safely looked into, though directed right towards the slit—the increased number of lines, their steadiness and definiteness in all the several hydro-carbon bands—and then the resolving of the mere haze in the field of view into closely ranked little lines or linelets, proved an inimitable reward, as well as a priceless source of the best kind of reference-data in all his subsequent inquiries; especially too because these advanced results were procured without increasing either the temperature, or size, or combustion material of the flame at all.

Next applying the same principle to the Geissler-Plucker tubes, by having their form modified by M.

Salleron, so that they could be similarly looked at in the direction of the long line of the capillary—the effects were found almost startling in the brilliancy of the principal lines (chiefly indeed at the red end of the spectrum, for only weak sparks were employed) and in the immense number of additional lines in almost every tube-spectrum examined. These results had been communicated to the Royal Scottish Society of Arts in 1879, before it was ascertained that similar tubes for end-on use in photographing the violet lines had been made by the eminent Dr. van Monckhoven, at Gand, Belgium, three years earlier. But while fully acknowledging the Doctor's undoubted priority of invention, and inviting him to communicate his first published results at one of their meetings, the Society found the case already before them a perfectly independent invention; a part, too, of a more general system, and accompanied by a series of measures of some of the gas spectra, both in blowpipe flames and spark-illumined tubes, to a greater refinement than had ever been made before. They therefore graciously crowned the paper with a prize and printed it at full length in their *Transactions* for March, 1879.

Now some of these increased refinements in knowledge of the spectra of the gases referred to matters long in dispute before the world; and especially to the contention of whether the so-called "carbon-lines" of some observers seen by them in candle-flames, could possibly be the lines of that most refractory element carbon, or were not rather the lines of some of the very easily volatilised compounds of carbon, unless all the usual chemistry of carbon be utterly at fault. Herein the powers of the aurora spectroscope with its bright images, its still brighter end-on methods of viewing gas-flames, and its easy powers of rotation from one source of light to another, proved of inestimable advantage; for not only could large dispersions, approaching those employed on the sun, be used with effect, but the minutest line in one spectrum could be so quickly compared with a similar line in any other, and decided on absolutely as to whether it was or was not in the same spectrum place.

Wherefore the Edinburgh experimenter proceeded in the following manner: after repeating Prof. Swan's ancient observations and finding with him that all the various hydrocarbons gave more or less completely the same spectrum as the blue base of a candle-flame does, he set up for permanent reference, end-on, a blowpipe flame of coal-gas with common air as the best example of that kind of spectrum, viz., the spectrum of a something which vapourises at merely lamp-flame temperature. That that thing could be pure carbon, the chemists one and all declare is impossible, because no furnace heat can vapourise that element; but the Royal Society, London, had printed a paper declaring that the unknown agent must be carbon, pure and elemental, because the author of that paper had seen the same spectrum, not only in all combinations of hydrogen with carbon, but in those of oxygen, and also nitrogen, with carbon. This statement too was further strengthened by a Report from the Greenwich Observatory in 1877, to the effect that gas-vacuum tubes electrically illuminated, having been examined there spectroscopically, no sensible or material differences were found between carbo-hydrogens, carbo-oxygens, and carbo-nitrogens; the one common spectrum seen there must also, it was argued, though very different from the blowpipe flame spectrum, be the spectrum of pure carbon.

But as soon as the Edinburgh experimenter tried his end-on vacuum tubes he found an immense difference between carbo-hydrogens on one side, and both carbo-oxygens and carbo-nitrogens on the other; for the former, though with some other features constant, invariably showed many most brilliant lines in the orange, the citron, the green, and the blue; while the other tubes either had not any trace at all of those lines, or only so faint a marking as to indicate they were there as impurities and not as the whole contents of the so-called "vacuum-tube."

What were these lines then, so peculiar to carbo-hydrogen tubes? A reference to the coal-gas blowpipe flame showed that they were *its* characteristic lines; the lines, too, of an easily dissociable compound gas therein, and not of an ultimate and most refractory element; for as soon as the electric sparks illuminating the tubes were somewhat increased in intensity, quantity, and heat, these blowpipe, or we may now safely call them carbo-hydrogen, lines faded out of view; while the two elements which had made them, viz., pure hydrogen, showed its lines, and pure carbon showed, not its ultimate, elemental lines (which nothing short of the most powerful sparks, large batteries, and enormous condensers far above the private means of the Edinburgh experimenter can bring forth), but its low-temperature, compound-linelet, or *band*, spectrum.

Next, on examining the tubes of carbo-oxygen and carbo-nitrogen certain differences between them were detected, due apparently to the compound gas in each case being partly dissociated, and partly left untouched, by the simple, small induction-sparks employed. When largely dissociated, then carbon bands and oxygen lines were grandly present in one case, and carbon bands and nitrogen bands in the other; with some indications also of the compound's presence in either case, though never to the magnificent degree of the carbo-hydrogen in tubes of that gas. This, however, was merely for the simple reason that carbo-hydrogen is by nature a more magnificent "lighter-up" in luminous spectra; just as it is indeed the basis of all the means yet adopted in the history of mankind to correct the darkness of night; and there seems little chance that science will ever find anything better for every kind of occasion wherein we now employ candles, gas-lights, and lamps.

On further examining the carbon bands in the end-on tubes by a dispersion power of 33° from A to H, a peculiar structure was discovered by the experimenter in their component lines; and when he found that to be as distinct in a cyanogen tube which contained no trace of either oxygen, or more unusual still, hydrogen impurity, he considered it a proof that that electric spark-raised carbon-band (to which the chemists will probably not object) was the low-temperature spectrum of that element, and not the spectrum, as argued by M. Thalèn, of an oxide of carbon.

Many important points, therefore, seem to be indicated by these experiments, but with the general effect also of showing that spectroscopy loses much of its exceeding accuracy in power of discrimination, unless its observation be accompanied by some record of the particular "heat-level" at which the materials examined by it were rendered incandescent.

Hence a paper on these subjects was communicated to the *Philosophical Magazine*, London, in August, 1879; and further observations are now being carried on by the same experimenter on a new variety of his end-on tubes, prepared also by M. Salleron, and giving still brighter spectra than before, with the same electric illumination.

But all this is only while waiting for the aurora to appear, that phenomenon being the proper cynosure of this particular Edinburgh spectroscope. And now all men trust that the said aurora is soon to reappear, as the multifarious solar activities of a new sun-spot cycle have so evidently begun in the increased size and number of these spots ever since October, 1879; when they were critically considered, and openly announced in NATURE, to have at last shaken off the languor of their long minimum epoch, and to have begun in earnest their preparation for the new series now fairly under way.

(Since the above paper was written, the first of the new cycle of auroras to come, *has* been caught. See NATURE, vol. xxi. p. 492).

PNEUMATIC CLOCKS

TO distribute the time with accuracy and uniformity in a large city is a problem of great utility and extreme importance. This problem has been all but completely solved by the pneumatic clocks erected since March last in the principal streets of Paris and among a considerable number of subscribers, who, for a halfpenny a day, receive the time from the observatory *every minute* without winding up or any care on their part. The details of the system established in Paris we take from an article by M. E. Hospitalier in a recent number of *La Nature*. The system consists of (1) a central station where the compressed air is produced and sent every minute through the system of tubes; (2) a distributing system of tubes with ramifications to streets and houses; (3) a series of

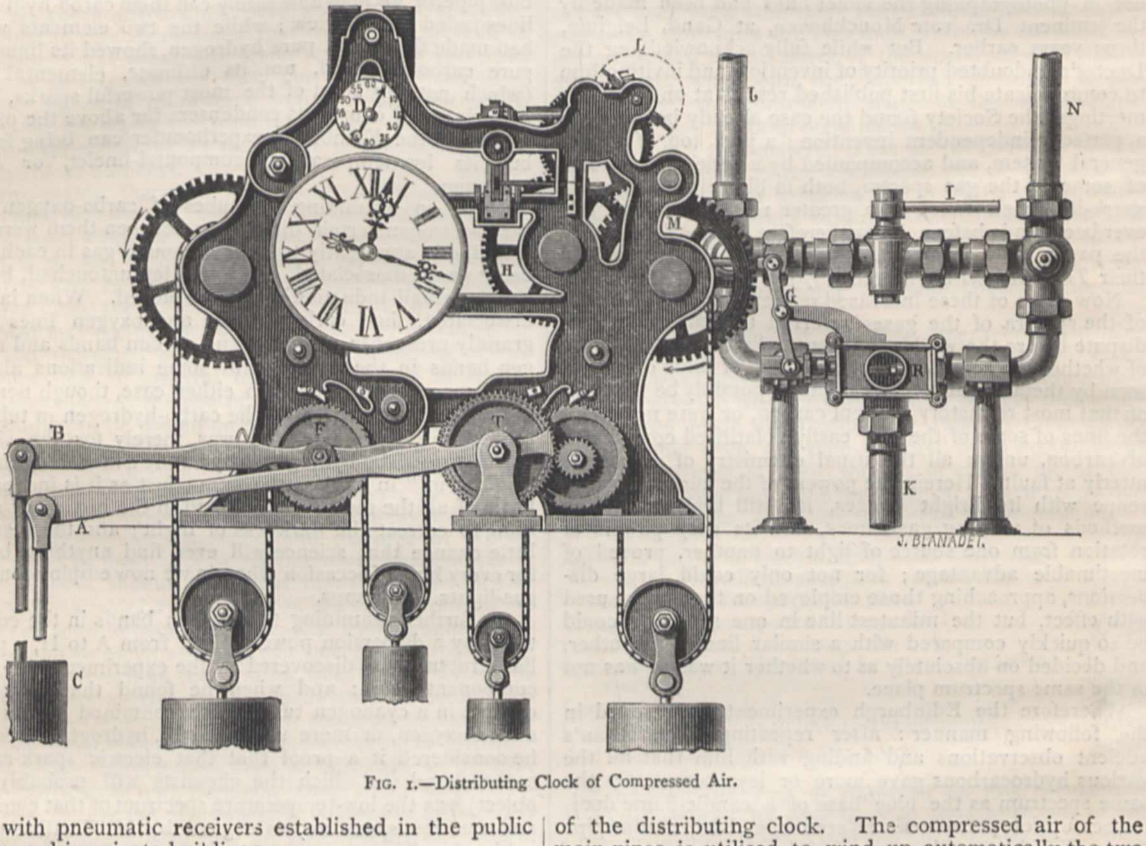


FIG. 1.—Distributing Clock of Compressed Air.

dials with pneumatic receivers established in the public streets and in private buildings.

At the central works a steam-engine sets in motion two pumps, which compress air into a large reservoir of about eight cubic metres, at a pressure of five atmospheres. This compressed air, by means of a special regulator, is transmitted to a second chamber called the distributing reservoir, where the pressure is kept at seven-tenths of an atmosphere by means of a simple automatic apparatus. This reservoir is put into communication every minute with the main distributing pipes for twenty seconds by means of a distributing clock shown in Fig. 1. The distributing clock comprises two quite distinct movements: the left movement is intended to set the clock going in the ordinary manner; the right movement is specially intended to work the distributing valve R. The seconds-hand is at D. At the beginning of each minute the air of the distributing reservoir arriving by the tube J in the distributing box is sent into the main distributing pipes by the tube M. At the end of twenty seconds a displacement of the lever G places the valve R in its second position. The tube N then communicates with the tube K, open to the atmosphere, while the tube J no longer communicates either with K or with N. The valve R remains 40 seconds in this position, to complete the minute, when a new displacement of the valve again places J in connection with N, and so on. All these displacements of the valve are effected by means of gearings arranged in the works of the distributing clock. The compressed air of the main pipes is utilised to wind up automatically the two movements by means of the levers A and B, which are connected with pistons placed in the cylinders C, and

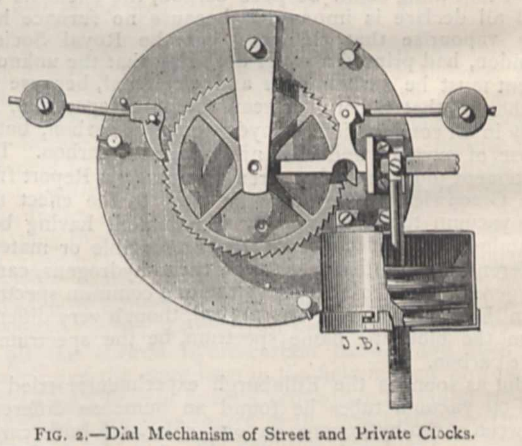


FIG. 2.—Dial Mechanism of Street and Private Clocks.

raised every minute by the compressed air to a distance exactly equal to that through which the motor weight has descended during the preceding minute. There is no need, therefore, to trouble about the winding up of the distributing clock. This clock is regulated by the Observatory, by hand; but soon a special system will be established, by which the exact time will be distributed from the Observatory by electricity. As the system is established in duplicate at the central works, should anything go wrong with one clock the other is put in working order in a few seconds. The function of the distributing clock may be performed by the hand by working properly, every minute, the three-way tap, I, which plays exactly the part of the valve R.

For the system of distribution the air is sent every minute into the tube N, which bifurcates into a certain number of smaller branches, forming so many networks completely separate and independent, so that a derangement of one of the systems does not affect the others. The principal tubes, carried underground, are of wrought iron, and have

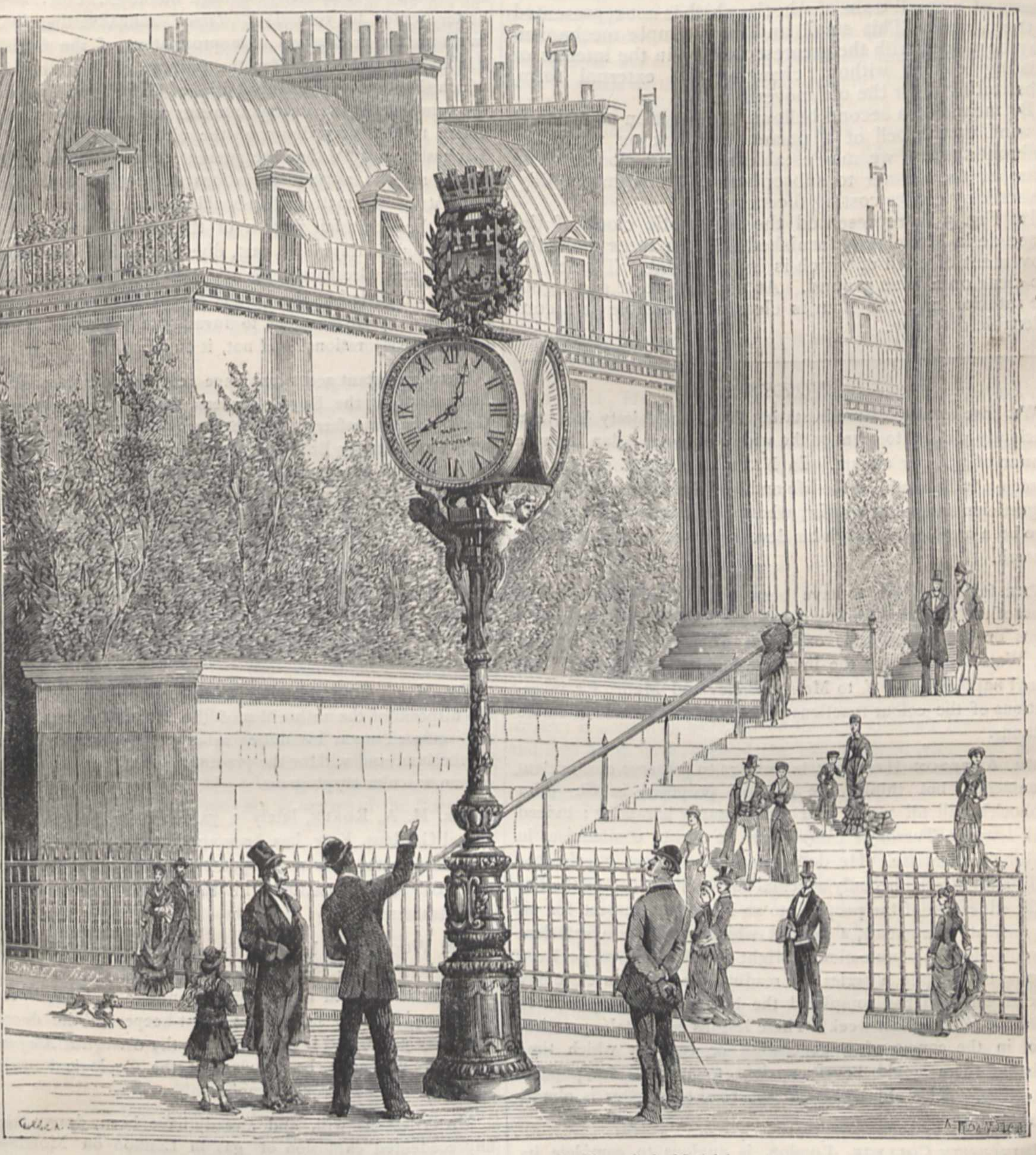


FIG. 3.—The Pneumatic Clock on the Place de la Madeleine.

an internal diameter of 27 millimetres. The tubes placed in private houses are of lead, 15 mm. in diameter; in apartments and passages this diameter is reduced to 6 mm., and the tube attached to the clock, in lead or india-rubber covered with silk, is only 3 mm. in diameter. With a pressure of seven-tenths of an atmosphere, by leaving the distributing system for 20 seconds in communication with the distributing reservoir, as we have said, it is easy to set the clocks going several miles from the central works, notwithstanding the inevitable escape from the pipes. Differences have occasionally been observed between some of the clocks, probably in most cases the results of mischievous meddling; these, and other accidents, however, become fewer and fewer, and will no doubt gradually disappear. Owing to the division of the service into various distinct networks, any flaw is soon detected and easily repaired.

Whatever be the form or size of the dial, public or private, the mechanism is always the same. A caoutchouc bellows, like that used in Walker's pneumatic air-bells, is in communication with the main pipes. Every minute the pressure of the air raises it (Fig. 2); this bellows acts on a lever which draws a wheel of sixty teeth, in the axis of which is fixed the minute-hand. The wheel makes one-sixtieth of a revolution; a ratchet-click, shown on the left of the toothed wheel, prevents any return of the wheel. The movement of the hour-hand is effected by means of a small train of wheels, which is not represented in the figures. This small and very simple mechanism may be placed with the greatest facility in the interior of existing clocks, without changing the external form, substituting it for the old movement.

By means of a second bellows, the function of which is to wind up the bell of a pneumatic clock on a slightly different system, we may establish striking clocks. The price of the former to subscribers is 5 centimes a day, the striking clocks costing 6 centimes.

In Fig. 3 is represented the pneumatic clock of the Place de la Madeleine, furnished with its three dials, the movement of each of which is independent. The letters are clear on a blue ground. At night a jet of gas lights the interior, and the hour is clearly discernible at a considerable distance.

NOTES

WE have much pleasure in stating that Her Majesty has been graciously pleased to grant to the widow of John Allan Broun a pension of 75*l*. per annum. In NATURE, vol. xxi. p. 112, will be seen a full account of the life and works of that distinguished magnetician and meteorologist, whose life may truly be said to have been sacrificed through his devotion to the cause of scientific research.

THE following grants have been made from the Research Fund of the Chemical Society:—10*l*. to Mr. Kingzett for experiments on the atmospheric oxidation of phosphorus; 25*l*. to Mr. Watson Smith for the investigation of the di-napthyls and phenyl napthalene; 25*l*. to Messrs. Bailey and Munro for investigations of the colour reactions of certain metals and metallic solutions.

MR. AUBERON HERBERT is anxious to preserve our ancient monuments, but thinks the method proposed in Sir John Lubbock's Bill all wrong and unnecessarily harassing; indeed in his letter in Tuesday's *Daily News* he scents communism in Sir John's enterprise. He deprecates Government interference at all, and thinks the only effectual and enlightened method to be the education of the people into an intelligent respect for all our ancient monuments, a respect which would be a sufficient guarantee for their protection. Might not Mr. Herbert get Lord Norton to compile a series of reading-lessons on archæology after his lordship has completed the botanical reading-book to which we referred last week? These lessons might take practical effect in the course of a generation or two, by which time probably there would be no ancient monuments for popular protection. The obtuseness of Mr. Herbert's letter is almost phenomenal.

UNIVERSITY COLLEGE, London, is anxious to complete its buildings, and in connection with this purpose a meeting was held at the Mansion House last Friday. We have frequently had occasion to speak of the great services rendered by the institution to the raising and broadening of education in this country. It has not only itself aimed to carry out a high standard of education, but has given a strong and healthy impulse to older institutions, and led, directly or indirectly, to the establishment of other institutions in which science has its fair place. Of the desirability of completing the buildings of University College there can be little doubt. The sum required is large—105,000*l*.; but if Edinburgh could raise 90,000*l*. for a similar purpose surely the wealthiest city of the wealthiest country in the world need have little difficulty in raising the sum required. Of this sum 20,000*l*. has already been subscribed; about the balance we trust there will be no difficulty.

IN connection with the recent meeting to raise funds for the completion of University College buildings, Prof. Ray Lankester writes to yesterday's *Times*, animadverting in strong terms on the scandalous misappropriation of the funds left by Sir Thomas Gresham "for the purpose of providing a college which should rival the Universities of Oxford and Cambridge in the completeness of its appointments and bring the highest education to the very doors of the citizens of London." Prof. Lankester suggests that the present representatives of the Corporation, who appear so anxious to promote the educational interests of the metropolis, should restore "to University education in London a fair portion of the sum which the Corporation of London, in days long past, diverted to its own benefit from Sir Thomas Gresham's trust." But could not the Gresham funds be included in the inquiry of the Commission now being appointed by Government to investigate the whole question of the City Corporations? If not, it ought to be.

TWO important accessions have recently been received by the Herbarium of the Royal Gardens, Kew. The corporation of Carlisle has transferred to it the herbarium of Dr. Goodenough, who was formerly Bishop of the Diocese, and who died in 1827. This is rich in specimens of plants cultivated at Kew and Chelsea in the end of the last century, but which have hitherto been very imperfectly represented in the Kew Herbarium. The very extensive collections of mosses accumulated by the late Prof. Schimper of Strassburg, and upon which his well-known works upon this group of plants were based, has been purchased (together with the accompanying drawings and notes) from Prof. Schimper's family by the Baroness Burdett-Coutts, and also presented to Kew.

DR. M. C. COOKE having been placed by the India Office at the disposal of the authorities of the Royal Gardens, Kew, has now entered upon his duties as cryptogamist attached to the Herbarium, and will for the present take charge of the collections of non-vascular cryptogams.

MR. H. A. ROLFE, lately a gardener in the employ of the Royal Gardens, Kew, has been appointed by the Civil Service Commissioners, after a competitive examination, to the vacant post of second assistant in the Herbarium of the same establishment.

DR. WOODWARD has been appointed keeper of the geological department of the British Museum in succession to Mr. Waterhouse, who resigned about three months ago. Dr. Woodward has occupied the position of assistant-keeper in the department for many years, and is the editor of the *Geological Magazine*, in which, as well as in the *Journal* of the Geological Society, he has published numerous memoirs.

MANY lessons will, and already have been, drawn from the unprecedented explosion of gas in London on Monday; the results were disastrous enough, but we may congratulate ourselves that they were no worse. The science of the explosion is simple enough, as the daily papers have been telling the public; and when science is properly taught in our elementary schools such accidents can only be due to perversity, not lack of knowledge. We recommend this explosion and its immediate cause, to the consideration of Lord Norton.

OUR readers may remember that some months ago Sir William Thomson made several valuable suggestions as to the readjustment of our present system of lighting our coasts, which, he maintained, is a fruitful source of danger to navigation. A Parliamentary paper has just been issued containing a correspondence between Lloyd's Committee and the Trinity House on these suggestions. Naturally the Elder Brethren of the Trinity House attempt to show that their system is by no means so unsatisfactory as Sir William Thomson maintains it is, though they admit it is by no means perfect. They assured Lloyd's Committee of two things—(1) that the lighthouse system was not in the crude state which Sir William Thomson appeared to imply, and (2) that its present custodians were actuated by a very earnest desire yet further to simplify and improve it. The Committee of Lloyd's remarked, in their reply, dated January 16, 1880, that they were glad to find that they were at one with the Elder Brethren in thinking that some distinctions more marked than those already existing would be useful. They had no special interest in Sir William Thomson's plan, but they had always understood that his inventions and improvements in electrical apparatus, the mariner's compass, and the sounding machine had been of great service to the community at large. We suspect there is much more in Sir William Thomson's animadversions and suggestions, the result of the practical experience of an eminent man of science, than the Elder Brethren of the Trinity House are willing to admit.

THE engineers of the St. Gothard Tunnel are stated to be in a fair way to overcome the difficulty arising from the falling in of the roof in the part known as the "windy stretch." This stretch, which is 200 metres long, and situated almost directly under the plain of Andermatt, passes through strata composed alternately of gypsum and aluminous and calcareous schists, which absorb moisture like a sponge and swell on exposure to the atmosphere. It has given the contractors immense trouble, and has fallen in so often that it was seriously proposed a short time ago to allow it to collapse, and make a bend so as to avoid the "windy stretch" altogether. The expedient now adopted, which has so far been successful, is the rebuilding of the supporting masonry in rings of solid granite. The rings are each four metres long, so that in the event of any one of them giving way the others will not thereby be affected. The building is constructed slowly and with the utmost care; no imperfect stones are allowed to be used; the masonry is perfect, and the walls of extraordinary thickness—in the parts most exposed to pressure not less than ten feet. At the beginning of June only 34 metres of the "windy stretch" required to be revaulted.

M. TRESCA, whose name has been connected with the Conservatoire des Arts et Métiers for about twenty-five years, no longer belongs to that establishment. His office has been suppressed by a recent decision of M. Tisard, the Minister of Agriculture and Commerce. This unexpected resolution has created some sensation in the Paris scientific world.

WE have received the first volume of the *Archives* of the *Deutsche Seewarte*, a neatly-printed quarto volume of above 300 pages, with numerous plates, containing an account of the first four years' working of the Meteorological Office at Hamburg, 1875-78, under the able guidance of Dr. G. Neumayer, well known as the former Superintendent of the Flagstaff Observatory at Melbourne. The volume contains some elaborate reports, among which may be specially mentioned an account of the activity of the Office in the departments (1) of Marine Meteorology, (2) of Weather Telegraphy and Storm Warnings, (3) a Report on the Testing of Chronometers, and (4) a paper on the Non-periodical Monthly Variations of the Barometer. Subsequent annual volumes are promised in regular succession, and we look forward with confidence that an addition of much useful knowledge on the subject of meteorology generally will be gained by their publication. The *Seewarte* already possesses a library of 9,400 volumes, and includes that formerly belonging to Prof. Dove of Berlin, which was acquired at a cost of 1,500*l*.

A CURIOUS work, impressively illustrative of the "science" of the Dark Ages, has just been published at Berlin, under the title of "Compendium der Naturwissenschaften an der Schule zu Fulda in IX. Jahrhundert." Its purpose is to expound the works of Rhaban, the celebrated Abbé of Fulda (788-856). The Abbé, under the title of *De Universo*, published what would now probably be classed as an encyclopædia, and as we have said, its divisions and contents are a curious illustration of the state of systematic knowledge at the time it was written. Book I. treats of the Trinity and Angels; Book II. Patriarchs and Prophets; Book III. Men and Women spoken of in the Old Testament; Book VI. Man and the various parts of the Human Body; Book IX. the World, Atoms, Elements, the Sky, Stars, Meteors; Book X. the Almanack and Feasts; Book XII. the Earth; Book XIII. the Vertical (?) Parts of the Earth; Book XV. Philosophers, Poets, Sorcerers, Idols, Pagans; Book XVIII. Measures, Weights, Numbers, Music, Medicine, and Diseases; Book XX. War, Horses and Ships, &c. Of course the book is full of curious mythological and other mysteries, a remarkable feature, however, being the important part given to etymology; indeed it would almost seem as if all science consisted in good etymology.

DR. R. F. HUTCHINSON of Mussooree, India, writes that on the afternoon of May 25 a hail-storm, remarkable for its fury, extensive area, and size and structure of its stones, enveloped that station, and Deyrab and Rajpore, at the foot of the hill. A discharge of stones as large as pigeon-eggs opened the attack, and this was followed by a continuous downpour of stones, oblate spheres as large as small marbles. The whole station was penetrated by these, and it presented the appearance of being strewn broadcast with acidulated drops. These stones were of pure, clear ice, and, barring their shape, quite amorphous. Not so the large stones, whose structure and mode of formation were very puzzling. First, an opaque nucleolus surrounded by a concentric nucleus of clear ice, and this by a radiating periphery. The nucleolus being opaque, was rapidly frozen; it must then have moved through alternate layers of hot and cold air to have received the concentric accretions of clear ice. The radiating periphery (which was translucent, but not transparent) quite puzzles our correspondent.

A VALUABLE paper of observations of the aspect of Mars during his recent opposition, of the red spot of Jupiter, and the spots of Venus, by M. Terby, appears in the Belgian Academy's *Bulletin* (No. 3). The most delicate part of the work is that relating to the spots of Venus, of which he supplies ten carefully executed drawings.

CAPTAIN DOUGLAS GALTON gives an address to-day in connection with the Sanitary Institute at the Royal Institution.

THE 126th annual meeting of the Society of Arts was held on the 30th ult., when the Report was presented and officers elected. The Society is in a more satisfactory condition than at any previous period.

Scientific Practice is the title of a periodical published three times a year for the students of the School of Practical Engineering at the Crystal Palace. No. 7, which we have received, contains several papers likely to interest young engineers.

MR. W. SAVILLE KENT's long-promised "Manual of the Infusoria" will be published by Mr. David Bogue. The complete MS. and drawings are in the printer's hands. The work will be issued in six monthly parts, the first of which is to be ready in October.

A NEW list of members of the Institution of Civil Engineers has just been issued, from which it appears that there are now on the books 1,217 members, 1,299 associate members, 579 associates, 18 honorary members, and 657 students—together 3,770 of all classes. At the same period last year the numbers of the several classes were 1,148, 1,200, 622, 17, and 591, making a total of 3,578, showing an increase at the rate of nearly 5½ per cent. During the past session the elections have comprised 2 honorary members, 43 members, 129 associate members, and 15 associates; and 160 students have been admitted.

A COMMISSION appointed on November 27, 1879, has visited the five French provincial observatories. A report has been written by M. Lœwy, sub-director of the Paris Observatory, discussed at a meeting of the directors of the establishment, approved by the Minister of Public Instruction, and published by the *Journal Officiel* on June 29.

IN a report which he has lately sent to the Foreign Office, the acting Consul-General at Bangkok remarks that the year 1879 will long be memorable in the provinces of Battambong and Chantaboon for the discovery of valuable sapphire mines in that part of Siam. Mines of inferior value have long been known in the neighbourhood, and about five years ago new mines were discovered by a native hunter. Being, however, in a very remote and secluded position, it was long before their fame spread to the Burman and Indian gem-traders and miners. Eventually they became more widely known, and large numbers flocked to them, especially from British Burmah. The largest sapphire hitherto found weighed, according to Mr. Newman, 370 carats in the rough, and when cut turned out 111 carats of the finest water. The ruby, onyx, and jade are also found in the district, but are apparently of inferior quality.

THE *Liverpool Courier* understands that the telephone has been successfully laid down from Childwall Church, Liverpool, to the house of a lady half a mile off who is unable to go out; the chants, hymns, and lessons are distinctly heard, but only fragmentary sentences of the sermon can be caught.

WE see from the *Otago Witness* of May 22 that Prof. Black of Otago University has commenced a second course of public lectures on chemistry, in continuation of the course last winter, to which we referred as having been attended by teachers from all parts of the province of Otago, many of them coming distances of sixty, seventy, eighty, and ninety miles. The present course promises to be quite as successful. The *Witness*, we are informed, publishes the lectures in response to several requests, and in view of the heartiness with which the course (both of last year and this) has been received.

MR. J. LEE JARDINE writes from Capel, Surrey:—"I felt what may have been the tremor of an earthquake on Sunday, June 27, at 9 p.m. I was sitting with friends talking and reading on the ground floor of a house close to a road, and noticed a low rumbling lasting two or three seconds; this was repeated five or six times in the course of four or five minutes, sounding so like the noise of wheels that I watched for a cart, but in vain. The last three or four times the rumbling was accompanied by a slight vibration sensible only to the feet. It was felt also by one of my friends, who remarked upon the curious sensation."

THERE was a severe shock of earthquake at Brieg, Switzerland, on Sunday. Many buildings were injured, but, so far as is known, no lives were lost. The movement was also much felt at Zermatt and Belalp, and very slightly at Geneva.

M. FERRY, French Minister of Public Instruction, presided at the first meeting of a commission established for the improvement of popular publications. It has been resolved that a sub-commission shall decide what works shall be rewarded and what subjects proposed by way of competition.

IN a work published by Dr. Ricoux of Philippeville, Algeria, on "Demographie figurée de l'Algérie," it is proved that marriages are more prolific than in France, the mean number of children being 3·67 in the colony, as contrasted with 3·07, in the mother country. In the first twenty years after the French occupation it was taken for granted that European children could not be reared in the colony. The increase of the European population is very remarkable; in 1830, 600; ten years afterwards, 27,000; twenty years, 125,000; thirty years, 200,000; forty years, 271,000. In 1880 the number is not yet known, but is probably 400,000, having been found 323,000 in 1876.

WE have received the Calendar of the "Tokio Daigaku," or University of Tokio for 1879-80. This university seems to be quite as complete in all its departments as any similar institution in this country, and the education provided seems, to judge from the examination papers, thorough. The place given to science is what it ought to be, on an equal footing with any other department in all respects. An interesting historical summary is prefixed of the introduction of Western learning into Japan.

THE *Report* of the Miners' Association of Cornwall and Devon for 1879 shows that the Association continues to do good work among the mining population of these two counties. The numbers attending the classes continue to increase, and the instruction given is well calculated to be of great service to a mining population. The *Report* contains a paper by Mr. A. T. Davies on the "Phenomena of the Heaves or Faults in the Mineral Veins of St. Agnes."

WE have received a very favourable *Report* (the 22nd) from the East Kent Natural History Society. The *Report* contains several good papers read at the meetings of the Society, the most important and the longest being that of Capt. McDakin, "An Outline and Index to the Geology of East Kent."

WE are asked to state by Mr. Walter Baily (not *Baillie*) that in our report of the Physical Society last week, p. 210, second column, line 29, *notes* should be *nodes*.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. Fred. Felix; a Banded Ichneumon (*Herpestes fasciatus*) from East Africa, presented by Mr. H. Hall; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Mr. T. Douglas Murray, F.Z.S.; a Java Sparrow (*Padda oryzivora*) from Java, a Spotted-sided Finch (*Amadina lathami*), a Chestnut-eared Finch (*Amadina castanotis*) from Australia, two Chestnut-bellied Finches (*Munia rubro-nigra*), a Yellow-bellied Liothrix (*Liothrix luteus*) from India, two Red-beaked Weaver Birds (*Quelea sanguinirostris*), a Crimson-crowned Weaver Bird (*Euplectes flammiceps*), a Paradise Whydah Bird (*Vidua paradisea*) from West Africa, a Brazilian Tanager (*Ramphocœlus brasilius*) from Brazil, a Bearded Tit (*Calamophilus biarmicus*), European, presented by Mr. St. Julien Arabin; two Common Peafowls (*Pavo cristata*) from India, presented by Miss Wedderburn; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from South Australia, presented by Mr. H. F. Bussey; a Jaguar (*Felis onça*), two Huanacos (*Lama huanacos*), two Coypu Rats (*Myopotamus coypus*), two American Barn Owls (*Strix flammea*) from South America, deposited; a Cereopsis Goose (*Cereopsis novæ-hollandiæ*) from Australia, a Doubtful Toucan (*Ramphastos ambiguus*) from United States of Columbia, six Chinese Quails (*Coturnix chinensis*) from China, two American Kestrels (*Tinnunculus sparverius*) from America, an Ocellated Monitor (*Monitor ocellata*) from West Africa, purchased; a Red Deer (*Cervus elaphus*), a Reeves's Muntjac (*Cervulus reevesi*), born in the Gardens, three Upland Geese (*Bernicla magellanica*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE VARIABLE NEBULA NEAR ζ TAURI.—Though there has been no mention of late of observation of the vicinity of the nebula discovered near ζ Tauri on October 19, 1855, by Chacornac, at Paris, and of which he found not the least trace in November, 1862, it may be nevertheless hoped that attention has been directed to the neighbourhood, even if with negative results. As we do not find a sufficiently detailed account of Chacornac's experiences bearing upon this nebula in our astronomical treatises, we may recapitulate them here.

Chacornac tells us that when constructing, at Marseilles, the chart No. 17 of the Atlas employed in the search for small planets, he registered between December 3, 1853, and February 20, 1854, a great number of stars in this part of the heavens, and amongst others he observed, from January 26 to 31, a star of the eleventh magnitude, the position of which for the beginning of 1852 was in R.A. 5h. 28m. 35·6s., and Decl. + 21° 7′ 18″. At that time and later he did not perceive any nebulosity about it; at the Observatory of Paris on September 1 and December 17, 1854, with a refractor of ten inches aperture he did not detect any such appearance. On October 19, 1855, in verifying the chart of this region, he remarked a faint nebula about the star and delineated it upon the map. He was then, as he says, far from thinking that objects generally considered to be masses of small stars could vary in brightness like the isolated variables, and attributed the degree of visibility to the greater or less degree of transparency of our atmosphere. But under the idea that the nebulosity might really be a distant comet, he endeavoured to repeat his observation on following nights, though from clouds and moonlight it was not till November 10 that he could satisfy himself that the object was precisely as he saw it on October 19, having changed neither in position, extent, nor form. It brightness was particularly remarked on January 27, 1856, when it is recorded: "Elle offre l'apparence d'un nuage transparent qui semble reflecter la lumière de l'étoile ζ Taureau, et son aspect tout différent de celui de la nebuleuse 357 (Herschel II.) ne fait naître aucune idée de points stellaires visibles sur toute l'étendu de sa surface. Cette nebuleuse d'Herschel se présente en effet comme un amas d'étoiles qui s'aperçoivent distinctement séparées les unes des autres même avec un faible grossissement, tandis que le souvenir que je garde de la nebuleuse variable ne l'a fait comparer à un leger *cirro-stratus* strié de bandes paralleles: cette description est, du reste, en toute conforme au dessin de la carte."

From the end of January, 1856, until November, 1862, the dates of comparisons of this chart with the sky were not recorded, but on the 20th of the latter month Chacornac failed to see the least trace of the Nebula, though the star of the eleventh magnitude, upon which it was formerly projected, remained of precisely the same brightness. On frequent occasions subsequently, before notifying his discovery in April, 1863, he could see no vestige of nebulosity with the instruments at the Observatory of Paris. With regard to the appearance of the nebula Chacornac remarks: "Elle offrait une forme presque rectangulaire, dont le plus grand côté mesurait un arc de 3 minutes et demie, et le plus petit 2 minutes et demie." The eleventh magnitude, according to his position, precedes ζ Tauri, 12·6s., and is 4′ 26″ north of that star; it appears to be No. 907 of the zone + 21° in the *Durchmusterung*, where it is rated 9·4m., the scale of magnitudes in that catalogue not being identical with Chacornac's.

In the same neighbourhood is a variable star notified by Prof. Julius Schmidt, which follows the bright nebula *h* 357, about 23·8s., with 4′·2 less declination. It is No. 894, zone + 21° in the *Durchmusterung*, and there called 9·5m. According to Schmidt's observations it was 8·9 on February 4, 1861, 11·12 on March 21, 1862, 9 on January 9, 1864, and 10 at the end of the same year; he found its place for 1861·0 in R.A. 5h. 26m. 33·7s., and Decl. + 21° 50′ 47″; a twelfth magnitude follows it 3·7s., about 1′ 18″ to the south.

THE GREAT COMET OF 1880.—Dr. B. A. Gould has calculated a third parabolic orbit for the southern comet which he finds to represent his observations very closely; the elements are:—

Perihelion passage, 1880, January 27·41170 Washington M.T.

	°	′	″	
Longitude of perihelion ...	280	11	10	Mean equinox, 1880·0
,, ascending node	7	7	38	
Inclination	35	12	27	
Log. of perihelion distance..	7·7268724			

Motion—retrograde.

He has also computed an ephemeris for February, from which we extract positions and distances for the period during which the tail was visible.

At Washington mean noon.

	Right Ascension. h.	m.	s.	Declination. °	′	Log. distance from the Earth.	Sun.
Feb. 2	21	47	38	−28	57·6	9·86856	9·53319
3	22	3	4	30	8·8	9·85728	
4	22	19	12	31	10·8	9·84799	9·62292
5	22	35	54	32	3·1	9·84064	
6	22	53	1	32	44·9	9·83521	9·69139
7	23	10	24	33	15·8	9·83167	
8	23	27	52	33	35·8	9·82994	9·74677
9	23	45	13	33	44·9	9·82997	
10	0	2	17	33	43·8	9·83165	9·79326
11	0	18	55	33	33·1	9·83487	
12	0	34	58	33	13·7	9·83949	9·83333
13	0	50	20	32	47·0	9·84538	
14	1	4	57	−32	14·0	9·85237	9·86853

This gives the least distance of the comet from the earth 0·6757 of the earth's mean distance from the sun at about 6h. a.m. Greenwich time on February 9.

THE DIAMETER OF VESTA.—Prof. Tacchini has taken advantage of the recent favourable opposition of this planet to measure the apparent diameter, which with a power of 1,000 on his refractor he found to be, on June 9, 1″·706. This value reduced to the mean distance is about double that resulting from Secchi's observation at the opposition of 1855, when he judged the apparent diameter to be a little less than that of the first satellite of Jupiter, or about 0″·8, but "molto più debole di luce, e di colore ranciato carico." For distance *unity*, Tacchini's measure gives 1″·96, and Secchi's estimate 1″·01. Probably we may hear of other measures of Vesta at the opposition of the present year, made with large instruments.

GEOGRAPHICAL NOTES

THE collections in natural history and ethnography brought home from the coasts of Siberia and Eastern Asia by the *Vega* are to be exhibited in the old hall of the Royal Library at the Palace, Stockholm. The exhibition was opened yesterday, and Baron Nordenskjöld invites naturalists and geographers to visit the collection.

AT the German Athenæum last week the Chevalier Ernst von Hesse Wartegg gave a lecture on his recent travels in North Africa, comprising chiefly the southern parts of Algiers and Tunis and the rarely-visited frontier regions between these two countries. Herr von Wartegg's principal aim was the thorough revision and completion of the very defective Tunisian map of the French General Staff, edited in 1858, and the investigation of the Schott region in Southern Tunis, adjoining the Lesser Syrtes. The first object was, according to the lecturer, satisfactorily completed by the substantial aid of the Tunisian Government and the foreign consular body at Tunis. To point out a few instances of the deficiency of the French maps, Herr von Wartegg mentioned the large river Kassab, a tributary of the Medjerdah, which in the map empties into the Mediterranean about 200 kilometres from its actual mouth. Large lakes are entirely omitted, and cities invented which do not exist. The main fault of the map is the erroneous spelling of the topography, Frenchifying and mutilating nearly every name. For instance, the Arab word Sandjak has been turned into "Saint Jacques," &c. Regarding the well-known project of Capt. Roudaire and M. de Lesseps, the lecturer states that neither the geological formation nor any other sign indicates the former connection between the so-called "submarine basin" in Southern Tunis and Algiers, and he believes, contrary to the sanguine dreams of Capt. Roudaire, that it never was connected with the Mediterranean. According to his observations the submarine basin in the interior approaches the coast only at a distance of about seventy miles, and the canal to be constructed across the isthmus would have to be therefore of that length. The cost of such a work, rivalling the Suez Canal in magnitude, would never be in proportion to the benefit derived, which latter is entirely doubtful. No thorough investigation of the region was ever made, and its results would never be certain, as the constant vibration of the air in this hot climate and the deceptions caused by frequent *fata morganas* render scientific measurements very problematic. If the connection between the two basins were to be established, some of the most flourishing cities of the Schott region, like Tooser and Nephta, would be submerged by the floods, and most probably all the large date-tree forests of the Djerid destroyed by the change of climate and the increased moisture. Herr von Hesse Wartegg spoke at length of his travels through the Regency, and mentioned some curious meteorological and botanical observations. The traveller brought back with him a large collection of plants, ethnological objects, and insects, as well as drawings and photographs. He will exhibit his collection at his lecture before the British Association at the forthcoming Swansea meeting.

THE new number of the Geographical Society's *Proceedings* opens with the presidential address on the progress of geography, in which the chief space is devoted to the Arctic regions and Africa; it is supplemented, however, by a summary of Admiralty and Indian surveying operations. A letter is next given from Mr. James Stewart of Livingstonia to the Free Church of Scotland, furnishing a further account of his recent explorations north-west of Lake Nyassa, up to the south end of Lake Tanganyika, and which was accompanied by valuable longitude observations. The latter is illustrated by Mr. Stewart's route surveys, which are of great value from a geographical point of view. Among the notes information is given respecting Dr. Lenz' progress in North-Western Africa, which had reached the Foreign Office through the British Minister at Tangier. Dr. Lenz is stated to have crossed the Atlas, and Moorish protection being refused him beyond Terodant, he has pushed on alone towards Timbuctoo and the Soudan, disguised as a Mohammedan doctor and accompanied by a Moor named Hadj Ali. There are also interesting particulars respecting the movements of a Roman Catholic missionary expedition to the Matabele country and the Upper Zambesi region.

SIGNOR FRACCAROLI, the delegate of a society formed last year at Milan for the development of commerce with Central Africa, has lately paid a visit, in company with Emiliani Bey, to the centre of the Darfur province, which he found in a state of desolation from the recent wars. After a vain attempt to reach the summit of Jebel Si, a lofty isolated peak in the Jebel Marra, he returned to Khartum, whence he expected to proceed on a journey up the Balor el Ghazal.

COUNT LOUIS PENNAZZI is about to undertake a journey in Abyssinia and the neighbouring region. He proposes to start from Massowah and visit the city of Gondar and Mount Debra Tabor, hoping to find King John and obtain from him an escort to accompany him through the Gojam province and to the Blue Nile. Thence he will proceed in a west-south-west direction, following the Sobat and the White Nile along the eighth parallel, and eventually join Signor Gessi.

NEW METALS

WITHIN a period of about two years the chemical world has been startled by the successive announcement of the discovery of no less than fourteen[1] new elementary bodies. All of them are classed as metals, and eleven are said to belong to the yttrium or to the closely-allied cerium group. Without pausing to examine the advisability of announcing the discovery of a new element whenever an unknown reaction crops up, we purpose to give a brief account of these discoveries, and to investigate, as far as possible, what claim they may have to be honoured with a place in our lists of the chemical elements.

In July, 1877, M. Sergius Kern published[2] the discovery of a new metal belonging to the platinum groups, to which he gave the name *davyum*. The davyum was, he said, contained in the latter portions of the platinum ores precipitated by hydrogen at 100° together with the rhodium and iridium. The metals having been heated with barium chloride and chlorine in the usual manner, the rhodium and iridium were fractionally precipitated by acid sodium sulphite, and the davyum contained in the filtrate thrown down with ammonium chloride and nitrate. From this double chloride an ingot of the metal weighing 0·27 gramme was obtained. The properties of this metal and its compounds, as stated by M. Kern, all agree more or less closely with those of the other platinum metals. It is difficultly fusible, dissolves only in *aqua regia*, possesses an atomic weight of about 100, &c.

[1] M. Lecoq de Boisbaudran's *gallium*, the existence of which has now been fully established, is not included in this number.
[2] *Chemical News*, vol. xxxvi. p. 4.

Its specific gravity is, however, said to be 9·38, which is lower than that of any other metal of this group, but approximates to a mixture of rhodium with a little iron. The characteristic reaction is stated to be the red colour produced by potassium sulphocyanate, but unfortunately both iron and ruthenium produce the same result, and M. Kern does not tell us what means he has adopted to get rid of traces of these and the other platinum metals, or to convince himself that they were absent. It is to be regretted that no protest, except a letter of Mr. W. H. Allen,[1] has been raised against this endeavour to foist a "new metal" upon the chemical world, and that too by a chemist who has signallised himself by such inaccurate results in other directions.

Turning now to the recent additions to the yttrium metals, we have in the first place to notice a contribution by Marignac. In the summer of 1878, after examining the earths from gadolinite to establish the existence of terbium, this chemist was induced to attempt a further separation of the erbia obtained in the course of his experiments. These investigations led to the discovery that this pink earth contained another white earth with a somewhat higher atomic weight, and whose salts gave no absorption-spectrum. To the metal contained in this earth the name *ytterbium*[2] was given. These results have recently been fully confirmed,[3] and we may accept the existence of this metal as an established fact. Marignac gave some of his specimens to his colleague, M. Soret, to examine spectroscopically. The latter chemist, operating with sunlight and with a spectroscope of high dispersive power, found that certain lines in their absorption-spectra did not agree with those of erbia, and that this was particularly the case with regard to the violet and ultra-violet portions of the spectra. From these results he was led to suspect the presence of two new earths, one of which he named provisionally X, leaving the other unnamed.[4] All attempts to separate either of these earths were, however, futile.

Shortly afterwards Lawrence Smith published[5] the results of some investigations on these earths obtained from the mineral samarskite, abundant in North Carolina and other American localities, instead of from gadolinite. As the result of his investigations he announced the discovery of a new earth, to which, however, he gave no name. It was, he said, a yellow earth possessing most of the properties of terbia, but differing from it in some reactions. Marignac, who received a sample of this earth, found,[6] on examining it, that its properties did not differ appreciably from those of terbia, and we may very well accept the verdict of this distinguished chemist. Lawrence Smith also stated that the earth called X by Soret had been discovered by him in samarskite about a year previously, and had been named *mosandrum*. He has since admitted[7] that the salts of this metal give no absorption-spectrum, and he has furnished us with no details as its special properties, mode of separation, &c., which are conclusive enough to admit of its immediate recognition as a new metal.

We now come to a number of "new" metals all belonging to the same group, and mainly distinguished by slight differences in the absorption-spectra of their salts and in their atomic weights. The earth named X by M. Soret, as well as the one he left unnamed, have been already referred to. Besides these, two new metals have been announced by M. Delafontaine,[8] which he has named *phillipium* and *decipium*. The former is a yellow earth with an equivalent between that of yttria and terbia, the latter a white earth with a higher equivalent; both possess indistinct absorption-spectra. M. Soret, who has examined the absorption-spectra very carefully, thinks it probable[9] that the mixture formerly known as erbia may contain phillipia or his unnamed earth, together with the earth X and the real erbia, besides other earths giving no absorption-spectra. Of decipium we have no confirmation. These earths have also been investigated by Cleve, in conjunction with Thalén. They came to the conclusion that there are three distinct earths which yield absorption spectra in the old erbia.[10] These they named *thulium*, *holmium*, and the real *erbium*. Subsequently they have admitted[11]

[1] *Chemical News*, vol. xxxvi. p. 33.
[2] *Arch. des Sci., phys. et nat.*, vol. lxiv. p. 101.
[3] Nilson, *Ber. d. deut. ch. Gesell.*, v. xii., p. 550; Humpidge, Brit. Ass. Reports for 1879; Lecoq de Boisbaudran, *Comp. Rend.*, vol. lxxxviii. p. 1342.
[4] *Arch. des Sci., phys. et nat.*, vol. lxiii. p. 99.
[5] *Comp. Rend.*, vol. lxxxvii. p. 146.
[6] *Arch. des Sci., phys. et nat.*, vol. lxiii. p. 172.
[7] *Comp. Rend.*, vol. lxxxix. p. 478.
[8] *Comp. Rend.*, vol. lxxxvii. pp. 559, 632.
[9] *Arch. des Sci., phys. et nat.*, vol. lxiii. p. 99.
[10] *Comp. Rend.*; vol. lxxxix. p. 478.
[11] *Ibid.*, vol. lxxxix. p. 708.

that M. Soret has priority in the discovery of these new earths, since the absorption-spectrum of holmium coincides exactly with that of the earth X., and thulium is probably the same as the unnamed earth of Soret or the phillipium of Delafontaine. The existence of these three earths in the yttria group is also acknowledged to some extent by Marignac;[1] it may therefore be considered tolerably certain that these new earths are really contained in this group, whatever names they may ultimately receive. In connection with this we must not omit to mention the investigations of M. Lecocq de Boisbaudran. He has confirmed[2] the results of MM. Soret and Cleve concerning the three earths mentioned above, and even thinks that he has obtained sufficient evidence of a fourth, named *samarium*. He admits, however, that its separation is too tedious to allow of its extraction in a state approaching purity.

In operating upon the mixture of earths formerly known as erbia Nilson was able to separate, besides the earths giving absorption-spectra and besides ytterbia, another white earth, whose salts gave no spectrum and which possessed a low atomic weight (about 45). The new metal contained in this earth he named *scandium*,[3] and he states that it is distinguished by a special spark-spectrum. These results have been confirmed by Cleve,[4] and he has remarked that many of the properties of this scandium agree closely with the metal whose existence was predicted by Mendelef under the name of *ekabor*.

The following are a few of the more striking of these resemblances:—

Ekabor	Scandium
At. wt. = 44	At. wt. = 45
Only oxide = Eb_2O_3	Only oxide = Sc_2O_3
The oxide is white, infusible, and nearly allied to yttria.	
S.G. of oxide = 3·5	S.G. of oxide = 3·8

On the other hand it is difficult to understand how a metal with such a low atomic weight could remain associated with others possessing atomic weights three or four times as great throughout the long process of fractional separation. According to all analogy with yttrium, terbium, and erbium, it ought to remain with the first of these. The following table of the metals of the yttrium group will illustrate the present state of our knowledge with regard to them. The atomic weights are calculated on the supposition that their oxides are of the general formula M_2O_3—those in italics give distinct absorption-spectra:—[5]

	Scandium (?)	Sc = 45	(Nilson)
	Yttrium ...	Y = 89	Bunsen and Cleve)
Probably identical	*Phillipium*	Pp = 111	(Delafontaine)
Probably identical	*Unnamed metal of Soret* ...		Undetermined
	Thulium		Undetermined
Probably identical	*X. of Soret*		Undetermined
Probably identical	*Holmium*		Undetermined
	Terbium ...	Tr = 147	(Marignac)
Probably identical	*Samarium* (?)		Undetermined
Probably identical	*Decipium* (?)	Dp = 159	(Delafontaine)
Probably identical	*Yβ*	= 149·4	(Marignac)
	Yα	= 156·7	(Marignac)
	Erbium ...	Er	Undetermined
	Ytterbium ...	Yb = 172	(Marignac)

It must also be remarked that Delafontaine has suspected that the didymia obtained from cerite differs from that from samarskite, although Lecoq de Boisbaudran and L. Smith have since shown that the absorption-spectrum of the didymia salts may be considerably altered by making the solutions strongly acid, &c. And it is of course open to question whether some of the spectroscopic differences ascribed to different metals may not be due to differences in the concentration, acidity, &c., of the solutions employed.

It only remains to mention the newly-discovered metals—*norwegium* and *vesbium*. The former was announced to English chemists some twelve months ago by Dr. T. Dahll.[6] It is, he says, a white metal, allied to copper in many of its properties, but with a melting-point of about 350° C., and a specific gravity of about 9·4. Its atomic weight would lie between 141·6 and 150·6. The latter metal (vesbium) has been stated by M. A. Scacchi to be present in a green incrustation found on Vesuvius in the fissures of the eruption of 1631. It is, he says, present in the shape of a red metallic acid, giving colourless salts with the alkalies. Many of its properties agree with those of molybdenum or vanadium, particularly the latter, though M. Scacchi believes that both these metals are absent. Of numerical data only the proportion of silver in the silver salt is given. This is stated to be 48·8, while for the corresponding vanadium salt it would be 52·1, a coincidence too close to be disregarded.[1] Up to the present we are without any confirmation of the existence of these two metals, and we cannot do otherwise than suspend judgment on them for a time.

Indeed the scepticism which the chemist, in common with other scientific men, ought to practise cannot be too strongly insisted upon. No discovery of such importance as that of a new element should be generally accepted until it has been submitted to a series of rigorous confirmatory tests. It is obviously so much better to defer definite judgment until sufficient facts have been collected than to accept a hasty conclusion, probably based only upon one or two anomalous reactions. How often it happens that the chemist describes a reaction not as he saw it, but as he thought he saw it, or as he hoped to see it! Even in cases where the reaction possesses some peculiarity too little attention is often paid to the effects which even traces of other substances may produce, or to any extraordinary conditions under which the experiment may be made, and the chemist at once imagines that he has discovered a "new element." Time alone will prove how many of the fourteen substances enumerated above will pass the ordeal of further and perhaps more rigorous investigations.

T. S. HUMPIDGE

Since writing the above M. Marignac has published an account of some investigations on the earths contained in samarskite.[2] He divides these earths into four groups, according to their solubility, in a saturated solution of potassium sulphate:—

(i.) Those earths soluble in less than 100 parts of the solution.
(ii.) Those soluble in 100 to 200 parts.
(iii.) Those only slightly soluble.
(iv.) Those insoluble.

Group (i.) contains only well-known earths, and particularly yttria and terbia. Their equivalent was always below 119 (oxide = MO). Group (ii.) consists of earths with an equivalent between 119 and 115. It contains traces of the preceding and following groups, but principally consists of a pale yellow earth with an equivalent of about 120·5, and without any absorption spectrum. This earth he provisionally calls Yα; its properties do not agree with those of any of the others of this group mentioned above. Group (iii.) contains a considerable quantity of terbia and didymia, together with a colourless earth yielding an absorption-spectrum agreeing with that of Delafontaine's decipia, or better with that of Lecoq de Boisbaudran's samaria. This earth he calls Yβ, and he is of opinion that decipia, samaria, and Yβ are practically one and the same earth. The equivalent he makes 115·6 (oxide = MO), which would give an atomic weight of 149·4 (oxide M_2O_3). Group (iv.) consists principally of didymia, together with considerable portions of the other earths, which it is almost impossible to completely separate.

1 *Arch. des Sci., phys. et nat.* (*loc. cit.*).
2 *Comp. Rend.*, vol. lxxxix, pp. 212 and 516.
3 *Ibid.*, vol. lxxxviii. p. 645. 4 *Comp. Rend.*, vol. lxxxix. p. 419.
5 Lawrence Smith's *Mosandrum* is not included in this list, since its existence is so improbable.
6 *Chem. News*, vol. xl. p. 25.

1 *Ber. d. deut. ch. Gesell.*, vol. xiii. p. 250; NATURE, vol. xxi. p. 420.
2 *Compt. Rend.* vol. xc., p. 899.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—At Trinity College one Millard Scholarship, tenable for four years during residence, and of the annual value of 80*l.* without limit of age, will be awarded in October next for proficiency in natural science if any candidate of sufficient merit offers himself. The subjects of examination will be chemistry and physics. Candidates may also offer mathematics, if they wish to do so, and give notice a week before the examination. Special weight will be attached to excellence in one or two subjects, rather than to a less thorough knowledge of all. The scholar elected will not necessarily be required to commence residence immediately. The same papers will be set in chemistry and physics as in the examination for the Natural Science Scholarship at Exeter College. Every candidate will be considered as standing at both colleges, unless he makes a statement to the contrary on entering his name. Candidates are requested to state which college they would prefer in the event of their being elected at both colleges. The president will receive the names of candidates, and their testimonials of character, on Wednesday, October 13, between 8 and 9 p.m.

SCIENTIFIC SERIALS

Proceedings of the Linnæan Society of New South Wales, vol. iv. Part 3, 1879, contains:—W. A. Haswell, on the Australian amphipoda, with thirteen plates, describes many new species and several new genera; of these latter, one, Amaryllis, is unfortunately already familiar to the botanist; another, Glycera, has been in use since the days of Savigny as a generic name in the animal kingdom; on the phyllosoma stage of *Ibacus peronii;* notes on the anatomy of birds; on the cylostomatous polyzoa of Port Jackson.—E. P. Ramsay, notes on birds from the Solomon Islands.—Prof. F. W. Hutton, on the genus Phalacrocorax.—W. Macleay, on the Clupeidæ of Australia.—Dr. James Cox, on the genus Cypræa.—Rev. J. Tenison Woods, on some new Australian echini (plates 13 and 14), describes *Hemiaster apicatus* (sp. n. and *Phyllacanthus parvispina* (sp. n.), and gives a revised list of all Australian echini (fifty-eight in number); on *Heterosammia michelinii* (plate 15); on a new species of Disticophora; on some fossils from Fiji; on some post-tertiary fossils from New Caledonia.—R. B. Read, on *Doris arbutus*, Angus (plate 17).

Atti della R. Accademia dei Lincei, Fasc. 4, vol. iv., March.—Light and the transpiration of plants, by Dr. Comes.—The Ciminna volcano, by S. Verri.—On *Edwardsia claparedia* (*Halcampa clap.* of Panceri), by Dr. Andres.—Fierasfer, by Prof. Emery.—On some ancient eclipses of the sun, and that of Agathocles in particular, by S. Celoria.—On movements of a surface which does not constantly touch another fixed surface, by Prof. Gautero.—The Bacillus malariæ in the region of Selinunte and Campobello, by S. Tommasi-Crudeli.—Studies in experimental pathology on the genesis and the nature of abdominal typhus, by Prof. Tizzoni.—On the variations of area described by the moon about the earth, produced by solar action, by S. de Gasparis.—Reply on the secular variations of the magnetic needle in Rome, by Dr. Keller.—On neutral tungstates of cerium, by SS. Cossa and Zecchini.

Fasc. 5, April.—The colours of animals, by Dr. Camerano.—On some noteworthy configurations of points, straight lines, and planes, of conics and of surfaces of the second order, by Dr. Veronese.—On some observations of S. Klocke on striæ of dissolution of chrome alum, by Prof. Uzielli.—On yellow incrustation of the Vesuvian lava of 1631, by S. Hofman.—On bromocamphor, by Prof. Schiff.—On the chemical constituents of *Stereocaulon vesuvianum*, by Prof. Paterno.—On some new reactions of guanina, by Prof. Capranica.

THE *Bulletin de l'Académie Royale des Sciences de Belgique*, No. 3.—Researches on the nervous system of the Arthropoda; constitution of the œsophagean ring, by M. Liénard.—Notice on the Austro-American Cucurbitaceæ of M. Ed. André, by M. Cogniaux.—Aspect of the planet Mars during the opposition of 1879, and observations of the red spot of Jupiter and of the spots of Venus, by M. Zerby.—Several reports on memoirs.

THE *Rivista Scientifico-Industriale*, No. 8, April 30.—The nefodoscope, a new instrument for showing the direction of motion of clouds, by Prof. Fornioni.—The Etna observatory, by S. Da Roberto.—Considerations on regular polygons, by Prof. Mantino.

Journal of the Franklin Institute, June.—Influence of speed on the frictional and air resistances of an unloaded steam-engine and its connected lines of shafting, by Chief-Engineer Isherwood.—The decimal gauge, by R. Briggs.—Review of the report on the Irwin injector, by W. Lewis.—Eye memory (continued), by C. G. Leland.—Nodal estimation of the velocity of light, by P. E. Chase.—Early use of anthracite coal in Pennsylvania.—On the adhesion of belts, by J. H. Cooper.

Reale Istituto Lombardo di Scienze e Lettere, vol. xiii. Fasc. viii. and ix.—Geo-mechanical solution of some problems of interpolation, by Prof. Jung.—Compensation of *proportional errors* by a given system of direct observations, by the same.—On cooling of a liquid in contact with a body in course of liquefaction or of vaporisation, by S. Cantoni.—Influence of temperature on the distribution of magnetism in a permanent magnet, by Dr. Poloni.—A curious phenomenon presented by boiling liquids, by Dr. Grassi.

Fasc. x. and xi.—On the origin of red earth in the vegetation of the calcareous soil, by Prof. Taramelli.—On the problem of the tautochrone, by Prof. Formenti.—On two new species for the Italian flora, by Prof. Ardissone.—On the aberration of sphericity in lenses of ordinary strength and aperture, and in centred dioptric systems, by Prof. Ferrini.—On the necessity in Italy of a geological institute independent of the R. Corps of Mining Engineers, by Prof. Taramelli.—On neuropathic arthritis, by Prof. de Giovanni.—On *Cilio-flagellati*, by Prof. Maggi.—On a theorem of Abel and some of its applications, by Prof. Beltrami.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 17.—"Notes of Observations on Musical Beats." By A. J. Ellis, F.R.S.

This paper gave the results of three years of observations made for the purpose of discovering the cause and amount of error in Appunn's reed tonometers, and for obtaining materials for the writer's "History of Musical Pitch" (NATURE, vol. xxi. p. 550). The principal results were these:—In free air the number of beats between two musical notes are exactly equal to the difference of their pitch, or number of double vibrations made in one second by the lowest partial or prime; this was proved by the exact agreement of the pitch of the forks in Scheibler's tonometer, determined by such beats, with their measurement by Professors McLeod and Mayer, and with the results of Koenig when reduced to a uniform temperature. For this reduction the coefficient by which the number of vibrations must be multiplied for each degree Fahrenheit varies from ·00004 to ·00006, and may be assumed as ·00005 (forks flattening by heat and sharpening by cold). It differs for different forks, and depends on the action of temperature on elasticity. Tuning-forks are very stable, proved by the fact that Scheibler's extreme forks have not varied by one-tenth of a vibration in a second since his death in 1837, and that a fork measured and marked by himself as 438 single vibrations, that is, 219 double vibrations, fifty years ago, although much rusted, has not lost more than 0·3 d. vib. Beats which take place in confined compressed air, as in Appunn's reed tonometers, are accelerated by 76 in 10,000, or, say ¾ per cent., as a mean; proved by taking the beats within and without the box of the tonometer, and determining the pitch of the reeds by beats with Scheibler's forks, the two means agreeing precisely. All beats are beats of the simple partial tones of which the compound tones are made up; proved by the bell-like beats of the disturbed unisons and higher consonances in Appunn's tonometer, while the "surge" of the non-beating partials was distinctly evident, and by the beats of the higher upper partials themselves of very low and very compound reed tones in a single note. The independent existence of the partial tones, without any assistance from reinforcing resonance cavities, was proved by determining the pitch of low reeds by the beats of their upper partials with the prime or lowest partial of different forks; thus the pitch of a reed of 31·47 vib. was determined by beats with partials 7, 9, 10, 11, 12, 13, each with a different fork, and the results varied only from 5 to 9 in the second place of decimals; the pitch of a reed of 11·90 vib., of which the prime was quite inaudible, was determined by beats with partials 20 and 28, giving 11·88 and 11·91 respectively. The best mode of constructing a tuning-fork tonometer was shown to be dependent on the fact that all tuning-forks contained their own octave, or second partial, distinctly enough to count beats between it and a fork forming its approximate octave, so that there was no occasion to tune an octave. Practical directions were given for this construction. Practical directions for performing the experiments on Appunn's tonometers have been deposited at the South Kensington Museum, where the instruments used exist, especially for the delimitation of the higher considences and consonances where the terms of the ratios are any of the numbers 1 to 16.

"Preliminary Note on the Ossification of the Terminal Phalanges of the Digits," by E. A. Schäfer, F.R.S., and F. A. Dixey, B.A.

The diaphyses of the ungual phalanges of the digits offer an exception to the usual mode of ossification of diaphysial bones (including the other phalanges) in the fact that the calcification of the cartilage and its attendant changes begins at the tip and not in the centre of the diaphysis. The subperiosteal intramembranous ossification also commences at the same point—the tip, namely, of the cartilage—as a cap-like expansion over the end of the cartilage. The irruption of the osteoblastic subperiosteal tissue also first occurs here, so that this part seems to correspond morphologically with the centre of the shaft of othe long bones. The expanded portion of the phalanx which bears the nail, claw, or hoof is entirely formed by an outgrowth of the subperiosteal bone, and is not preceded by cartilage.

A detailed account of the mode of ossification of these phalanges will be shortly published.

"The Aluminium-Iodine Reaction," by J. H. Gladstone, Ph.D., F.R.S., and Alfred Tribe, F.C.S., Lecturer on Chemistry in Dulwich College.

"Note on the Discovery of a Freshwater Medusa of the Order Trachomedusæ," by E. Ray Lankester, F.R.S. (See NATURE, vol. xxii. p. 147.)

"Note on the Bearing on the Atomic Weight of Aluminium of the Fact that this Metal occludes Hydrogen," by J. W. Mallet, F.R.S.

Zoological Society, June 15.—Prof. W. H. Flower, F.R.S., president, in the chair.—The Secretary exhibited the skin of an antelope received from the Gaboon, and remarked that it appeared to belong to the female of an undescribed species of *Tragelaphus*, allied to *Tragelaphus spekii*, which he proposed to name *T. gratus*.—Dr. A. Günther exhibited and made remarks on a series of horns of the Sambur deer of Borneo.—Mr. W. T. Blanford made some remarks on the proper name of the Himalayan marmots, now living in the Society's Gardens, which he believed to be *Arctomys hodgsoni*.—Prof. Mivart called attention to the Medusæ, now living in the Victoria-Lily house, in the Botanic Gardens, Regent's Park.—Mr. Edward R. Alston read a paper on *Antechinomys* and its allies, in which he described the anatomy of that little-known marsupial. He regarded the four genera, *Phascologale*, *Antechinus*, *Podabrus*, and *Antechinomys* as constituting a sub-family of the *Dasyuridæ*, the first and the second, and the third and the fourth, being most nearly related to one another.—Mr. G. E. Dobson read a paper on some new or rare species of Chiroptera, in the collection of the Göttingen Museum. Amongst these was a new species of *Megaderma* from Australia, which, on account of its large size, Mr. Dobson proposed to name *Megaderma gigas*.—Mr. W. A. Forbes read a paper on the anatomy of *Leptosoma discolor*, and adduced further evidence to show that this bird is related not to *Cuculidæ*, but to the rollers (*Coraciidæ*).—A second paper by Mr. Forbes contained remarks on two rare Ploceine birds in the Society's collection (*Viana splendens* and *Pytelia wieneri*).—Mr. Forbes likewise read some notes on the anatomy of a male Denham's Bustard, lately living in the Society's Gardens, and on its mode of "showing off" when alive.—Mr. Edgar A. Smith read the descriptions of twelve new species of shells from various localities. Specimens of all but two were in the collection of the British Museum.—Sir Walter Elliot, K.C.S.I., read some notes on the Indian Bustard, and its manner of "showing off," as observed by him in India.—Mr. F. H. Waterhouse read a list of the dates of publication of the several parts of Sir Andrew Smith's "Illustrations of the Zoology of South Africa."—Mr. A. W. E. O'Shaughnessy read the description of a new species of lizard of the genus *Anolis*, from Ecuador, which he proposed to call *Anolis buckleyi*, after its discoverer, Mr. Clarence Buckley.—Mr. Sclater read a paper containing a list of the certainly-known species of Anatidæ, with notes on such as have been introduced into the zoological gardens of Europe.—Mr. Wilfred Powell read some notes on the habits of the Mooroop (*Casuarius bennetti* of New Britain).

Anthropological Institute, June 22.—Edward B. Tylor, F.R.S., president, in the chair.—Mr Wilfred Powell exhibited a collection of ethnological objects from New Britain and New Ireland. Amongst them was a mask formed from a human skull and a sling which was chiefly remarkable for its great length.—Don Francisco P. Moreno exhibited two skulls from Patagonia (Rio Negro).—Prof. W. H. Flower, F.R.S., gave the substance of a paper on a collection of crania from the Fiji Islands. The two principal islands of this group are Viti Levu and Vanua Levu; until very recently we have had no skulls from either of these islands, all that have reached Europe having come from one or other of the small Eastern Islands. There has been for some time in the Museum of the Royal College of Surgeons one skull obtained from the hospital at Hobart Town, which was said to be Fijian, but this specimen is not at all typical, but rather misleading in its characters. These skulls (fourteen in number) were all found by the Baron Anatole von Hügel in the same cave in the Landongo district, quite the southern end of Viti Levu. No skull has ever been brought from the northern island, Vanua Levu. The most noticeable feature is the great similarity between the skulls; in every essential particular they are precisely alike, proving that they belong to a pure race. They are the longest and narrowest of any known, the average cephalic index being 66; they are also very high skulls. All these skulls are prognathous and platyrhine, the alveolar index being 102 and the nasal index 57. They are also mesosemes, having an orbital index of 85. A great difference is seen between these skulls and Samoan skulls, and five skulls from Vanua Velava, where the two races are brought into contact, show characters between these two extremes:—

	Bi	Hi	Ai	Ni	Oi
Fiji	66 ...	74 ...	102 ...	57 ...	85
Vanua Velava ...	72 ...	75 ...	101 ...	50 ...	88
Samoan	83 ...	78 ...	98 ...	44 ...	92

Meteorological Society, June 16.—Mr. G. J. Symons, F.R.S., president, in the chair.—T. W. Barry, M.D., A. W. Martin, and C. E. Peek, were elected Fellows, and Señor A. Aguilar and Dr. H. H. Hildebrandsson were elected honorary members of the Society.—The following papers were read:—Ozone in nature, its relations, sources, and influences, &c., from fifteen years' observations ashore and afloat under all condition, of climate, by J. Mulvany, M.D., R.N. The meteorological elements with which ozone is most intimately associated are such as occasion high vapour tension and a high degree of saturations therefore it is promoted by wind passing over a large aqueous expanse and by heat producing rapid evaporation. Hence heat if humid is no bar to atmospheric ozonisation, but no definite relation exists in the atmosphere between that *per se* and ozone; its relation to humidity is more definite and direct, but subject to many exceptions; in consequence of this relation it most abounds where its chemical qualities render it most useful. It appears to be formed in the upper strata and to be carried downwards by rain-drops, whose office is vehicular. The spherules of water which constitute clouds, and have their origin in radiation and condensation, have a similar office. Ozone does not appear to diffuse readily downwards, so that when the lower strata are robbed of ozone by jungle, &c., a considerable difference in the ozonic condition close to and at 170 feet above the surface may exist. The author is of opinion that no disease can be clearly traced to ozone as met with in the atmosphere.—The average height of the barometer in London, by Henry Storks Eaton, M.A., F.M.S.—Note on a waterspout observed at Morant Cays, Jamaica, March 23, 1880, by Lieut. Alfred Carpenter, R.N., F.M.S.—Account of a balloon ascent from Lewes in a whirlwind on March 23, 1880, by Capts. James Templer and H. Elsdale. — Results of meteorological observations made at Stanley, Falkland Islands, 1875-77, by William Marriott, F.M.S.—A new thermograph, by William David Bowkett.—The winter climate of Davos, by C. T. Williams, M.D., F.M.S. Among the high altitude sanitaria of Europe, Davos at present enjoys the greatest reputation, partly on account of its easy accessibility, and partly on account of certain peculiarities of position and shelter. The valley of Davos lies in the canton of the Grisons, between the valleys of the Lower Rhine and the Upper Engadine. The valley runs from N.N.W. to S.S.E. for about ten miles in length, with an average breadth of about a third of a mile, being for the most part of this extent a plain gently sloping towards the north, and varying in elevation from 5,400 to 4,500 feet. Davos Platz is 5,105 feet above the sea level. The author discusses the observations made during the four winters of 1876-7 to 1879-80. The peculiar effects of Davos winter climate seem to depend on (1) the rarefaction of the atmosphere; (2) its dryness; (3) the absence of strong currents, owing partly to shelter and partly to the uniform layer of snow spread around; and (4) the large percentage of the *direct* solar rays reaching the locality, owing to rarefaction of the air, and also the considerable amount of heat reflected from the extensive snow plain in front of the village of Davos Platz.

Royal Microscopical Society, June 9.—Dr. Braithwaite, vice-president, in the chair.—The following papers were read:—On the relative visibility of minute structures in solutions of phosphorus, sulphur, &c., by Mr. Stephenson.—On the life-history of the Diatomaceæ, illustrated by a large number of coloured drawings, by Prof. Hamilton L. Smith.—On a parabolised gas slide, by Dr. Edmunds.—On the structure and functions of scale leaves of *Lathrea squamaria*, by Mr. Gilbert.—On the interference-phenomena produced by luminous points, by

Mr. Woodall.—On an isophotal binocular microscope, by Mr. S. Holmes.—On the theory of microscopic vision, by Prof. Abbe.—Amongst the objects exhibited were new turntables by Dr. Matthews; slides illustrating invertebrate embryology, by the Naples Geological Station; and several new forms of microscopes and apparatus by Mr. Crisp.

PHILADELPHIA

Academy of Natural Sciences, February 17.—Germination of acorns, by Mr. T. Meehan.

March 2.—Report on plants introduced by means of the International Exhibition of 1876.

March 9.—Dr. H. Allen on the mammary glands of bats.

March 16.—Carcinological notes, No. 4, by J. S. Kingsley.

March 23.—On the gestation and generative apparatus of the elephant, by H. C. Chapman, M.D.

PARIS

Academy of Sciences, June 28.—M. Edm. Becquerel in the chair.—The death of M. Lissajous was announced.—The following papers were read:—Researches on the determination of wave-lengths of calorific rays at low temperatures, by MM. Desains and Curie. A beam of dark heat was sent through a slit to a grating of fine wire, opposite which was a rock-salt lens; beyond this lens the calorific image was formed, and examined with a thermopile. The results mainly agree with those of M. Mouton (by another method).—On the heat of vaporisation of anhydrous sulphuric acid, by M. Berthelot. This vaporisation, about 18°, absorbs − 5·9.—On some general relations between the chemical mass of elements and the heat of formation of their combinations, by M. Berthelot.—On M. Breguet's regulators with vanes, by M. Villarceau. M. Breguet has recently made three apparatus for Lisbon Observatory for determination of personal equations, and the mean errors of isochronism are, respectively, a fifteen-thousandth, an eighteen-thousandth, and a forty-thousandth. It is hoped to go further.—On a new species of the genus Dasyurus, from New Guinea, by M. Milne-Edwards. This is named *D. fuscus*; it comes nearest the Australian *D. hallucatus*.—Craniology of African negro races; dolichocephalic races, by MM. Quatrefages and Hamy.—Possible causes of variation in the results of anthracic inoculation of Algerian sheep; influence of infectant agents; applications to the theory of immunity, by M. Chauveau.—Results obtained in treatment of vines with sulphocarbonate of potassium, by M. Marés.—On the healthiness of the Isthmus of Panama, by M. de Lesseps. Many persons affected by yellow fever have landed there without restriction, but the fever has not at all spread. M. de Lesseps' opinion that quarantines could not prevent epidemics from spreading where their spread was favoured by atmospheric conditions, was called in question by M. Bouley.—On a new form of galvanometer, by M. Gostynski. Proportionality is gained to nearly 90°. The bobbin is continuous, or without slit for passage of an astatic system. A U-piece of aluminium wire hung by a cocoon fibre supports two astatic systems of the same kind, crossed at 45° and connected. A small mirror above the aluminium wire reflects the divisions of a semi-cylindrical scale.—On an apparatus for registering the law of motion of a projectile, &c. (continued), by M. Sebert. This relates to the case of the projectile meeting a sudden resistance, as when entering sand. A plan for recording the law of motion in the entire bore of the gun consists in having two guides and runners in the projectile; one runner is free, and on reaching the end of its course it removes a stop holding the other, which then begins its motion. The resistance of the air in part of the course might similarly be measured.—On the existence in tobacco-smoke of prussic acid, of an alkaloid as poisonous as nicotine, and of various aromatic principles, by MM. Le Bon and Noel. The alkaloid seems identical with the compound collidine, got in distillation of several organic substances.—Researches on the electric properties of collodion, with reflections on the nature of static electricity, by M. Leure. Collodion in thin sheets is negative with all bodies.—On transcendants which play an important part in the theory of planetary perturbations, by M. Callandreau.—On the application of the theory of sines of superior orders to the integration of linear differential equations, by M. Farkas.—Vibrations on the surface of liquids, by M. Lechat. Lagrange's supposition is incorrect, that below a very slight depth the influence of depth is *nil*.—Relation between the major and minor modes in the gamut agreed according to equal temperaments, by M. Ricard.—Strong and constant voltaic pile, furnishing results susceptible of regeneration by electrolysis, by M. Reynier. The zinc (unamalgamated) is in caustic soda solution, the copper in sulphate of copper solution, separated from the other by a rectangular vessel of parchment paper (several thicknesses). The electromotive force is 1·3 volt to 1·5 volt, according to concentration. The couple is regenerated by passing through it the current of a magneto-machine. M. Edm. Becquerel said the arrangement was not new, his father having used a similar one.—On the mechanical effects in a magnetic core from magnetising action of an electric current, by M. Ader. He has proved that all bars of magnetic nature submitted to a mechanical action of compression, torsion, or traction, tend to recover their original molecular arrangement under influence of the magnetising current.—Independent optical compass for iron-clads, by M. de Fraisseix.—Thermal study of alkaline polysulphides, by M. Sabatier.—On the transformation of amylene and valerylene into cymene and benzenic carburets, by M. Bouchardat.—On the etherification of hydriodic and hydrochloric acids, by M. Villiers.—On anhydrous crystallised lime, by MM. Levallois and Meunier. This was found on the walls of a kiln of bauxite, for burning lime.—On the presence of iron in falls of dust in Sicily and Italy, by M. Tacchini. This iron is thought to have come from the Sahara.—On the organisation and the development of Gordians, by M. Villot.—On an acarian destroyer of the gallicolar phylloxera, by M. Pickard.—Zinc: its existence in the state of complete diffusion in all rocks of the primordial formation and in the waters of seas of all ages, by M. Dieulafait.—On the cretaceous formation of the Northern Sahara, by M. Rolland.—On the discovery of new mammalia in the phosphate of lime deposits of Quercy, by M. Filhol.—On the transmissibility of tuberculosis by milk, by M. Peuch. This was proved in pigs and rabbits which drank the milk of a diseased cow. MM. Bouley and Larrey made remarks on the subject.

VIENNA

Imperial Academy of Sciences, April 22.—The following, among other papers, were read:—A new synthesis of sulphydantoïn, by Herr Andreasch.—A new derivative of sulphydantoïn, carbonid sulphonacetic acid, by the same.—On some transformation-products of rufigallic acid and the so-called oxychinon, by Dr. Schreder.—Geological Researches in the Western Balkans and neighbouring region, by Dr. Joule.—Diluvial fauna of Zuzlawitz, near Winterberg, in the Böhmerwald, by Prof. Woldrich.

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