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NATURE

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XXI.

NOVEMBER 1879 to APRIL 1880

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

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NATURE

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

THURSDAY, NOVEMBER 6, 1879

ON CERTAIN ERRORS RESPECTING THE STRUCTURE OF THE HEART ATTRIBUTED TO ARISTOTLE

IN all the commentaries upon the "Historia Animalium" which I have met with, Aristotle's express and repeated statement, that the heart of man and the largest animals contains only three cavities, is noted as a remarkable error. Even Cuvier, who had a great advantage over most of the commentators in his familiarity with the subject of Aristotle's description, and whose habitual caution and moderation seem to desert him when the opportunity of panegyrising the philosopher presents itself, is betrayed into something like a sneer on this topic.

"Du reste il n'attribue à cet organe que trois cavités, erreur qui prouve au moins qu'il en avait regardé la structure."[1]

To which remark, what follows will, I think, justify the reply, that it "prouve au moins" that Cuvier had not given ordinary attention, to say nothing of the careful study which they deserve, to sundry passages in the first and the third books of the "Historia" which I proceed to lay before the reader.

For convenience of reference these passages are marked *a*, *b*, *c*, &c.[2]

Book i. 17.—(*a*) "The heart has three cavities, it lies above the lung on the division of the windpipe, and has a fatty and thick membrane where it is united with the great vein and the aorta. It lies upon the aorta, with its point down the chest, in all animals that have a chest. In all, alike in those that have a chest and in those that have none, the foremost part of it is the apex. This is often overlooked through the turning upside down of the dissection. The rounded end of the heart is uppermost, the pointed end of it is largely fleshy and thick, and in its cavities there are tendons. In other animals which have a chest the heart lies in the middle of the chest; in men, more to the left side, between the nipples, a little inclined to the left nipple in the upper part of the chest. The heart is not large, and its general form is not elongated but rounded, except that the apex is produced into a point.

(*b*) "It has, as already stated, three cavities, the largest of them is on the right, the smallest on the left, the middle-sized one in the middle; they have all, also the two small ones, passages (τετρημένας) towards the lung, very evidently as respects one of the cavities. In the region of the union [with the great vein and the aorta] the largest cavity is connected with the largest vein (near which is the mesentery); the middle cavity, with the aorta.

(*c*) "Canals (πόροι) from the heart pass to the lung and divide in the same fashion as the windpipe does, closely accompanying those from the windpipe through the whole lung. The canals from the heart are uppermost.

(*d*) "No canal is common [to the branches of the windpipe and those of the vein] (οὐδεὶς δ' ἐστὶ κοινὸς πόρος) but through those parts of them which are in contact (τὴν σύναψιν) the air passes in and they [the πόροι] carry it to the heart.

(*e*) "One of the canals leads to the right cavity, the other to the left.

(*f*) "Of all the viscera, the heart alone contains blood [in itself]. The lung contains blood, not in itself but in the veins, the heart in itself; for in each of the cavities there is blood; the thinnest is in the middle cavity."

(Book iii. 3).—(*g*) "Two veins lie in the thorax alongside the spine, on its inner face; the larger more forwards, the smaller behind; the larger more to the right, the smaller, which some call *aorta* (on account of the tendinous part of it seen in dead bodies), to the left. These take their origin from the heart; they pass entire, preserving the nature of veins, through the other viscera that they reach; while the heart is rather a part of them, and more especially of the anterior and larger one, which is continued into veins above and below, while between these is the heart.

(*h*) "All hearts contain cavities, but in those of very small animals the largest (cavity) is hardly visible, those of middling size have another, and the biggest all three.

(*i*) "The point of the heart is directed forwards as was mentioned at first; the largest cavity to the right and upper side of it, the smallest to the left, and the middle sized one between these; both of these are much smaller than the largest.

(*k*) "They are all connected by passages (συντέτρηνται) with the lung, but on account of the smallness of the canals this is obscure except in one.

[1] "Histoire des Sciences Naturelles," i. p. 152.

[2] The text I have followed is that given by Aubert and Wimmer, "Aristoteles Thierkunde; kritsich berichtigter Text mit deutschen Uebersetzung;" but I have tried here and there to bring the English version rather closer to the original than the German translation, excellent as it is, seems to me to be.

(*l*) "The great vein proceeds from the largest cavity which lies upwards and to the right; next through the hollow middle (διὰ τοῦ κοῖλου τοῦ μέσου) it becomes vein again, this cavity being a part of the vein in which the blood stagnates.

(*m*) "The aorta [proceeds from] the middle [cavity], but not in the same way, for it is connected [with the middle cavity] by a much more narrow tube (σύριγγα).

(*n*) "The [great] vein extends through the heart, towards the aorta from the heart.

(*o*) "The great vein is membranous like skin, the aorta narrower than it and very tendinous, and as it extends towards the head and the lower parts it becomes narrow and altogether tendinous.

(*p*) "In the first place, a part of the great vein extends upwards from the heart towards the lung and the attachment of the aorta, the vein being large and undivided. It divides into two parts, the one to the lung, the other to the spine and the lowest vertebra of the neck.

(*q*) "The vein which extends to the lung first divides into two parts for the two halves of it and then extends alongside each tube (σύριγγα) and each passage (τρῆμα), the larger beside the larger and the smaller beside the smaller, so that no part [of the lung] can be found from which a passage (τρῆμα) and a vein are absent. The terminations are invisible on account of their minuteness, but the whole lung appears full of blood. The canals from the vein lie above the tubes given off from the windpipe."

The key to the whole of the foregoing description of the heart lies in the passages (*g*) and (*l*). They prove that Aristotle, like Galen, five hundred years afterwards, and like the great majority of the old Greek anatomists, did not reckon what we call the right auricle as a constituent of the heart at all, but as a hollow part or dilatation of the "great vein." Aristotle is careful to state that his observations were conducted on suffocated animals; and if any one will lay open the thorax of a dog or a rabbit, which has been killed with chloroform, in such a manner as to avoid wounding any important vessel, he will at once see why Aristotle adopted this view.

For, the vena cava inferior (*b*), the right auricle (*R.a*) and the vena cava superior and innominate vein (*V.I.*) distended with blood, seem to form one continuous column, to which the heart is attached as a sort of appendage (*g*). This column is, as Aristotle says, vein above (*a*) and vein below (*b*), the upper and the lower divisions being connected διὰ τοῦ κοῖλου τοῦ μέσου—or by means of the intervening cavity or chamber (*R.a.*)—which is the right auricle.

But when, from the four cavities of the heart recognised by us moderns, one is excluded, there remain three—which is just what Aristotle says. The solution of the difficulty is, in fact, as absurdly simple as that presented by the egg of Columbus; and any error there may be, is not to be put down to Aristotle, but to that inability to comprehend that the same facts may be accurately described in different ways, which is the special characteristic of the commentatorial mind. That the three cavities mentioned by Aristotle are just those which remain if the right auricle is omitted, is plain enough from what is said in (*b*), (*c*), (*e*), (*i*), and (*l*). For, in a suffocated animal, the "right cavity" which is directly connected with the great vein and is obviously the right ventricle, being distended with blood, will look much larger than the middle cavity, which, since it gives rise to the aorta, can only be the left ventricle. And this, again, will appear larger than the thin and collapsed left auricle, which must be Aristotle's left cavity, inasmuch as this cavity is said to be connected by πόροι with the lung. The reason why Aristotle considered the left auricle to be a part of the heart, while he merged the right auricle in the great vein, is, obviously, the small relative size of the venous trunks and their sharper demarcation from the auricle. Galen, however, perhaps more consistently, regarded the left auricle also as a mere part of the "arteria venosa." The canal which leads from the right cavity of the heart to the lung is, without doubt, the pulmonary artery. But it may be said that, in this case, Aristotle contradicts himself, inasmuch as in (*p*) and (*q*) a vessel which is obviously the pulmonary artery, is described as a branch of the great vein. How-

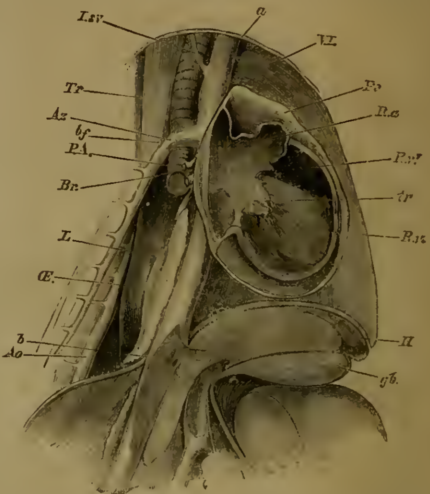


Fig. 1.—A dog having been killed by chloroform, enough of the right wall of the thorax was removed, without any notable bleeding, to expose the thoracic viscera. A carefully measured outline sketch of the parts *in situ* was then made, and on dissection, twenty-four hours afterwards, the necessary anatomical details were added. The woodcut is a faithfully reduced copy of the drawing thus constructed; and it represents the relations of the heart and great vessels as Aristotle saw them in a suffocated animal.

All but the inner lobe of the right lung has been removed; as well as the right half of the pericardium and the right walls of the right auricle and ventricle. It must be remembered that the thin transparent pericardial membrane appears nothing like so distinct in nature.

a.b., Aristotle's "great vein": *V.I.*, right vena innominata and vena cava superior; *b*, the inferior vena cava; *R.a*, the "hollow middle" part of the great vein or the right auricle; *R.v'*, the prolongation of the cavity of the right ventricle *R.v* towards the pulmonary artery; *tr*, one of the tricuspid valves; *Pc*, the pericardium; *I.sv*, superior intercortal vein; *Az*, vena azygos; *P.A.*, right pulmonary artery; *Br*, right bronchus; *L*, posterior lobe of the right lung; *Œ*, œsophagus; *Ao*, descending aorta; *H*, liver, in section, with hepatic vein, vena portæ, and gall-bladder, *gb*, separated by the diaphragm, also seen in section, from the thoracic cavity.

ever, this difficulty also disappears, if we reflect that, in Aristotle's way of looking at the matter, the line of demarcation between the great vein and the heart coincides with the right auriculo-ventricular aperture; and that, inasmuch as the conical prolongation of the right ventricle which leads to the pulmonary artery (Fig. 1, *R.v'*), lies close in front of the auricle, its base may very easily (as the figure shows) be regarded as part of the general opening of the great vein into the right ventricle. In fact it is clear that Aristotle, having failed to notice the valves of the heart, did not distinguish the part of the right ventricle from which the pulmonary artery arises (*R.v*) from the proper trunk of the artery on the one hand, and from the right auricle (*R.a*) on the other. Thus the root, as we may call it, of the pulmonary artery and the right auricle, taken together, are spoken of as the "part of the great vein which extends upwards;" and, as the vena azygos (*Az*) was one branch of this, so the "vein to the lung" was another branch of it. But the latter branch, being given off close to the connection of the great vein with the ventricle, was also counted as one of the two πόροι by which the "heart" (that is to say the right ventricle, the left ventricle, and the left auricle of our nomenclature) communicates with the lung.

The only other difficulty that I observe, is connected with (*k*). If Aristotle intended by this to affirm that the middle cavity (left ventricle), like the other two, is directly connected with the lung by a πόρος, he would be in error. But he has excluded this interpretation of his words by (*e*), in which the number and relations of the canals, the existence of which he admits, are distinctly defined. I can only imagine then, that so far as this passage applies to the left ventricle, it merely refers to the indirect communication of that cavity with the vessels of the lungs, through the left auricle.

On this evidence I submit that there is no escape from the conclusion that, instead of having committed a gross blunder, Aristotle has given a description of the heart which so far as it goes, is remarkably accurate. He is in error only in regard to the differences which he imagines to exist between large and small hearts (*h*).

Cuvier (who has been followed by other commentators) ascribes another error to Aristotle:—

"Aristote suppose que la trachée-artère se prolonge jusqu'au cœur, et semble croire, en conséquence, que l'air y pénètre (*l. c.* p. 152)."

Upon what foundation Cuvier rested the first of these two assertions, I am at a loss to divine. As a matter of fact, it will appear from the following excerpts that Aristotle gives an account of the structure of the lungs which is almost as good as that of the heart, and that it contains nothing about any prolongation of the windpipe to the heart.

"Within the neck lie what is called the œsophagus (so named on account of its length and its narrowness) and the windpipe (ἀρτηρία). The position of the windpipe in all animals that have one, is in front of the œsophagus. All animals which possess a lung have a windpipe. The windpipe is of a cartilaginous nature and is exsanguine, but is surrounded by many little veins . . . .

"It goes downwards towards the middle of the lung and then divides for each of the halves of the lung. In all animals that possess one, the lung is divided into two parts; but, in those which bring forth their young alive, the separation is not equally well marked, least of all in man.

"In oviparous animals, such as birds, and in quadrupeds which are oviparous, the one half of the lung is widely separated from the other; so that it appears as if they had two lungs. And from being single the windpipe becomes [divided into] two, which extend to each half of the lung. It is fastened to the great vein and to what is called the aorta. When the windpipe is blown up the air passes into the hollow parts of the lung. In these, are cartilaginous tubes (διαφύσεις) which unite at an angle; from the tubes passages (τρήματα) traverse the whole of the lung; they are continually given off, the smaller from the larger." (Book i., 16.)

That Aristotle speaks of the lung as a single organ divided into two halves and says that the division is least marked in man, is puzzling at first, but becomes intelligible if we reflect upon the close union of the bronchi, the pulmonary vessels and the mediastinal walls of the pleuræ in mammals;[1] and it is quite true that the lungs are much more obviously distinct from one another in birds.

Aubert and Wimmer translate the last paragraph of the passage just cited as follows:—

"Diese haben aber knorpelige Scheidewände, welche unter spitzen Winkeln zusammentreten, und aus ihnen führen Oeffnungen durch die ganze Lunge, indem sie sich in immer kleineren verzweigen."

But I cannot think that by διαφύσεις and τρήματα, in this passage, Aristotle meant either "partitions" or openings in the ordinary sense of the latter word. For, in Book iii., Cap. 3, in describing the distribution of the "vein which goes to the lung" (the pulmonary artery), he says that it

"Extends alongside each tube (σύριγγα) and each passage (τρῆμα), the larger beside the larger, and the smaller beside the smaller; so that no part [of the lung] can be found from which a passage (τρῆμα) and a vein are absent."

Moreover, in Book i., 17, he says—

"Canals (πόροι) from the heart pass to the lung and divide in the same fashion as the windpipe does, closely accompanying those from the windpipe through the whole lung."

And again in Book i., 17.—

"It (the lung) is entirely spongy, and alongside of each tube (σύριγγα) run canals (πόροι) from the great vein."

On comparing the last three statements with the facts of the case, it is plain that by σύριγγες, or tubes, Aristotle means the bronchi and so many of their larger divisions as obviously contain cartilages; and that by διαφύσεις χονδρώδεις he denotes the same things; and, if this be so, then the τρήματα must be the smaller bronchial canals, in which the cartilages disappear.

This view of the structure of the lung is perfectly correct so far as it extends; and, bearing it in mind, we shall be in a position to understand what Aristotle thought about the passage of air from the lungs into the heart. In every part of the lung, he says, in effect, there is an air tube which is derived from the trachea, and other tubes which are derived from the πόροι which lead from the lung to the heart, *suprà* (*c*). Their applied walls constitute the thin "synapses" (τὴν σύναψιν) through which the air passes out of the air tubes into the πόροι, or blood vessels, by transudation or diffusion; for there is no community between the cavities of the air tubes and cavities of the canals; that is to say, no opening from one into the other, *suprà* (*d*).

On the words "κοινὸς πόρος" Aubert and Wimmer remark (*l.c.* p. 239), "Da A. die Ansicht hat die Lungenluft würde dem Herzen zugeführt, so postulirt er statt vieler kleiner Verbindungen einen grossen Verbindungsgang zwischen Lunge und Herz."

But does Aristotle make this assumption? The only evidence so far as I know in favour of the affirmative answer to this question is the following passage:—

[1] In modern works on Veterinary Anatomy the lungs are sometimes described as two lobes of a single organ.

"*Συνήρτεται δὲ καὶ ἡ καρδία τῇ ἀρτηρίᾳ πιμελώδεσι καὶ χονδρώδεσι καὶ ἰνώδεσι δεσμοῖς· ᾗ δέ συνήρτεται, κοῖλόν ἐστιν. φυσωμένης δὲ τῆς ἀρτηρίας ἐν ἐνίοις μὲν οὐ κατάδηλον ποιεῖ, ἐν δὲ τοῖς μείζοσι τῶν ζῴων δῆλον ὅτι εἰσέρχεται τὸ πνεῦμα εἰς αὐτήν*" (i. cap. 16).

"The heart and the windpipe are connected by fatty and cartilaginous and fibrous bands; where they are connected it is hollow. Blowing into the windpipe does not show clearly in some animals, but in the larger animals it is clear that the air goes into it."

Aubert and Wimmer give a somewhat different rendering of this passage:—

"Auch das Herz hängt mit der Luftröhre durch fettreiche, knorpelige und faserige Bänder zusammen; und da, wo sie zusammenhängen, ist eine Höhlung. Beim Aufblasen der Lunge wird es bei manchen Thieren nicht wahrnehmbar, bei den grösseren aber ist es offenbar, dass die Luft in das Herz gelangt."

The sense here turns upon the signification which is to be ascribed to *εἰς αὐτήν*. But if these words refer to the heart, then Aristotle has distinctly pointed out the road which the air, in his opinion, takes, namely, through the "synapses"; and there is no reason that I can discover to believe that he "postulated" any other and more direct communication.

With respect to the meaning of *κοῖλόν ἐστιν*, Aubert and Wimmer observe:—

"Dies scheint wohl die kurze Lungenvene zu sein. Schneider bezieht dies auf die Vorkammern, allein diese werden unten als Höhlen des Herzens beschrieben."

I am disposed to think, on the contrary, that the words refer simply to the cavity of the pericardium. For a part of this cavity (*sinus transversus pericardii*) lies between the aorta, on the one hand, and the pulmonary vessels with the bifurcation of the trachea, on the other hand, and is much more conspicuous in some animals than in man. It is strictly correct, therefore, in Aristotle's words, to say that where the heart and the windpipe are connected "it is hollow." If he had meant to speak of one of the pulmonary veins, or of any of the cavities of the heart, he would have used the terms *πόροι* or *κοιλίας* which he always employs for these parts.

According to Aristotle, then, the air taken into the lungs passes from the final ramifications of the bronchial tubes into the corresponding branches of the pulmonary blood vessels, not through openings, but by transudation, or, as we should nowadays say, diffusion, through the thin partitions formed by the applied coats of the two sets of canals. But the "pneuma" which thus reached the interior of the blood vessels was not, in Aristotle's opinion, exactly the same thing as the air. It was "*ἀὴρ πολὺς ῥέων καὶ ἀθρόος*" ("De Mundo," iv., 9)—subtilized and condensed air; and it is hard to make out whether Aristotle considered it to possess the physical properties of a gas or those of a liquid. As he affirms that all the cavities of the heart contain blood (*f*), it is clear that he did not hold the erroneous view propounded in the next generation by Erasistratus. On the other hand, the fact that he supposes that the spermatic arteries do not contain blood but only an *αἱματῶδης ὑγρόν* ("Hist. Animalium," iii., 1), shows that his notions respecting the contents of the arteries were vague. Nor does he seem to have known that the pulse is characteristic only of the arteries; and as he thought that the arteries end in solid fibrous bands, he naturally could not have entertained the faintest conception of the true motion of the blood. But without attempting to read into Aristotle modern conceptions which never entered his mind, it is only just to observe that his view of what becomes of the air taken into the lungs is by no means worthy of contempt as a gross error. On the contrary, here, as in the case of his anatomy, what Aristotle asserts is true as far as it goes. Something does actually pass from the air contained in the lungs through the coats of the vessels into the blood, and thence to the heart; to wit, oxygen. And I think that it speaks very well for ancient Greek science that the investigator of so difficult a physiological problem as that of respiration, should have arrived at a conclusion, the statement of which, after the lapse of more than two thousand years, can be accepted as a thoroughly established scientific truth.

I trust that the case in favour of removing the statements about the heart, from the list of the "errors of Aristotle" is now clear; and that the evidence proves, on the contrary, that they justify us in forming a very favourable estimate of the oldest anatomical investigations among the Greeks of which any sufficient record remains.

But is Aristotle to be credited with the merit of having ascertained so much of the truth? This question will not appear superfluous to those who are acquainted with the extraordinary history of Aristotle's works, or who adopt the conclusion of Aubert and Wimmer, that, of the ten books of the "Historia Animalium" which have come down to us, three are largely or entirely spurious and that the others contain many interpolations by later writers.

It so happens, however, that, apart from other reasons, there are satisfactory internal grounds for ascribing the account of the heart to a writer of the time at which Aristotle lived. For, within thirty years of his death, the anatomists of the Alexandrian school had thoroughly investigated the structure and the functions of the valves of the heart. During this time, the manuscripts of Aristotle were in the possession of Theophrastus; and no interpolator of later date would have shown that he was ignorant of the nature and significance of these important structures, by the brief and obscure allusion—"in its cavities there are tendons (*a*)." On the other hand, Polybus, whose account of the vascular system is quoted in the "Historia Animalium" was an elder contemporary of Aristotle. Hence, if any part of the work faithfully represents that which Aristotle taught, we may safely conclude that the description of the heart does so. Having granted this much, however, it is another question, whether Aristotle is to be regarded as the first discoverer of the facts which he has so well stated, or whether he, like other men, was the intellectual child of his time and simply carried on a step or two the work which had been commenced by others.

On the subject of Aristotle's significance as an original worker in biology extraordinarily divergent views have been put forward. If we are to adopt Cuvier's estimate, Aristotle was simply a miracle:—

"Avant Aristote la philosophie, entièrement spéculative, se perdait dans les abstractions dépourvues de fondement; la science n'existait pas. Il semble qu'elle soit sortie toute faite du cerveau d'Aristote comme Minerve, toute armée, du cerveau de Jupiter. Seul, en effet, sans antécédents, sans rien emprunter aux siècles qui l'avaient précédé, puisqu'ils n'avaient rien produit de solide, le disciple de Platon découvrit et démontra plus de vérités, executa plus de travaux scientifiques en un vie de soixante-deux ans, qu'après lui vingt siècles n'en ont pu faire,"[1] &c., &c.

"Aristote est le premier qui ait introduit la méthode de l'induction, de la comparaison des observations pour en faire sortir des idées générales, et celle de l'expérience pour multiplier les faits dont ces idées générales peuvent être déduites."—ii. p. 515.

The late Mr. G. H. Lewes,[2] on the contrary, tells us "on a superficial examination, therefore, he [Aristotle] will seem to have given tolerable descriptions; especially if approached with that disposition to discover marvels which unconsciously determines us in our study of eminent writers. But a more unbiased and impartial criticism will disclose that he has given no single anatomical description of the least value. All that he knew may have been known and probably was known, without dissection. . . . . I do not assert that he never opened an animal; on the contrary, it seems highly probable that he had opened many . . . . . . He never followed the course of a vessel or a nerve; never laid bare the origin and insertion of a muscle; never discriminated the component parts of organs; never made clear to himself the connection of organs into systems."—(pp. 156-7.)

In the face of the description of the heart and lungs, just quoted, I think we may venture to say that no one who has acquired even an elementary practical acquaintance with anatomy, and knows of his own knowledge that which Aristotle describes, will agree with the opinion expressed by Mr. Lewes; and those who turn to the accounts of the structure of the rock lobster and that of the lobster, or to that of the Cephalopods and other Mollusks, in the fourth book of the "Historia Animalium" will probably feel inclined to object to it still more strongly.

On the other hand, Cuvier's exaggerated panegyric will as little bear the test of cool discussion. In Greece, the century before Aristotle's birth was a period of great intellectual activity, in the field of physical science no less than elsewhere. The method of induction has never been used to better effect than by Hippocrates; and the labours of such men as Alkmeon, Demokritus, and Polybus among Aristotle's predecessors, Diokles, and Praxagoras, among his contemporaries, laid a solid foundation for the scientific study of anatomy and development, independently of his labours. Aristotle himself informs us that the dissection of animals was commonly practised; that the aorta had been distinguished from the great vein; and that the connection of both with the heart had been observed by his predecessors. What they thought about the structure of the heart itself, or that of the lungs, he does not tell us, and we have no means of knowing. So far from arrogantly suggesting that he owed nothing to his predecessors, Aristotle is careful to refer to their observations and to explain why, in his judgment, they fell into the errors which he corrects.

Aristotle's knowledge, in fact, appears to have stood in the same relation to that of such men as Polybus and Diogenes of Apollonia, as that of Herophilus and Erasistratus did to his own, so far as the heart is concerned. He carried science a step beyond the point at which he found it; a meritorious, but not a miraculous, achievement. What he did required the possession of very good powers of observation; if they had been powers of the highest class he could hardly have left such conspicuous objects as the valves of the heart to be discovered by his successors.

And this leads me to make a final remark upon a singular feature of the "Historia Animalium." As a whole, it is a most notable production, full of accurate information and of extremely acute generalisations of the observations accumulated by naturalists up to that time. And yet, every here and there, one stumbles upon assertions respecting matters which lie within the scope of the commonest inspection, which are not so much to be called errors as stupidities. What is to be made of the statement that the sutures of women's skulls are different from those of men; that men and sundry male animals have more teeth than their respective females; that the back of the skull is empty, and so on? It is simply incredible to me that the Aristotle who wrote the account of the heart, also committed himself to absurdities which can be excused by no theoretical prepossession and which are contradicted by the plainest observation.

What, after all, were the original manuscripts of the "Historia Animalium"? If they were notes of Aristotle's lectures taken by some of his students, any lecturer who has chanced to look through such notes, would find the interspersion of a foundation of general and sometimes minute accuracy, with patches of transcendent blundering, perfectly intelligible. Some competent Greek scholar may perhaps think it worth while to tell us what may be said for or against the hypothesis thus hinted. One obvious difficulty in the way of adopting it is the fact that, in other works, Aristotle refers to the "Historia Animalium" as if it had already been made public by himself.

T. H. HUXLEY

[1] "Histoire des Sciences Naturelles."—t. i. p. 130.
[2] "Aristotle, a Chapter from the History of Science."

ON THE NECESSITY FOR A NEW DEPARTURE IN SPECTRUM ANALYSIS

IT is now about a year since I gave an account of the results to which the final discussion of a complete set of photographs of the spectra of the metallic elements compared with the spectrum of the sun had led me.

The comparison was limited necessarily to the blue and violet portions of the spectrum, as photography was employed, and the methods since worked out by Capt. Abney for photographing the other regions were not then available. Of set purpose I limited it still more, as I wished to find the *dernier mot* in the present state of science regarding the coincidence of metallic with Fraunhofer's lines; and for this it was imperative to work on a large scale over a small region rather than on a small scale over a large one.

In point of fact, the work was limited to about the $\frac{1}{100}$th part of the spectrum, and this small part was mapped on a large scale. A complete map of the spectrum on the scale adopted would be about half a furlong long. The work took time: including interruptions of one kind and another, some four years were expended on it.

I have elsewhere discussed at some length the conclusion which stared us in the face when all the work was brought to focus, but it is important that I should here dwell upon it for a moment, especially as it is now possible, perhaps, to state it with more terseness and clearness than one could at first, when the new conception thus forced upon us and its consequences were less familiar to one's mind.

Simply, it amounted to this. The new work had made us acquainted with the fact that there were coincidences in the lines of metallic spectra of two perfectly distinct kinds.

The lines of one kind we could explain, on the hypothesis that the elements are truly elementary, by supposing that in the case, let us say, of coincident lines in the spectrum of iron and cobalt, the common line was due to an impurity either of iron in the cobalt or of cobalt in the iron. Most spectroscopic workers were of the true faith in this matter; they accepted the dicta of the chemist, and not only was the work which had shown how the phenomena observed *might be* thus explained received with favour, but no one, so far as I know, inquired whether there was any other "might be" in the matter. It is more than probable, however, that the future will have much to say on this very point; but with this set of coincidences I am not dealing in this paper.

So much for the one set of coincidences.

The other set was as different as possible. In this category there was, on the impurity hypothesis, no possible explanation forthcoming without changing ground. In fact, the separation of the coincidences into two classes was brought about by this very circumstance, since all the coincidences which, in accordance with a general law established for a constant temperature some years before, could be attributed to impurity had, as a matter of fact, been eliminated from the maps at a prior stage of the investigation. Further, be it noted that all the photographs represented the work of similar temperatures, for they were all taken with electric arcs, for the production of which the same number of Grove's cells was used in all cases.

Since therefore these lines which were common to two or more spectra, could not be traced to impurities, what was their probable origin? Their number was so great that to attribute them to physical coincidences, and to rest and be thankful accordingly, would have been to take the very pith and marrow out of the science of spectrum analysis, which we have heard so often is based absolutely upon different substances giving us spectra with special lines for each. The matter then was worthy of serious investigation.

Using the analogy presented by the spectroscopic behaviour of known compounds when simplified by heat, a simple explanation of these common lines lay on the surface. This explanation is as follows:—

The temperature of the sun and the electric arc is high enough to dissociate some of the so-called chemical elements, and give us a glimpse of the spectra of their bases, just as in the case of the various salts of calcium there is a temperature which just allows us to get a glimpse of a line indicating the metal calcium common to them all.

Hence it was allowable to term the coincident lines of the second order "basic lines," since they might point to the existence of a base common to the substances in the spectra of which they appeared. Davy, before he discovered potassium, used, as I have since found, the word "basic" to express the same idea.

I propose in the present paper to refer to some of the facts collected along one line of work to which my subsequent studies of these lines has led me, with a view to show that their true basic nature can now no longer be open to doubt.

Naturally the first thing to do was to see if these basic lines varied in their behaviour from other lines of spectra taken at random. Supposing them to represent mere chance coincidences—"physical coincidences," as they have been called, or again, lines so near together that our means cannot separate them—there is no reason why they should vary together when the temperature is changed; while, if they be truly basic, they *must* vary with temperature. Further, they must vary in such a way that other conditions being equal, they shall become stronger when the temperature is increased, and become fainter when the temperature is reduced.

Now what was the best mode of attacking this problem? I was unable to see a more expeditious one than that presented to us by the sun. The following consideration will show how we might hope for help in this quarter.

We are accustomed to say that the sun is surrounded by an enormous atmosphere, and that this atmosphere has in it the vapours of metals, such as iron, magnesium, &c., with which metals we are familiar on this planet. This statement has been based on the near agreement presented by the places of the lines in the spectrum of the substances as studied in our laboratories and the Fraunhofer lines themselves. The matching of these spectra is nothing like so perfect, and the conclusion drawn, therefore, is nothing like so firmly based, as is generally imagined; but this point need not occupy our attention at present; what it is important for us to bear in mind is this: whatever be the chemical nature of this atmosphere, it will certainly be hotter at bottom—that is, nearer the photosphere—than higher up. Hence, if temperature plays any part in moulding the conditions by which changes in the resulting spectrum are brought about, the spectrum of the atmosphere close to the photosphere will be different from that of any higher region, and therefore from the general spectrum of the sun, which practically gives us the summation of all the absorptions of all the regions from the top of the atmosphere to the bottom.

Now as a matter of fact we have the opportunity, when we observe the spectrum of a sun-spot or a prominence, of determining the spectrum of an isolated mass of vapours in the hottest region open to our inquiries, and seeing whether it is like or unlike the general spectrum of the sun. What then are the facts?

It is as unlike as possible: the intensities of the lines are inverted to a wonderful extent. More than this there is a constant difference between the spectra of sun-spots and the spectra of metallic prominences, though we see these phenomena generally at about the same *niveau* in the sun's atmosphere. This may arise from the fact that in the case of the spots we deal generally with a greater thickness of the vapours.

To get the best idea of this inversion I have prepared maps of the spectra of the chief chemical substances showing the behaviour of the various lines under the various conditions. The result is very striking; indeed it is striking to quite an unexpected degree. The whole character of the spectrum of iron, for instance, is changed when we pass from the iron lines seen among the Fraunhofer lines to those seen among the spot-and storm-lines; a complex spectrum is turned into a simple one, the feeble lines are exalted, the stronger ones suppressed almost altogether.

Since then the spectra of spots and prominences are confessedly the spectra of the hottest region of the sun available to our inquiries, we can test the nature of the basic lines by seeing how they behave when we pass from the general solar to these special solar spectra.

With special reference to this point I have brought together the various observations which have been recorded of the lines visible in solar disturbances at the sun's limb, and those observed to be widened, brightened, or otherwise modified in the spectra of solar spots.

The finest series of observations of this kind that we possess is that collected by Prof. Young near the time of the last maximum of sun-spots, during his stay at Sherman, at a height of 8,000 feet. The result which stares us in the face when we examine the work done by Young is most striking; but although his observations of the chromospheric lines extend over the whole visible spectrum, the list of lines in the solar spots is limited to the less refrangible region; we must therefore limit the discussion to this region.

As a basis for the discussion, I have used the lines given in Thalén's admirable tables, comparing them with those shown in Ångström's map, and indicating the intensities of the lines which are given in the tables, and which particular line occurs in the map only. A glance then shows which line is seen in spots and prominences, and how it is affected. In short we have in one view, for each metallic substance, exactly what happens to the lines of that substance—which lines are not touched; those which are visibly affected both in spots and storms, or those recorded in one table and not in the other.

Taking all the lines included in the discussion, the following statistics will show how they are distributed:—

Total number of lines in Thalén's list and map included in the discussion	345
Number of lines affected in spots	108
Number of lines bright in storms	122
Number of lines common to spots and storms	68
Number of lines seen in neither spots nor storms	183

So much for the list of lines as a whole. It is also necessary to show the number of lines assigned to each metal, and those among them which occur in both spots and storms, or only in one or the other.

Metal.	Number of Lines.	Number of lines common to spots and storms.	Number of lines due to		Unaffected.
			Spots.	Storms.	
Sodium ...	8	4	6	6	0
Magnesium	4	3	4	3	0
Barium ...	23	1	3	7	14
Calcium ...	25	7	15	10	7
Strontium ...	18	0	0	0	18
Nickel... ...	12	1	3	2	8
Cobalt... ...	19	3	3	3	16
Manganese ...	16	2	3	6	9
Cadmium ...	15	0	0	0	15
Chromium ...	14	3	3	5	9
Titanium ...	87	11	18	18	62
Iron... ...	104	33	50	62	25
	345	68	108	122	183

It will be seen that the ratio between the affected and unaffected lines is very variable. What strikes one, indeed, is the wonderful irregularity in the behaviour of the various lines; there is no relation, for instance, between the widening of the lines in the spots and their appearances in the prominences.

It may here be asked, "But what has this to do with basic lines?" I answer, it would have nothing to do with basic lines if Thalén had not observed them; but in his observations, which are the *ne plus ultra* of spectroscopic accuracy, he came across them abundantly. The basic lines therefore have the great advantage of not being new.

Among the 345 *lines given by Thalén are* 18 *with identical readings in two spectra.* They are, therefore, the exact equivalents of those lines which I have found to be basic in work on another part of the spectrum.

Now, for the reasons above given, if my explanation of their basic character be the correct one, then we should expect a considerable development of these lines in the spectrum of the hottest regions of the sun, which spots and storms enable us to study apart from the absorption going on at higher levels.

It is not too much to say that the result of this inquiry settles this question in the most conclusive way. What does come out in the strongest manner is the following very remarkable fact.

The only constant thing in the tables employed in the inquiry is, that *these basic lines are always widened in the spots.* However badly the brighter lines of a chemical substance, taken as a whole, may be represented amongst the spot lines, as the basic lines, among these which are often of the second or third order of intensity and sometimes even of the fourth, are never absent. The same fact holds almost equally true with regard to the storms.

The following comparison of Thalén's basic lines with those seen by Young in solar spots and storms shows this result:—

Thalén.					Young.		
Wave-length.	Common to		Intensity.		Spots.	Storms.	
					Widening.	Frequency.	Brightness.
5207·6	Fe	Cr	3	1	4	10	6
5203·7	Fe	Cr	3	1	4	10	6
5340·2	Fe	Mn	2	3	2	1	2
6064·5	Fe	Ti	2	2	3	5	2
5661·5	Fe	Ti	3	1	4	15	2
5403·1	Fe	Ti	2	3	4	5	3
5396·1	Fe	Ti	2	2	7	4	2
5352·4	Fe	Co	4	3	2	4	2
5265·8	Fe	Co	2	3	2	10	4
5168·3	Fe	Ni	3	5	4	40	30
5166·7	Fe	Mg	2	1	2	30	20
5681·4	Fe	Na	3	3	3	2	1
6121·2	Co	Ca	1	3	4	5	3
5601·7	Ca	Fe	4	1	2		
5597·2	Ca	Fe	3	1	2		
5856·5	Ca	Ni	3	4	2		
5425·0	Ba	Ti	3	3	4		
6449·0	Ca	Ba	2	3	2		

So far as my own knowledge of these matters goes, I can imagine no severer test to apply to the hypothesis that the basic lines in the above table are produced by the dissociation of the metals to which the lines are common,—in this case chiefly the metals of the iron group—in the hottest region of the sun, and to my mind the proof is conclusive that at that temperature we have a mixed mass of vapours in which the base is more predominant than the so-called chemical elements to which that base is common.

But although I hold that this is the most conclusive test to apply, it is not the only one which the sun affords us.

We have every reason to believe that there is a considerable difference in the temperature of the spot- and storm-stratum when it is absolutely quiescent and cut off from all visible action from below, and again when it is riddled with convection currents of the most tremendous character, in other words that its temperature at the sun-spot maxima and minima is not the same. Hence we may imagine that the difference of temperature will affect the basic lines especially, and that they will be stronger at one period of the sun-spot curve than at another.

I limit myself for the present to the statement that this comparison has also been made to a certain extent, and that the result of it is entirely in harmony with what has gone before, so far as the observations go, but more spots must be observed before a complete discussion is possible. This, however, is certain, that basic lines widened at Sherman in 1872 were not observed widened at Greenwich in 1877, or at Kensington in the spots which appeared last month.

I for my part, then, am perforce driven by the stern logic of facts to the conclusion that these "basic lines" are not accidental; are not "physical coincidences;" and do not owe their origin to impurities; but that their appearance in two or more spectra is dependent upon high temperature merely.

The original statement, then, that the spectrum of each element consists only of lines special to that element, is found to be insufficient when the highest temperatures and the greatest dispersions are employed, and a "higher law" has to be introduced to bring the statements of the text-books into harmony with the facts.

The dissociation of the elements of the iron group at the highest temperatures we can command and in the sun, is a cause by which this fact can be explained, if we accept the law of continuity, and reason on well based analogies.

This, of course, constitutes a new departure in spectrum analysis, whatever its bearing may be found to be upon Chemical Philosophy, when that subject is again studied as it once was.

To those who follow the line of reasoning on such a subject which the spectroscope provides us with, and even to those who admit the cogency of the conclusions, it will be astonishing that such a result has been arrived at in such an indirect way; there are, however, many minds so constituted that they will prefer to endow matter with any number of undreamt of qualities before they will accept such a solution.

But for all that, when the facts are well considered by competent authorities, it will, I think, be granted that an inorganic evolution is already glimpsed, in the study of which we shall not be baffled by any "breaks in strata."

J. NORMAN LOCKYER

MIND IN THE LOWER ANIMALS

Mind in the Lower Animals in Health and Disease. By W. Lauder Lindsay, M.D., F.R.S.E., F.L.S., &c. (London: C. Kegan Paul and Co., 1879.)

DR. LAUDER LINDSAY has long been known as a contributor to periodical literature in the province of comparative psychology. The work which he now publishes with the above title clearly represents a great amount of labour. It is in two large octavo volumes which together present somewhat over 1,000 pages, and contain references to the writings of about 200 authors. It is furnished with an excellent index and a bibliography. The latter, we are told, is "confined to works consulted by the author," and "almost exclusively to those published in Britain and in the English language." The work is also furnished with a long "enumeration of the animals whose character and habits form the basis of the author's generalisations." The list includes 908 species belonging to 516 genera, both the popular and the scientific names being in every case supplied.

In so extensive a work by so well-known a man there is, as we should expect, a great deal that is both of interest and value. Particularly in this connection may be pointed out his compilation and digestion of facts regarding the psychology of savages as contrasted with that of animals, and also many of his observations on the insanity of animals as compared with the insanity of man. His chapters on "General Adaptiveness and "The Use of Instruments" also deserve, on the whole, to be commended.

But while we welcome a book—and especially a popular book—the leading object of which is to prove the kinship of animal intelligence to human, it is impossible not to regret the occurrence of certain faults which the exercise of a little more judgment might have obviated. In the first place the work is painfully diffuse. Whole pages, and even chapters, might with advantage have been omitted, while there are but few chapters which might not, with equal advantage, have been considerably condensed. Those, for instance, on "Faults of Terminology," "Animal Reputation," "Responsibility of Animals," and others, appear utterly useless. Whether or not it is accurate to call the lower animals "dumb," "lower," &c., and whether or not the "reputation" of a dog suffers from the use of such terms as "dogging," "hounding," "cat and dog life," &c., and whether or not any one is so foolish as to suppose that a smuggler's dog is morally responsible for a smuggler's acts; whether or not these things are so, they are certainly not of sufficient importance to demand lengthy discussion. Again, such statements as the following are quite superfluous, at least out of a nursery-book:—

"While the dog barks, bites, growls, howls, whines, sniffs, and snarls; the horse neighs, kicks, stamps, paws, snorts, champs, lashes its tail; the cat purrs, scratches, hisses, mews; cattle low, butt, gore, bellow; the elephant trumpets, roars, screams; the sheep and goat bleat; the ass brays, the cock crows, and the hen clucks and cackles."

This is all quite true, but it is not new; and the same remark is applicable to pages and pages of both volumes. In short, unlimited diffusiveness is the worst fault of the book. The next worst fault is that of presenting alleged facts of animal intelligence on evidence that is obviously insufficient. Thus, for example, we are told that the hermit crab "has been noticed to feed the anemone (on his shell) with his pincer-like claws;" that ants "employ language of command;" that "snails are capable of concerted action;" that fish may die of "grief from bereavement;" that dogs exhibit "modesty or decency;" that monkeys "turn keys in doors, without noise, to secure themselves against interruption, discovery, or capture;" and so on, while in none of these cases are any facts or authorities given to support the assertions. Again, in many other cases where the facts and authorities are given, they are of a kind that ought not to have any place in a treatise which aims at a scientific discussion of its subject. For instance, we are told, without any expression of doubt on the part of the author, that "Daniell shows how a mere passing fancy for—a glimpse at—some dog, on the part of a pointer bitch, so impressed her memory and imagination that she transmitted this impress in a physical form to her progeny." Again, on no better authority than that of *The Animal World*—from which, indeed, Dr. Lindsay is very fond of quoting—we are expected to believe that "certain sparrows that failed, by seizing its wings with their bills, to lift a wounded companion, so as to convey it to a position of safety, got a twig, and while the maimed bird took hold of its centre by its bill, two of its companions seized, one each of its ends, so raised the helpless sparrow from the ground, and removed it to a safer place." And, to give only one other illustration, on the authority of an American paper called the *Christian Union*, we are told this painfully pathetic story:—"A young rat had fallen into a pail of pig-food; six older ones held a consultation so earnest in its character as to lead them to ignore the presence of human on-lookers. They decided on an ingenious scheme of rescue, and successfully carried it out. Entwining their legs together, they formed a chain, hanging downwards over the edge of the pail. The foremost or downmost rat grasped the drowning, and, as it subsequently proved, drowned, young one in its fore-paws, and both rescued and rescuer were then drawn up and out. When found to be dead, the rescuers gazed at their young comrade in 'mute despair,' wiped the tears from their eyes with their fore-paws, and departed without making any attempts to resuscitate it."

Evidently these rats were not acquainted with the Royal Humane Society's directions for the restoration of the apparently drowned, and considering that the calamity occurred in a civilised country, the most striking feature of the incident appears to be the ignorance which the animals displayed in yielding to grief "without making any attempts" to produce artificial respiration.

Another fault which pervades the work is that of undue eagerness to prove that no difference in kind exists between the mind of man and the mind of the lower animals—a fault which leads the author into the opposite error of disparaging such difference as does exist. Thus the book abounds with such statements as the following:—"There are countless thousands—many whole races—(of men) that are intellectually and morally the *inferiors* of many well-trained mammals, such as the chimpanzee, orang, dog, elephant, or horse; or birds, such as the parrot, starling, magpie, jackdaw, and various crows; as well as many animals much lower in the zoological scale, and not trained by man at all, such as the ant, bee, and wasp." And this belief in the mental equality, or even superiority, of animals as compared with the lower races of man, is doubtless the explanation of the writer's tendency to attribute to rational thought actions of animals which are much more probably due to other causes. For instance: "A cat was found drowned in a pond immediately after the death of a master to whom it had been much attached. It had left the house on his illness a fortnight previously, refusing to enter it again (*Animal World*). The inference was that grief had led to deliberate self-destruction; but the verdict of accidental drowning, is, of course, equally permissible." The word "equally" here serves to illustrate our meaning.

With regard to references there is also a serious complaint to be made. It is not enough to give the name of an author without any reference to the part of his writings where his facts or opinions are stated. Thus, although Dr. Lindsay's pages are thickly strewn with the names of his authorities in brackets, his readers will but rarely have the opportunity, without an impracticable amount of trouble, of seeing exactly what these authorities themselves have to say on the topics in connection with which they are quoted.

On minor faults or errors it is needless to dwell—such as the curious notion which Dr. Lindsay seems to entertain, that the word "glutton" is derived from the synonym of the wolverine, instead of *vice versâ* (p. 92). The chief faults are undoubtedly those which have been mentioned, and they have been mentioned in order to suggest that, should there be a second edition of the book, it would be greatly improved by presenting less diffusiveness and more discrimination than is presented by the first edition.

GEORGE J. ROMANES

OUR BOOK SHELF

An Atlas of Anatomy; or, Pictures of the Human Body, in Twenty-four Quarto Coloured Plates, comprising One Hundred Separate Figures. With descriptive Letterpress by Mrs. Fenwick Miller, Member of the London School Board, &c. (London: Edward Stanford, 1879.)

THIS work has been issued at a comparatively low price in the hope that it may be found useful both to science teachers and to all kinds of students. Children, we have it on the authority of Mrs. Miller, with their keen interest in the facts of Nature and with their fresh undistracted minds full of curiosity about what is around them, are always found to take a deep interest in the wonderful structure and functions of their own bodies. The subjects of anatomy and physiology have been introduced into many of the London Board Schools and have been found wonderfully popular among the children. An Inspector records that he has often been struck with the alacrity with which the children rush to their seats for an oral examination in physiology, even at the end of a long and tiring day of inspection. Truly such children must be very desirous to know all about themselves, and for such no doubt such a volume as this would prove quite an acceptable gift. Nearly all the drawings represented in the plates are new—never before published in any form in England. Some of them are from Dr. Heitzmann's Atlas, others are drawn from preparations in the Vienna Museum of Anatomy. In writing the letterpress the authoress had mainly in view the requirements of young students, and she has not assumed that any of her readers possess any knowledge of the subject. We are not disposed to be critical on a work published with such evidently good intentions. The physiological portions of the text are good, and if thoroughly taught to students and understood by them will place them far above the ordinary standpoint of the medical student of the day. The more purely anatomical descriptions would have been improved if written more for the plates than they have been. The plates themselves will be found extremely useful. We should have preferred that the amount of enlargement of the figures was always given; structures also like those figured at A on Plate xxiv. should be clearly defined as only diagrammatic representations, and a little greater attention to correctness of outline might fairly have been bestowed on the figures representing parts of the skeleton. The letterpress is accompanied by a pretty copious index to the plates, which might even still with advantage be greatly enlarged. This book in the hands of an intelligent teacher will be found most useful and instructive, and it may be made the text from which to preach many a most important practical lesson. Take the short paragraph headed Salivary Glands, how much human suffering might be avoided by a right comprehension of the facts therein stated.

Electric Transmission of Power. By Paget Higgs, LL.D., D.Sc. (London: E. and F. N. Spon, 1879.)

One of the important practical questions which an engineer continually has to face is the transmission of power from the place where the power is generated to the spot where the power is needed. Where the distance is great, belts and shafting are not only wasteful but impracticable, and hydraulic or pneumatic transmission is called into play. Here, again, great distances cannot be surmounted without great loss of power, and hence from time to time many wistful glances have been turned in the direction of electricity. It is only to-day, however, that, amid the manifold applications of electricity, its employment as an economical means of transmitting power has become a question of practical importance.

At the Loan Collection of Scientific Apparatus exhibited at South Kensington in 1876, two small magneto-electric machines made by Gramme were to be seen illustrating this electric transmission of power. The mechanical work expended in one machine was converted into electricity, conducted over a considerable space, and transformed again into mechanical work by the other machine. The amount of power practically reclaimable by such an arrangement, as shown by recent experiments quoted in the little work before us, "may amount to 48 per cent. of that expended in the first instance. This amount of reclaimed power is indubitably superior to that obtained with compressed air, and approaches the practical efficiency of hydraulic transmission" (p. 85). With great distances the relative efficiency of electric transmission must be still more marked, besides the advantage that the conductor, having nothing to burst or give way, can be led in any direction or freely moved whilst transmitting many horse-power. Already in France ploughing has been done by electricity with advantage, and where natural sources of power, as waterfalls or tidal action, exist in any neighbourhood, the extreme value to a community of this novel application of electricity is sufficiently obvious. Municipal authorities might find in the water supply of a town an unexpected source of income. For where there is a continuous supply of water under considerable pressure, as is the case in an increasing number of our large towns, baths and washhouses might be erected in the lower parts of the town, and the energy possessed by the water converted into electricity and distributed for sale as power, whilst the matter of the water would of course remain equally serviceable for the purposes intended.

To those interested in the general question of the electric transmission of power we do not know any better guide than Prof. Ayrton's admirable lecture on this subject before the British Association. To the student the work before us will be found useful for more extended reference, as it gives the salient features of the investigations by Mascart, Hopkinson, Siemens, Houston and Thomson, and others, on the efficiency of various dynamo-electric machines. But we regret that Dr. Higgs has issued this book with such precipitate haste, for, as it stands, it is a most slovenly piece of patchwork, and to be of real use to the public it must be in part rewritten and the facts presented in a more intelligible and orderly sequence.

W. F. B.

LETTERS TO THE EDITOR

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

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

Sun-Spots in Earnest

The communications in Nature, vol. xx. p. 625, regarding the note of Prof. Piazzi Smyth, Nature, vol. xx. p. 602, induce me to send an extract from my observing-book on those spots, together with some observations of them by Herr Hartwig, assistant to the observatory.

My observations of the sun are made with a rather small telescope, aperture of object-glass by Reinfelder and Hertel, of Munich, 74mm., with Merz polarisation eye-piece, power 55, images very fine, colourless.

1879.	M.T. Strassb. h. m.	
October 6	... 0 0	No spot on the sun.
,, 7	... 0 10	On the following limb two great regions of faculæ, with extremely narrow black spots in them.
,, 8	... 1 0	The group of faculæ, seen yesterday, contains to-day three great spots, with double nuclei; besides that there is a fourth system of three or four smaller spots with penumbra.

I did not look at the sun on the following days. The observations of Herr Hartwig are made by projection and with the heliometer of the observatory. By this instrument the polar and equatorial diameter of the sun has been measured every day since April, 1876, clouds permitting. It was during this series of micrometric measurements that Herr Hartwig made his remarks.

	Sid. T. Strassb.	
October 6–7	... 12 50	The sun appears without spots.
,, 7–8	... 12 25	Sun without spots; very bad definition.
,, 8–9	... 12 10	Beautiful group of spots near the following limb.
,, 10–11	... 12 15	Same group of spots, as seen the day before yesterday. Four very great spots; the following, which had *two* nuclei, like the others, has to-day *three*.
,, 12–13	... 13 10	Double spot on the middle of the disk; group of spots on the following limb.

Afterwards the clouds did not permit the sun to be seen for a week. It appears from these observations, that this first great display of solar activity after the minimum of spots, entered the disk October 6-7; it passed off, as Mr. Christie remarks, October 21.

A. Winnecke

Strassburg Observatory

Subject-Indexes

Most of those engaged in scientific work will probably agree with the views on this subject put forth by Mr. Wheatley in Nature, vol. xx. p. 627. There can be little doubt that a complete subject-index of scientific literature, in the sense in which it is generally understood, could not be compiled, and that the result of an attempt to do so would be as useless as it would be cumbrous, for the obvious reason that in a given paper, much valuable work is recorded which served only as a means to the end treated of; this work, therefore, lies hidden under a title which does not even remotely refer to it.

On the other hand, the compilation of lists of papers on particular subjects is fraught with no great difficulty, and would be of very great value. While the preparation of such minor indexes founded on the Royal Society Catalogue may be left to private enterprise, great advantage would, I think, be derived from some united action in the matter. I have myself made considerable headway with a classified list of papers on the subject which chiefly interests me, and which perhaps is best named Molecular Physics. This work necessitates my going through the whole catalogue for the sake of comparatively few papers, and I am further obliged to copy out the titles of, and references to, the papers I require. Now, if a movable copy of the Royal Society's Index were made as suggested by Mr. Garnett (NATURE, vol. xx. p. 554), and the different entries classified in sciences, these difficulties would be removed; Mr. Garnett, however, underrates the cost of preparing such a movable index, which would be large enough to deter many "gentlemen with leisure" from undertaking it. This work, therefore, must be carried out either by the Royal Society, or by a committee of those who take an interest in the subject; when completed the index could be distributed among those willing to undertake the subsequent arrangement in subjects.

There is another suggestion which I should like to make before closing this letter. Every month as it slips by adds rapidly to the enormous accumulation of scientific papers; unless these are catalogued and classified immediately they are published, the subject catalogue will never be satisfactory. What is wanted, then, is the publication (say every quarter) of a *complete* list of the scientific papers published during that period. I am aware that, as mentioned by Mr. Garnett, many such lists now appear, but none of them can be trusted as complete records.

If, however, a list were published "by authority" (for example, by the British Museum or the Royal Society), scientific men all over the world would send the titles of their papers to be entered in it, and it would soon be recognised that those who did not do so would stand a chance of rendering their work useless to those who travel after them along the same paths.

Science Schools, November 3 F. D. BROWN

Easter Island

IN the very interesting review of Mr. Wallace's "Australasia," in NATURE, vol. xx. p. 598, there is a passing reference to some views of my own concerning the stone images of Easter Island. The nature of the inferences that may be drawn in this case is not, I think, generally understood; and without wishing to give the subject more importance than it deserves, I should be glad if you could allow me space for a few words upon it.

Any positive ideas about the people who made them can hardly be got from the images themselves. They are rudely carved and ugly, and no existing race attempts to make anything really like them. But they are very numerous and very large; many of them weigh twenty tons, some probably two or three times as much. They have been quarried from a volcanic hill, conveyed several miles, and set upright upon pedestals, on massive stone terraces of great length. Work of this kind requires a definite amount of labour and strength. The amount available depends on the population. The population of a solitary island inhabited by savages is strictly limited by its area; the area of Easter Island is not more than forty square miles. There is, I believe, no known example in which an island of this kind supports, in an uncivilised state, more than fifty persons to the square mile. This is double the usual limit among savages.

Two thousand, therefore, would be the extreme limit of the population of Easter Island, unassisted from without; it has not more than half this number at present. In a population of 2,000 there are about 500 adult males, and we are to consider whether the work could have been done or even thought of with this amount of physical strength. It is, doubtless, quite impossible. A much larger number of people, or the help of civilised appliances, must necessarily have been at hand; but neither of these could be at hand without external help, and this could only reach the island across two thousand miles of ocean.

This is the really important point in this chain of inferences. We are led by what I think are inevitable steps to the conclusion that when these images were made there was a nation somewhere whose ships navigated the Pacific Ocean in such a manner that Easter Island could for a long period be supported as a colony.

I will not speak here of the anthropological bearings of this inference. Let me, however, enter a gentle protest against the sentence in which your reviewer speaks of "the accepted scientific position that primitive man was savage."

No doubt this is at present the belief of the majority of those who express their views; but there are names of great weight on the other side, and, considering what our actual knowledge of "primitive man" amounts to just now, it is rather hard upon science to make her responsible for our speculations.

November 3 ALBERT J. MOTT

Animals and the Musical Scale

IN a criticism in the *Examiner* of a book of mine on the "Theory of Music," the writer says:—

"We can hardly agree with Dr. Pole's view as to the essential artificiality of the diatonic scale, especially in the light of many facts collected by Mr. Darwin and other good observers. It is now almost certain that several of the lower animals have a very fair notion of the scale, and employ notes almost, if not quite, identical as to interval with our own."

If any of your readers can bring forward well authenticated facts of the kind they will be very interesting.

Athenæum Club, October 29 WILLIAM POLE

John Miers

IN your notice of the late venerable botanist, Mr. John Miers, in NATURE, vol. xx. p. 614, it is stated that "to the last he disbelieved in the action of the pollen and of the pollen-tube in the formation of the embryo-plant."

It is possible that the writer may have had some further warrant for this statement than the views published by Mr. Miers in his memoir on *Myostoma* (*Trans.* Linn. Soc., xxv. pp. 461-475 (1866), but it is scarcely borne out by them.

Mr. Miers's position as there expressed is that "it is not the pollen-tube, but simply the fluid-material contained in the pollen-grain, and emitted from its tubes, which is the direct agent in the process of fertilisation."

Whatever may be thought of this view, it is far from justifying the strong statement that in supporting it Miers "disbelieved in the action of the pollen." HENRY TRIMEN

October 28

[It would certainly have been more explicit had we added the word "tube" to pollen. At p. 468 of the paper cited by Dr. Trimen, Mr. Miers remarked "that the very important fact alluded to (the impact of the pollen-tube on the embryo-sac and the consequent fertilisation of the ovule) has not yet been satisfactorily proved." This was written in 1866. In the same paper "we have it demonstrated that in this case (Myostoma) the theory of the application of pollen-tubes for the fertilisation of its ovules is distinctly disproved."—ED.]

The Howgate Arctic Expedition

CAPT. HOWGATE, U.S.A., having for some years past fruitlessly endeavoured to obtain the comparatively small grant of 50,000 dollars from the American Government, for the purpose of carrying out his peculiar scheme of Arctic exploration, by forming a colony of active and experienced men, with a few families of Eskimos, at the coal-bed discovered some years ago in Lady Franklin Bay, Smith Sound, lat. 81° N., has determined to equip a private expedition on a smaller scale with this object.

A screw-steamer of about 140 tons (cargo measurement) has been bought for Capt. Howgate in the Clyde, has been refitted there, but not strengthened for ice navigation, which is to be done at Washington, and will, wind and weather permitting, sail for America on Thursday, November 6.

As most of your readers probably already know, Capt. Howgate's intention is that the explorers, instead of living on board ship, shall pass the winter in wooden houses taken out on purpose in frames, to be set up near the coal-seam, the party to remain in this locality for two or more years, watching a favourable opportunity of smooth ice or open water to push northward, and occupying their time usefully in making scientific observations, which are still much wanted in that far north region. Balloons, the telegraph, and probably the telephone, may be brought into use. J. R.

Intellect in Brutes

I AM in possession of an intelligent pointer dog, not quite two years old. The manner in which he makes his exit from the garden brought forcibly to my recollection Prof. Möbius's experiment with a pike, as narrated by Mr. Romanes in his article "Animal Intelligence" in the *Nineteenth Century* for October 1878, p. 659. A pike took three months to learn that he could not reach a minnow separated from him by a sheet of plate glass, and after its removal he never afterwards attacked the minnow. As Mr. Romanes says: "the firmly-established association of ideas never seems to have become disestablished." My pointer seems to arrive at an established association of ideas as fixed as the pike, a fact extremely interesting, considering that the dog is much higher in the scale of life than a fish.

The dog, when young, could only escape out of the garden through a small and difficult gap between the gate-post and the fence—a rose one. Some months ago a spar was broken out of the gate, and though the hole thus made was from the ground upwards, and quite large enough to allow of the passage of a large dog through it, yet it never took advantage of it. About a month ago a friend presented me with a young dog of the same variety, and it *at once* discovered the hole in the gate and went through it. But the older dog continues still to use the old gap between the post and the fence, and singularly enough it will see its companion pass through the hole in the gate, and it will even put its head through the vacant space and then turn aside and painfully crawl through the fence gap, which as a young dog it had discovered and used.

The discussion concerning the intelligence of the lower animals carried on in NATURE has interested some of us here. The following, regarding the gnawing of lead by rats, may perhaps interest your readers. Capt. Moir of the 99th Regiment, at present stationed here, showed me three bullets, still in the cartridge (for the Martini-Henry rifle), half eaten away by the rats, at Fort Chelmsford, Zululand. The rodents had made their way into the haversack in which the cartridges were, cut the strings tying the packet of cartridges, tore the brown paper off in which they were rolled, and then nibbled at the balls. These cartridges are made up in thin brass—which in no case was gnawed at. Nearly the longitudinal half of the exposed part of one bullet was eaten away; they had eaten into half the bullet, crossways of another cartridge, and in the third case they had nibbled off the point of a bullet.

It cannot be supposed that they nibbled for nibbling's sake; doubtless the smell of the grease in the cartridges attracted their attention to the haversacks, and the smell of the grease behind the bullets led them to attack the bullets—the only vulnerable point. JAMES TURNBULL

Grey Town, Natal, September 8

P.S.—There is a rat in Natal which, so far as I can gather, frequently carries its young ones before they are covered with hair; the little things cleave to the teats with mouth and feet. Gilbert White mentions that he once met with such an instance in England. I have not secured a specimen of this rat, though I have seen it once, and once only.—J. T.

Centipedes and Bees

As a postscript to Dr. Hutchinson's letters, I offer the following:—

The centipede does not "bite" at all—it makes tiny incisions with its numerous feet, which in themselves cause trifling inconvenience; but, when alarmed, it drops into each some kind of venom that causes intense inflammation (the *modus operandi* I now forget, but a medical friend explained it very clearly). I once had a centipede's nest in or near my bath-room, no less than eleven of different sizes having been killed there. Our first knowledge of them was derived from an infant child of the female servant, who, having been left on the floor there, was found crying and writhing beyond all soothing. When brought to me the child was feverish and restless, the *left* hand specially hot; on removing the little jacket, the fore-arm was found greatly swelled and inflamed, with two rows, less than half an inch apart, of pricks showing white on the delicate brown flesh. Ipecacuanha and eau de luce soon subdued the pain, but it was days before the child was well again. Several other persons also suffered from them, but only in one case was the line of pricks clearly traceable. Once, stooping to take up a water-pot, I felt a little *froissement* about the thumb; looking down, I perceived a centipede fully four inches long, which deliberately crawled across my hand near the knuckles, causing no pain, but a most unpleasant titillation, which continued for some time, though I put the hand in cold water immediately. On another occasion, seeing a centipede on the naked foot of one of the women, I called out to her, "Roho mut" (do not stir), and she similarly escaped all serious injury, while an application of warm oil very quickly removed all irritation. Of course it is only when crawling straightforward and undisturbed that the line of pricks can possibly be detected. On disturbance the animal shrinks up, curls round, and brings a number of them into one spot; at least such was the case the only time I ever *saw* a centipede do mischief; and the same appeared probable on other occasions when I saw merely the after-result.

I remember once, in the jungles of Rohilkund, one of our line of elephants brushed down a bee's nest from an old tree. Some of the nearest men were immediately stung; the servant behind me instantly wrapped me in a shawl I had beside me, then wrapped himself from head to foot in his large Kummerbund, as did all the other men, and off we went at speed to a small river not far off, where the elephants (who had not escaped) plunged themselves to their very backs, as the only mode of getting rid of their little assailants.

I may add that a small black scorpion common in the Dehlie division is very venomous. I have myself seen a case in which its "strike" was nearly fatal to a shepherd of about fifty years of age. MEMORIA

Bone-Sucking—A Habit of Cattle

THE habit of bone-sucking in cattle (NATURE, vol. xx. p. 457) is not peculiar to Natal. The learned Archbishop of Dublin, Dr. Whately, many years since made a most interesting communication to the then existing Dublin Natural History Society on this subject, and stated his observation that animals addicted to bone-sucking invariably fell into an unhealthy state unless the bone was removed from the field. There is a scarcity of limestone, as Mr. Donovan suggests, with us to account for this "bad habit," for such the Archbishop considered it.

Dublin W. FRAZER

IN response to the letter of Mr. H. C. Donovan (NATURE, vol. xx. p. 457), in relation to the habit of cattle in the colony of Natal *chewing bones*, I beg leave to state that many years ago, in a monograph on "Geophagy," I had occasion to put on record a similar habit among the cows in one of the Southern Atlantic States of the United States (*vide Southern Medical and Surgical Journal*, new series, vol. i. pp. 417–444, August, 1845). From this paper I quote (p. 442–443) the following extract bearing upon the question:—

"In confirmation of the importance of inorganic principles in the food, I will here adduce a remarkable fact which has repeatedly fallen under my own observation: The cows which live on the extensive savannas and pine-barrens lying on the north side of the Altamaba River, in McIntosh County, Georgia, subsist upon very coarse species of grasses, which are probably deficient in some of the phosphatic or calcareous ingredients essential to healthy nutrition, for these animals are constantly observed to *chew bones*. They frequently remain stationary for hours, with the head elevated to prevent the saliva from escaping from the mouth; they will, by constant trituration, gradually reduce the bony mass to a very small size, when it is rejected as an unmanageable morsel. The cattle in this section of the state are usually rather lean, and cows brought from the fertile plantations in the neighbourhood, if allowed to subsist on what they can procure in the savannas and pine-barrens in the course of a year or two become equally thin, and ultimately fall into the habit of *eating bones*. I have not been able to ascertain whether these animals indulge in this habit to a *greater extent* when they are in a state of *pregnancy* and when they are giving *milk*, but it appears reasonable that the increased demand for mineral matters under such conditions of the economy would call for a proportionate supply. The intelligent instinct which prompts these animals to seek for a diet so extraordinary must originate in an inadequate supply, in their impoverished aliment, of some of the inorganic principles (probably the phosphatic salts) essential to a proper nourishment of the osseous structures."

Berkeley, California, October 4 JOHN LECONTE

Earthquake in China

THE north of China has been very unfortunate of late. Famine has raged in the provinces of Shantung, Shansi, Shensi, and

Honan within the last three or four years, and, in a less severe form, in one or two of the adjoining provinces. Shansi is still suffering. And now the south-east of the province of Kansah has been visited by a destructive earthquake. The *Peking Gazette* of the 22nd of August states that a memorial has been received from Tso Tsung-t'ang, Governor-General of Shensi and Kansuh, reporting that on June 29 a slight trembling was felt at *Chieh Chow*, and at other sub-prefectures and districts within the province of Kansuh. This trembling, which occurred at first on alternate days and afterwards continued for several successive days, did not entirely cease until July 11. The earthquake would appear to have reached its height on the third day; for Governor-General Tso reports that on July 1 there was a violent shaking accompanied by a noise. A temple, several official residences, and many dwelling-houses were completely destroyed, and many persons were killed and injured.

In the Imperial edict Tso Tsung-t'ang is directed to send officers to the scene of the calamity to hold an investigation into the matter and afford relief to the sufferers. A. H.

Canton, September 13

Vertical Shafts in the Chalk in Kent

In the current number of *Good Words* there is a pleasant, gossiping paper by the Rev. J. G. Wood, giving an account of the curious well-like shafts found in the chalk about Erith. They are 40 feet to 100 feet in depth. Mr. Wood states that the sides show traces of having been wrought with picks made of deer antlers. He appears to accept the theory of local archæologists that the shafts were executed in "prehistoric" times, in the quest for flints for weapons or for some less obvious purpose.

Under any circumstances I should be loth to dispute the view of so competent an authority, and in this instance I have no local knowledge to guide me; but I should be grateful if some of your readers would satisfy me on the following point:—Is there any instance of similar excavations which have been conclusively proved to be the work of savages ancient or modern? I know of none within my own personal experience.

Burrows on the "adit" or "gallery" principle, *i.e.*, more or less horizontal, can be carried surprisingly far, so long as the roof does not fall in. We see this in the abodes of certain quadrupeds. But, to carry down a *vertical* shaft a few feet in diameter to a depth of 40 feet to 100 feet from the surface, even in a soil as favourable as chalk, appears to me to involve recourse to mechanical appliances not yet observed in use among primitive races. If I am wrong in this matter, the mode of excavation pursued by these rude shaft-sinkers certainly affords interesting matter for study. H. M. C.

London, November 1

THE FUNCTIONS OF UNIVERSITIES

We reproduce with pleasure the following extract from an article on this subject from the *Times* of Friday last, in connection with Prof. Max Müller's address at the Birmingham Midland Institute:—

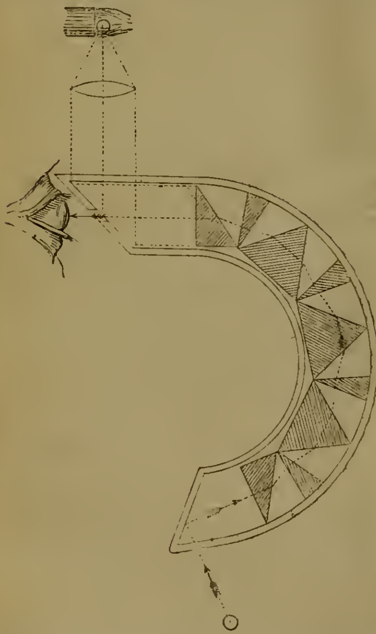
It would doubtless be unjust, as Prof Müller points out in his address, to attribute the lack of spontaneity, the tendency to mechanical uniformity in academical studies, exclusively to the influence of an elaborate system of examinations. Examinations are clearly necessary, as he justly contends, even though they are no better than a necessary evil; but they are rather means than ends, and they clearly become mischievous when they corrode and destroy the true spirit of academical life. Prof. Müller, a German professor in an English university, whose opinion is on that account entitled to peculiar weight, draws a favourable contrast between English and foreign universities; the former, he says, are free and self-governed, and that gives them an unrivalled position in spite of all their faults. The remark is true and appropriate, especially as a rejoinder to the hasty and ill-considered criticisms of Prof. Helmholtz in his rectorial address at Berlin, delivered some time ago. But the corporate freedom of the English universities, is, unhappily, not inconsistent with a good deal of personal bondage. Let us contrast, for instance, the career of a graduate of a German university with that of an English Fellow of a college. The former, as soon as he has passed the necessary examinations for his degree, is perfectly free to follow his own bent. Even in taking his degree he is entitled to claim it, partly at least, on the ground of some dissertation which he has written containing the results of his own independent study and research. If he elects to follow an academical career, he becomes at first a Privat-docent, and has to attract pupils, not by his power of preparing them for a particular examination, but by his command of all the available knowledge in a special branch of study, and by his capacity for enlarging its bounds. If he is called to be a professor, it is because he is known to be master of his subject, and to be keeping himself on a level with the march of knowledge in relation to it. The English graduade may have all the aspiration to follow this career of true academical freedom; but his pupils for the most part have no higher object than to pass an examination, and it is his business to prepare them for it. Any knowledge that he posseses beyond the range required for that purpose becomes a useless burden to him. The results of fresh research necessarily find their way but slowly into examination papers, and consequently the teacher at an English university, if he studies at all, is bound to study, not for himself, but for his pupils. He must learn all that they want to know, and he must put his knowledge into the form which will be most readily available for their purposes. Hence, if he has time to write at all, he writes summaries of history, essays in philosophy, or prepares a handy edition of a portion of a classic commonly read in the schools. A learned and scholarly edition of an author unrecognised in our somewhat narrow classical curriculum, a history like Grote's or Gibbon's, a philosophical work like the "Essay on the Human Understanding," or the "Critique of Pure Reason," are works hardly now to be looked for from a resident English graduate. Professorial work, of course, is different; it is beginning now to be recognised that it is the business of a professor to study widely and deeply and to advance the bounds of knowledge. But if the coming generation of teachers, the professoriate of the future, is to be confined to the range of a rigid and cramping system of examinations, narrow in their content, but all-embracing in their extent, what hope is there for that academic freedom, for that bracing spirit of living knowledge, of active thought, of ever-advancing study which, as Prof. Müller tells us, it is the true function of a university to foster and keep alive?

The truth is, perhaps, that our universities are a little too careful of the functions they so admirably discharge of finishing schools, a little too unmindful of those higher duties to which Prof. Müller's address forcibly calls attention. All that they do is done well, but there is still one thing needful. "That is the true academic stage in every man's life when he learns to work, not to please others, be they schoolmasters or examiners, but to please himself; when he works for sheer love of work in and for the highest of all purposes—conquest of truth." How many of our English University students ever reach this stage at all? That they learn much and learn it well cannot be doubted, that they are examined much and are examined well is equally indisputable. But we should be very sorry to see the Universities complacently resign the function of making scholars in favour of that of testing the attainments of schoolboys. We are very far from arguing that examinations can be dispensed with altogether. They have their purpose, and it is a very necessary purpose to fulfil. It is their indirect results in stereotyping academical effort, in extinguishing academical freedom, in discouraging wide study, in checking individuality, and in repressing spontaneity, rather than their direct results, that we have to fear The evil is no slight one, and we fear it is still on the increase. "Unless," said Mill, "individuality shall be able to assert itself against the yoke of public opinion, Europe, notwithstanding its noble antecedents and its professed Christianity, will tend to become another China." Prof. Müller would persuade us that our Universities are a safeguard against this catastrophe. But when China is mentioned in connection with education, examinations are suggested by an irresistible association. If, therefore, England is to escape the fate of China, it is not only encouraging to reflect that the most conspicuous modern building in Prof. Müller's own University is the new Examination Schools.

DESCRIPTION OF AN INSTRUMENT FOR EXPLORING DARK CAVITIES WHICH ARE INACCESSIBLE TO DIRECT LIGHT

AN electric lamp has recently been proposed for surgical and dental operations.[1] Some years ago I designed an instrument for illuminating the dark cavities of the body which would, I think, be very serviceable in connection with an electric lamp.

This instrument consists of a series of prisms arranged somewhat as in the corona employed for spectrum analysis. The accompanying woodcut will be sufficiently intelligible



without any detailed description. The different prisms are of glass of such refractive indices as to secure achromatism, and the rays of light are bent round corners, so as, finally, to reach an external observer.

In most cases one or two such prisms will be sufficient, but any number may be employed so long as the loss of light from absorption, superficial reflection, and other causes is not so great as to defeat the object in view by destroying the distinctness of the image.

THOMAS STEVENSON

[1] *Engineer*, March, 1879.

IMPROVEMENTS IN BLEACHING

A METHOD of applying the ordinary bleaching agents (hypochlorites) in a new way has been invented by Count Dienheim de Brochocki of Paris. Instead of immersing the goods to be bleached in an ordinary "chloride of lime" vat, and subsequently souring, the inventor treats bleaching-powder with an acid and simultaneously passes air through the mixture, so that chlorine and hypochlorous acid vapours are mechanically carried off; the resulting gases are passed through an alkaline solution in such proportions as to saturate part or the whole of the alkali, or to supersaturate it at will. The resulting liquid is said to be sufficiently stable to be kept without change for two or three months; it can readily be prepared of a density of 30° Beaumé, and acts as a bleacher without requiring any acidulation, and for many purposes is said to be superior to the ordinary bleaching-vat.

To this liquid the fanciful name "chlorozone" has been given, the inventor asserting that the oxidising power of a given quantity of bleaching-powder is *increased* by this treatment through the fixation in the product of some of the oxygen of the air used as carrying agent; the which oxygen he conceives to be liberated in the form of ozone in contact with the goods to be bleached! Although no experimental proof of the truth of this somewhat novel proposition appears to have been vouchsafed to the scientific world, yet it would seem that the new product has at least some practical advantages over the older bleaching agents, as it is used to a considerable extent in Paris, whilst works for its manufacture on a large scale have been recently erected at Warrington by Messrs. Nath. Holmes and Partners.

HERING'S THEORY OF THE VISION OF LIGHT AND COLOURS[1]

III.

IN the sixth and last memoir the author develops the part of his theory which has probably excited the most interest, namely, that of the vision of *colours*. He devotes his first section to the *mode of classification* of colours, and as this is not only the most important part, but differs materially from the generally received views, it is desirable to give its substance pretty fully.

He explains that, as he has based his general theory on what are naturally and physiologically two simple sensations, white and black, so he proposes to base his treatment of colours on the "natural system of colour-sensations." He then has to seek what the simple natural sensations of colour are, neglecting in this classification all consideration of the physical properties usually connected with them. He inquires, therefore, what simple colour-sensations there are. Taking the six usually admitted, violet, blue, green, yellow, orange, and red, he finds that two, namely, violet and orange, are obviously compound sensations; for in violet of every hue there can be distinguished clearly a mixture of the two sensations, blue and red; and similarly in orange there can always be traced the elements of red and yellow. The other four colours are red,[2] green, blue, and yellow. None of the sensations known by these names contain, when pure, any semblance of another colour-sensation. These four, therefore, may with perfect correctness, as was pointed out by Leonardo da Vinci, be considered as simple or fundamental colour-sensations. On this account they have received special names, not borrowed from any coloured natural objects.

All other colour-sensations than these may be called mixed or compound sensations, as two elements can always be discovered in them; but it is a fixed principle

[1] Continued from vol. xx. p. 639.
[2] This, however, is not the spectral red, which contains a mixture of yellow.

that *more than two simple colours* can never be evident in the same mixture.

There is also a natural peculiarity in the capabilities of the various simple colours for combining with each other. Red will combine with yellow or blue, but not with green, *i.e.*, red and green can never be both distinguished in the same combinations. Similarly, yellow will combine with red or green, but not with blue. Green will combine with blue or yellow, but not with red; and blue will combine with red or green, but not with yellow. In other words, we find the natural law that *on the one hand Red and Green*, and *on the other hand Blue and Yellow*, are never visible together in the same combination; they are incapable of combining together. What the cause of this is it is impossible to say. It is customary in books on physics to say that red and green, or blue and yellow combined, make white; but this is only true when by red, green, &c., are meant ether vibrations, and not physiological sensations; for to insist that red *plus* green makes white in the same sense that red *plus* blue makes violet would be contrary to common observation, for in pure white there is no trace of any colour-sensation whatever. It must, therefore, be something in the natural connection of these colours with our sense of vision that makes these combinations incompatible with each other; and for the sake of using a short expression for this relation, the author proposes, in consideration of their so-to-speak inimical relations to each other, to call red and green, or blue and yellow *opposite*, or *contrary*, or *antagonistic colours* (*Gegenfarben*).[1]

The combination of any simple colour-sensation with that of another (not antagonistic) gives a sensation of a different *hue* (*Farbenton*), and the hue will vary according to the proportions of the components. Thus different proportions of red and blue will give different hues of violet, and so on. The whole scale of these may be conveniently expressed by a "colour circle." Divide a circle into four quadrants, and at each point of division put one of the four simple colours, arranging the antagonistic ones diametrically opposite to each other. The intermediate portions may then be filled in with compound hues, passing in regular gradations from one of the simple colours to the next adjoining on either side. Such a circle, if supposed to be divided into very minute gradations, will contain all possible hues of colour. And every *hue, both simple and compound, will have, diametrically opposite to it, its natural antagonistic colour*.[1] Now every possible hue of colour may appear in many different states of "purity," or, as it is often called, "saturation." These various states are called by the author "nuances," and they are caused by the mixture with the hue in question of various proportions of black and white, *i.e.*, various degrees of the black-white sensation. Thus red may be mixed with black, white, medium gray, light gray, or dark gray, every grade giving a different nuance of the red hue.[2] The different hues and the different nuances of each taken together will comprise all colour-sensations possible.

The pure colour-sensations are unknown to us; what we experience are always nuances containing white or black. The fact that some colours, and some parts of the spectrum, appear so much brighter than others is due, the author asserts, to the fact of the former containing more white. He conceives that if the pure colour-sensations alone could be experienced they would all be of equal brilliancy, and would probably have the same degree of luminosity as the medium gray; for as each colour-sensation must be considered as an independent one, there is no reason for attributing to any of them the particular effect that we are accustomed to connect with whiteness in particular.

The varieties of colour-sensation admit of being expressed in a formula. Varieties of hue may be expressed by the proportions of each colour they contain; thus $\frac{\text{Blue}}{\text{Red}}$ or $\frac{\text{Red}}{\text{Blue}}$ will express all varieties of violet; the *blueness* of it will $= \frac{\text{Blue}}{\text{Blue} + \text{Red}}$, and the *redness* $= \frac{\text{Red.}}{\text{Blue} + \text{Red.}}$

The nuance of a hue, or its degree of purity, is expressed by the ratio the weight of the pure colour-sensation bears to the whole weight of the combination; thus the purity of a nuance of Blue $= \frac{\text{Blue}}{\text{Blue} + \text{White} + \text{Black}}$. Thus, suppose a red is mixed with double its weight of medium gray, then there are equal weights of each sensation, and the purity will be

$$= \frac{1}{1 + 1 + 1} = \frac{1}{3} = 0{\cdot}33.$$

For a compound hue, for example, violet, the purity will be $= \frac{\text{Blue} + \text{Red}}{\text{Blue} + \text{Red} + \text{Black} + \text{White}}$. For example, suppose the weight of the blue and red sensations are 4 each, the white 1, and the black 3, forming a dark nuance of violet, the purity

$$= \frac{4 + 4}{4 + 4 + 1 + 3} = \frac{8}{12} = 0{\cdot}66.$$

The author further forms an estimate of the *brightness* or *luminosity* (*Helligkeit*) of a nuance by the formula

$$\frac{\text{White} + \frac{1}{2}\,\text{Colour}}{\text{White} + \text{Black} + \text{Colour}}.$$

Thus in the former of the above two examples, the luminosity will be

$$= \frac{1 + \frac{1}{2}}{1 + 1 + 1} = \frac{1}{2}.$$

In the latter

$$= \frac{1 + \frac{8}{2}}{1 + 3 + 8} = \frac{5}{12}.$$

[1] The following observations of Sir John Herschel (extracted from his Report on my paper on Colour Blindness, presented to the Royal Society in 1856) strikingly confirm the views expressed by Herr Hering:—

"It is as necessary to distinguish between our sensations of colour and the qualities of the light producing them, as it is to distinguish between bitterness, sweetness, sourness, saltness, &c., and the chemical constitution of the several bodies which we call bitter, sweet, &c. Whatever their views of prismatic analysis or composition might suggest to Wollaston and Young, I cannot persuade myself that either of them recognised the *sensation* of greenness as a constituent of the sensations they received in viewing chrome yellow or the petal of a marigold on the one hand, and ultra-marine, or the blue salera, on the other; or that they could fail to recognise a certain redness in the colour of the violet, which Newton appears to have had in view when he regarded the spectrum as a sort of octave of colour, tracing, in the repetition of redness in the extreme refrangible ray, the commencement of a higher octave too feeble to affect the sight in its superior tones. Speaking of my own sensations I should say that in fresh grass or the laurel leaf, I do not recognise the sensation either of blue or yellow, but something *sui generis*; while on the other hand I never fail to be sensible of the presence of the red element in either violet or any of the hues to which the name of purple is indiscriminately given; and my impression in this respect is borne out by the similar testimony of persons, good judges of colour, whom I have questioned on the subject

"It seems impossible to reason on the joint or compound sensation which ought to result from the supra-position in the sensorium of any two or more sensations which we may please to call primary.

"Declaring red and green to be primary sensations, and yellow a mixture of them [is] a proposition which needs only to be understood to be repudiated—quite as decidedly as that the *sensation* of greenness is a mixture of the *sensations* of blueness and yellowness, and for the same reason; the complete want of suggestion of the so-called simple sensations by the asserted complex ones.

. . . .

"From these premises it would seem the easiest possible step to conclude the non-existence of yellow as a primary colour. But this conclusion I am unable to admit in the face of the facts (1) that a yellow ray incapable of prismatic analysis into green and red, may be shown to exist, both in the spectrum and in flames in which soda is present; and (2) that neither red nor green, as sensations, are in the remotest degree suggested by that yellow in its action on the eye.

"Whether under these circumstances the vision of normal-eyed persons should be termed trichromic or tetrachromic, seems an open question."—*Proceedings* of the Royal Society, vol. x., 1859-60, p. 72.—W. P.

[1] Such a circle has been published by Chevreul, but the colours are arranged somewhat differently, the antagonistic ones not being opposite to each other.—W. P.

[2] In technical language mixtures of a colour with white are called *tints*; with black, *shades*; but this nomenclature is imperfect, according to the author's view, as the various nuances are considered by him to contain black and white together.—W. P.

The luminosity of a pure colour will thus be $=\frac{1}{2}$, and if mixed with an equal quantity of white, it will be

$$=\frac{1+\frac{1}{2}}{1+1}=0·75\,;$$

that of pure white being 1.

After these preliminary explanations the author proceeds to develop the chief features of his theory of colour-sensation, adopting the principles previously laid down as applicable to black and white only. He expresses the chief points in two propositions :—

1. There are six fundamental sensations of the visual substance, arranged in three pairs. These are—

Black and white.
Blue and yellow.
Green and red.

2. Each of these pairs corresponds to a dissimilation process and an assimilation process of a special kind, so that the visual substance is subject to chemical change, or change of matter, in a threefold way.

The three kinds of change may be either connected or independent; the latter is the simplest supposition, and the author finds it convenient to assume that there are *three different components* of the visual substance, which be considers as corresponding with the three pairs of sensation, and which may, in short, be spoken of as the black-white, the blue-yellow, and the red-green substances respectively.

These three substances are not all present in equal quantities ; the black-white one is much more richly provided in the visual organs than either of the others, and the latter are not present in equal amount.

As in the black-white substance, both dissimilation and assimilation go on, the former corresponding to the white and the latter to the black sensation ; so the same processes take place in the two other substances, but with much less activity, whence the weight of the six fundamental sensations is very unequal ; relatively great in the black and white ; relatively less in the four colours. The author does not venture to pronounce which of a pair of colours corresponds to the D and which to the A action.

All rays of the visible spectrum have a dissimilating action on the black-white substance, but the different rays in different degrees. On the blue-yellow or the red-green substance certain rays alone have a D action, certain others an A action, and certain others no action at all. Thus each of the three substances has, so to speak, its own particular sensation-spectrum ; and in the actual impression of the spectrum these three overlap or intersect each other.

The spectrum of the black-white substance is the brightest in the yellow, and diminishes on both sides.

The spectrum of the blue-yellow substance consists of two parts, one yellow and one blue, which are separated by a spot which is lightless for this substance ; this is the place of the pure green.

The spectrum of the red-green substance consists of three parts, one green in the middle, and one red at each end, giving two spots which are lightless for this spectrum, *i.e.*, the place of the pure yellow and that of the pure blue.

Thus the total spectrum of the visual substance has three distinguished physiological points, where, in addition to the white, only one fundamental colour is visible, viz., yellow, green, or blue. The real red is very small in the spectrum, for the spectral red contains much yellow. The first part of the spectrum from red to pure yellow is thus a mixture of white, red, and yellow ; the second, from yellow to green, is a mixture of white, yellow, and green ; the third, from green to blue, of white, green, and blue ; the fourth, from blue to the end, of white, blue and red. In the pure yellow, green, and blue, only these colours mixed with white are seen.

Mixed light appears colourless, when it acts, on the blue-yellow or the red-green substance, with equal D and A power, for then both effects neutralise each other and the action on the black-white substance alone appears. For this reason two objective kinds of light, which, when mixed, give white, are not *complementary* but *antagonistic;* they do not produce the white by their combination, but merely destroy each other and leave visible the white which was already there.

The *excitability* (*Erregbarkeit*) may vary, doubly, on each of the three substances in the same manner as before explained, so that one and the same objective light-mixture may not only appear lighter or darker, but varying in colour according to the proportions present of the six kinds of excitability, giving various conditions (*Stimmungen*) of the visual organ.

Suppose the eye to have been long at rest, so as to be in what has been called the neutral condition (the D and A-actions being equal in regard to all three of the visual substances), the total sensation will comprise the two opposite colour-sensations of each colour-substance, as well as the white and black sensation, but the latter will be much the stronger, and more predominant, as each of the colour-sensations will neutralise its opposite one, *i.e.*, the red and green will neutralise each other, and so will the yellow and blue. This neutralising effect, however, does not take place in regard to the black-white substance, because the assimilation causing the black sensation is not produced by any direct rays ; if there were any solar rays causing A-action in the black-white substance, then solar light might, under certain conditions, be invisible, like an equal mixture of blue and yellow, or red and green. Hence the resulting total sensation, when the eye is at rest, is the mixture of white and black, called neutral gray.

Now if, in this condition, we allow the light of any one of the simple spectral colours, say green, to fall on the eye, it strengthens the already present green sensation, and also the white one. The result is a mixed sensation, formed of green, with a considerable mixture of white, and also with some mixture of black, already existing in the neutral gray. Thus it is that even the spectral colours never appear pure, but always obviously contain white and black impurity.

Pigmental colours are still more impure, as they reflect mixed light, in which only certain rays are more or less weakened. To the colour-action of those rays which are hereby unneutralised by antagonistic rays, is added not only the action of such rays on the black-white substance, but also the action of the whole remaining neutral-mixed light which only acts on the black-white sensation.

Mixed light which gives us a beautiful colour-impression may, if colourless light be added, appear entirely or nearly colourless, because the original colour-sensation is already mixed largely with colourless light. Even the spectral colours quickly lose their force and become pale and whitish, when the vision is steadfastly fixed for a time on one of the dark lines, for the excitability of the colour-substance is quickly lowered, while that of the black-white sensation retains its power.

In general the conditions are very unfavourable, in ordinary vision, for the powerful production of colour ; for both on the light and the dark parts the colour-sensations are rendered strongly impure, if not almost entirely suppressed by the black-white action. In the darkened eye, in which the latter has less power, the colour-conditions are more favourable, and hence the after-images are often highly coloured. The most favourable conditions are where the black-white substance has been fatigued by dazzling light, and hence the after-images in such cases often show colours almost more powerful than even those of the spectrum, where, in the original objects, scarcely any colour was appreciable.

It must be always borne in mind that every visual sensation, however it may appear, is really a mixture of all the six fundamental sensations. That one of the six, which has relatively the greatest weight, gives the character and name to the mixed sensation. If any one fundamental sensation is so strong in predominance over all the others, that the latter are not distinguishable, it approaches the idea of purity, which, however, in reality can never exist.

When the visual organ has been for a long time protected from any external stimulus, it assumes, more or less perfectly, that neutral condition in which the assimilation and dissimilation, as well as the D-excitability and the A-excitability are equal for all the three visual substances.

In this state, in order that a mixed light should produce a colourless impression, it is necessary that this light should have an approximately equal assimilating and dissimilating moment, by which is meant the product of the stimulus and the excitability. Such mixed light may be called objectively colourless light.

But the same light will appear, say, greenish, if the red-green substance is no longer in the neutral condition, but has its green excitability greater than that of the red. For in this case the A and D-moments will not be equal, and a small difference will exist to the advantage of the green.

Now when a part of the previously neutrally tuned visual organ has been stimulated by coloured light, the condition of this part will become so altered that the excitability for the perceived colour diminishes and becomes less than the excitability for the opposite colour. Under these circumstances any mixed light which, in the neutral condition appeared colourless, will now appear coloured with the opposite colour. And if a part of the visual organ has been affected, say, by the action of green light, on looking at a blue or yellow surface, the blue or yellow will appear tinged with red.

The phenomena of simultaneous colour-contrast and of colour-induction are explained in the same manner as for the corresponding phenomena in black and white.

It has been seen that by the white illumination of any part of the visual organ, the other parts of it, and particularly those adjoining, are, by the indirect action of the stimulus, darkened; or the sensation of black is intensified; and in a similar way, under the action of coloured light on any part, the sensation of the opposite colour is strengthened in the adjoining parts.

As a consequence of this the relations of excitability are altered; for, according to this theory the sensation of any colour implies also a change of those relations to the disadvantage of this colour and to the advantage of its opposite. If, then, light be allowed to fall on the whole retina, which, under a neutral condition, would be colourless, it now appears coloured; the colour on the previously excited part will be the opposite colour (successive contrast), while that around it will be the same colour as that previously observed (successive induction). In fact, all the phenomena explained for white and black may be, in this way, transferred to the colour-sensation.

The author makes some further remarks on the Young-Helmholtz theory. He admits that the attempt of Young to reduce the great variety of colour-sensations to a small number of physiological variables was a most important step in advance, but he considers that if, as before explained, every psychical result must correspond to some physiological process, the number of fundamental colour-sensations ought, as has been often urged, to be increased to four, and that separate physiological sensations ought to be allotted to white and black. But he considers the great defect of the theory to lie in its only acknowledging *one* kind of excitability, excitation, and fatigue, namely, that which he denotes by D, and that it ignores entirely the antagonistic relations of certain rays to the visual organ; hence it regards the production of white out of "complementary colours" as a result of their mutual combinations, and not of their mutual extinction.

He also remarks on the difficulties of explanation of many phenomena, on this theory, and in particular on the inconsistencies it causes in the attempted explanation of colour-blindness, as shown in the most modern literature on the subject.

In conclusion he gives some remarks on the chief points of his theory, which it may be instructive to repeat here.

The theory, although immediately dictated by a free and unbiased analysis of the visual sensations, is essentially based on certain fundamental principles, taken from the acknowledged phenomena of organic and psychical life, and it is by these principles that the author's views are brought into connection with the doctrines of physiology generally.

With respect to the doctrine of light and colour, the first thing to mention is the natural system of visual sensations, founded on their internal similarity; and further, the grouping of the six fundamental sensations in three pairs of opposite colours.

Next comes, as of fundamental importance, the appreciation of the visual sensations as the psychical correlatives of the nutritive processes, or changes of matter in the visual substance, which leads to the separation of the D and A sensations, and further, to the principle that every D sensation implies a decrease, every A sensation an increase of the visual substance. Corresponding to the three pairs of simple or fundamental sensations are assumed three kinds of D and A processes in the visual substance and three kinds of specific D and A excitability. The colourlessness of mixed light formed out of "complementary" rays, is explained by their antagonistic relations.

Further, here, for the first time the proof is methodically and comprehensively produced that the separate parts of the nervous visual substance are in internal functional changing relationship (*Wechselbeziehung*), which is to be regarded as reciprocally connected with the change of matter; for when $\frac{D}{A}$ is greater on a stimulated part, it is less in the surrounding parts, and *vice versâ*; so that after the stimulus the excitabilities of both parts change in opposite directions.

These propositions and their consequences afford the means of explaining the various phenomena mentioned, but it often happens that several explanations are possible for one and the same phenomenon, and that the decision between them must be reserved for more detailed inquiry. What we immediately appreciate in a visual sensation is the ratio of the corresponding D and A processes to each other, for this determines the *quality* of the sensation. A change of sensation gives only an indication of the change of this ratio, and not of the changes of its two components. Then it is that we have so often the choice between an increase of assimilation and a stoppage or decrease of dissimilation, and *vice versâ*. But the theory itself gives means of determining these, by further and more detailed and intricate investigations; and the author promises future communications by which the details will further be supplied, without as he hopes, any material alteration of the principles he has laid down.

WILLIAM POLE

THE "PARASOL" ANTS OF TEXAS: HOW THEY CUT AND CARRY LEAVES: ORIGIN OF CASTES BY EVOLUTION

IN Mr. McCook's recent investigation (NATURE, vol. xx. p. 583, and *Proc.* Acad. Nat. Sci. Phil., 1879, p. 35) he stated that he observed carefully both the mode of cutting and the system of carrying cut portions of oak-leaves at Camp Wright, and at a vegetable garden near Austin, Texas.

To investigate successfully he found it best to thrust small branches of live-oak into one of the mounds described, near the "gates." These were soon withdrawn, and seen to be covered with "cutters" busily occupied. It was thus possible to examine them at work by the light of a lantern, as it will doubtless be remembered that night is the busiest time with these active ants, supplying their minuteness with a most effective shelter.

The "cutter," usually an ant belonging to the caste next below the "soldier" in size, first grasps the leaf with outspread feet, and begins to cut into its edge by a scissors-like action of her sickle-shaped toothed mandibles. Thus she naturally proceeds, with steady motion, until the mandibles have clipped off a portion of the leaf, having a circular edge, clean cut. The feet turn as the head turns. The cutter sometimes drops, with the piece just cut, to the ground; but probably, if possible, retires when the piece has dropped, to continue her professional occupation. Mr. McCook found at the foot of one tree a pile of cut leaves, to which clippings were continually being added, dropped by the cutters. The carrier at the foot took them up and carried them to the nest. The loading of the cuttings is thus accomplished: the piece is seized by the curved mandibles, the head is raised, the piece is thrown back by a quick motion, seeming to be lodged on its edge within the deep furrow that runs along the entire median line of the head with the exception of the clypeus, and supported between prominent spines on the edge of this furrow and on the prothorax.

The young saplings near the mound at Camp Wright were found almost entirely stripped of leaves by these ants. The great tree (live-oak) near by was in parts stripped to the very top. In beginning work on a tree the cutters seem to aim first at the topmost leaves. They prefer trees with a smooth leaf; they eat grapes, radishes, &c., and can take celery, beet, young maize, and wheat, plum leaves, honeysuckle, and jessamine. Strangely enough, they do not like lettuce, paper-mulberry, figs, cedar, except the buds, when very hard up in winter. A nurseryman, on whose grounds Mr. McCook witnessed the ants at work and the scene of their former exploits, told him that they even entered his desk-drawers, and carried away part of his chewing-tobacco. At another plantation Mr. McCook saw an immense column of the ants engaged in plundering a granary of wheat.

One of the most interesting questions for evolutionists centres undoubtedly in the causes and mode of continuance of the castes or differentiated forms of species like this ant. The worker-castes are sterile, and produced from eggs laid at different periods by the female; and as to a blending of castes by intermediate forms, nothing has yet been seen or proved in the case of the cutting-ant, after careful examination by the microscope. The lowest castes of minims, in all individuals Mr. McCook examined, with special reference to the mouth-organs and eyes, had the same structure in equal definiteness and perfection, as the larger castes. Consequently, Mr. McCook again finds no way of comprehending how natural selection could have produced or preserved or improved these castes. May I suggest that we know as yet too little of the whole life-history of social animal communities, to say nothing of their past history in time, their conditions during long series of years, and the reaction of each community on its surroundings, to assert that any hypothesis of evolution admissible as a *vera causa* in one case is inadmissible in another? We are but on the threshold of the study of the influence of social laws and conditions upon human communities; how can we expect to understand the influence of society and common interests upon specialisation in ants? Yet there are even now several possible ways of imagining the influence of variation and changed conditions to have aided in producing castes. May it not be that the comparative study of *ant-communities* of the same species, or of different species of the same genus will at length furnish a key much more valuable than we yet know? How is it that nations of man rise and fall, increase or decrease? Are not all men of one species? Why are there so many castes? If we cannot answer these questions perfectly, why be dismayed if we quarrel about terms as to the intelligence or reason displayed by various animal forms? There is nothing to be done but for men to wait, study to comprehend the nature of proof, and then patiently investigate. The explanation of all difficult problems will, if we are to judge by the history of science, be very simple, much simpler and more illuminating than the acrobatic or the prejudiced intellects would have us believe.

G. T. BETTANY

NOTES

THE exhibition at Croydon, held in connection with the Congress of the Sanitary Institute of Great Britain, has a peculiarity attached to it which, though it has its advantages, is a disadvantage to the visitor. The peculiarity is that the awards of the judges will not be made known till the day of closing, viz., November 8. At most exhibitions visitors have their attention drawn to objects of high merit by the announcements of the honours the judges have awarded; but here, and this, too, on subjects often affecting their own health, visitors can, even if they care to take that trouble, only form their own opinions, guided by the skilled advocacy of the attendants at the different stalls. If all the objects announced in the catalogue as "essential," "indispensable," "infallibly safe," and "the only ones of the kind made," are really so, then the practical application of sanitary science in households is in a lamentably backward state, even in particulars where those who are our leaders in sanitation would least expect it. It can hardly be supposed, however, that all the exhibits shown have been admitted with the sanction of the Council as illustrations of the subjects discussed at the Institute. There are, for example, mus c stands, clocks, sausage mincers, billiard registers, weighing machines, mechanical toys, flower scissors, electric pens, nickel-plated goods, pantographs, bells, telephones, china cements, "lightning" knife sharpeners, &c. Some of the exhibits are made on principles that have been repeatedly denounced; for example, filters so closed that the filtering medium cannot be easily and frequently changed are now by our most experienced observers admitted to be unsafe, yet there are some in the exhibition. Traps of certain construction have been likewise denounced, yet they are shown. Ventilators of patterns generally regarded as practically useless, and so-called disinfectants which are only deodorisers, are shown. It might, perhaps, have been well had the exhibition been called one of "Sanitary and unsanitary appliances," and then the visitor would have been put on his guard not to believe in everything shown there. Mr. F. P. W. Essie, C.E., has contributed part of a collection of the materials on which his paper on the dangers of bad plumbing (read at the Congress) was based. It is intended as an unsanitary exhibition, and shows in an alarming manner how some so-called sanitary appliances may become a positive source of danger. Each specimen exhibited "has been associated with death and with disaster in some shape or other." It is a pity no handbook or any kind of guide other than the unclassified list of entries in the catalogue has been prepared. We may be able to return to the subject next week when noticing the list of awards.

AN article in the last number of the *Revue Scientifique* contains an interesting account of Mont Ventoux (1,928 metres high), and of the scheme for erecting a meteorological observatory thereon. The project, which has been prepared by M. Morard, under the direction of M. Bouvier, includes, first, the construction of a carriage road, which will render the summit accessible at all times. The total length will be 19 kilometres.

The observatory will be placed at the very summit of the mountain, on a platform of rock. It will consist of a small round tower, constructed to resist the most violent winds. Every means will be taken to establish an equilibrium of temperature between the inside of the tower and the outer air. The dwelling-house will be built a little lower, on the south slope, and thus sheltered from the mistral which is extremely violent on the summit of the mountain, and indeed has given to the mountain its name of *Ventoux*. A covered gallery of 11 metres will connect the house with the tower, access to which will thus be easy, even in the midst of snow and storms. At the instance of Admiral Mouchez rooms will be reserved in this house for scientific men, who may come in summer to carry on researches in astronomical physics, for which the limpidity of a Provençal sky is so favourable. The difficulties of execution would not appear to be very great, and, in comparing the situation of the future observatory with that of the Pic du Midi, General Nansouty has gone so far as to compare the summit of Ventoux to a sort of earthly paradise. The necessary expenses are calculated at 150,000 francs, and to this all the chief towns of the South-East have already contributed handsomely, their municipal councils having the intelligence to perceive the great practical benefit to be derived from such an observatory.

THE project of erecting a meteorological observatory on the top of the Ballon de Gervance, in the department of Haute-Saone, is progressing favourably. A fortress is being built on this elevated site, and will be finished next year. The garrison will very probably have the care of meteorological observations. A telegraphic line has been already established between the intended station and Belfort.

M. BISCHOFSHEIM is leaving for Nice with M. Garnier, the architect of the opera, and M. Lœwy, the sub-director of the Paris Observatory, in order to inspect the site on which he intends to erect the new observatory, on which he is to spend a sum of 60,000*l*., as we mentioned in our notes some months ago. Before determining on the details of his plan, M. Bischofsheim and his scientific and artistic advisers are to visit the most celebrated observatories of Austria, Germany, and England during this winter.

KING HUMBERT, of Italy has sent a donation of 20*l*. to a committee organised to obtain subscriptions for erecting a statue to Galvani at Bologna. Galvani was born in that city in 1717, where he was a professor in the University; he died in 1798.

THE *Journal Officiel* publishes a decree organising, at the Observatory of Paris, the School of Astronomy of which we announced, a few months ago, the imminent creation. The pupils are to be appointed by the Minister of Public Instruction rom pupils of the Normal or Polytechnic Schools, or graduates in the mathematical sciences. They must be more than twenty-five years of age. They are to receive 6*l*. a month during two years, and reside in the observatory. They will be obliged to follow courses of lectures at the Sorbonne and Collége de France. The Astronomers of the Observatory will give them special instruction. After having passed their examination, they will be appointed *aides-astronomes* in any of the Government observatories, with a salary of 10*l*. monthly. During their stay at the observatory they will practise calculations, meridian, and physical astronomical observations. *Elèves libres* will be admitted under a certificate of efficiency.

MR. C. L. WRAGGE, F.R.G.S., of Cheadle, has presented to the town of Stafford an excellent collection of specimens obtained by him in his travels in various parts of the world, and which will, no doubt, prove of great value to all those interested in geology and natural history.

IN the Cassel State Library, as well as in the Archives at Hanover, Dr. Gerland has succeeded in discovering a whole series of important original letters, hitherto not known, from the pen of Leibnitz, the philosopher, and of Papin, one of the inventors of practical applications of the power of steam.

RUSSIAN papers publish the project of the Exhibition of Manufactures and Fine Arts, which will be opened in 1881 at Moscow. We learn that the Moscow Anthropological Society and the University propose to take an active part in it, and to give to the exhibition a scientific value.

WE learn that in the month of January, 1880, an artistic and scientific exhibition will be opened in Algiers. It will be the first which has been ever held in the colony.

THE Society of Anthropology of Paris has received, at its last meeting, a letter from Felyx-Denys-Rapontayabo, a native King, in the Gaboon, who, having been educated in the Catholic mission, is a tolerably good French scholar. His Negro Majesty is sending to the Anthropological Society the skeleton of a gorilla, and volunteers to send any scientific documents which may be required.

IN his last report from Saigon, Mr. Consul Tremlett alludes to his having been ordered by the Foreign Office to procure and send home a quantity of the bark known as *hwang-nao*, which during the past four or five years has been exported from Tongking to Trinidad, and there seems to have proved efficacious in cases of leprosy. The tree from which it is obtained is hardly known except to the missionaries, and is only found in the mountain forests of the north of Annam.

A VIOLENT shock of earthquake is reported to have occurred in West Cumberland at 5.30 A.M. on Saturday week. A vivid flash of lightning was seen at the same time. The shocks of earthquake in the southern districts of Hungary, some lasting from forty to fifty seconds, continue in a north-easterly direction, and keep the population in a state of alarm. A shock of earthquake in the direction from south-west to north-east, was felt at Ekaterinodar, Caucasus, on October 9, at 8h. 55m. P.M.

THE Municipal Council of Paris has decided that artificial cold should be applied to the mortuary, in order to keep corpses in a state fit for public inspection and possible recognition for a longer period. In compliance with that decision a Commission, presided over by M. Vauthier, an engineer of the Ponts-et-Chaussées, who resided long in England, has been appointed to report upon the several ice-manufacturing machines. The work of the Commissioner is by no means an easy one. The pneumatic process is not, so far as we are informed, to be brought into the competition. The ammoniac, the chloride of methyl, and the sulphurous acid processes are then to be brought under consideration. The two last methods are now exhibiting at the Champs Elysées Palace, and the ammoniac process is used in the largest Parisian ice-house, the "Glacière du Bois de Boulogne."

A RETURN by the Director of Administrative Statistics at Vienna (based on the latest census of the great European states) shows that out of 102,831 persons who lived over ninety years, 42,528 were men and 60,303 women. The longevity of women is yet more apparent when we consider the numbers of human beings who attain and live beyond 100 years. In Austria, there were 229 women centenarians to 183 male ditto; in Italy, 241 female to 141 male; in Hungary, 526 female to 524 male, &c.

IN a recent Consular Report on the trade and commerce of Benguzi the sponge fishery is described as being entirely in the hands of Greeks belonging to Kalimnos, Hydra, and other islands, who annually frequent the coast of the Gulf of Sidra during the months of August and September. This branch of industry affords employment to upwards of 200 small vessels. A diving apparatus is used in fishing for sponges; the produce during the season is between 25,000 and 35,000 sponges. A duty of 40*l.* is levied by Government on each diving apparatus and 10*l.* on every vessel not carrying that appliance. The produce of the sponge fishery last year was estimated to be worth about 15,000*l.*, and was exported chiefly to England.

MESSRS. FRANCIS AND CO., of Hatton Garden, have recently devised an extremely useful telegraphic arrangement for ships, by which instant communication is given by the captain or officer of the watch to the helmsman. For the navigation of rivers and small waters such means of rapid telegraphing with the man at the helm must be invaluable, as in an instant an order can be given, and that, too, with absolute certainty. A leading and important feature in this new invention is that the signals to every part of the ship can be given from the one instrument, which is in form like a handsome capstan, with the commutators so arranged horizontally around its head that it may be worked by any one without the least instruction.

A COURSE of elementary lectures in continuation of a description of the solar system will be delivered in the theatre of Gresham College, Basinghall Street, London, E.C., on the evenings of November 11, 12, 13, and 14, by the Rev. E. Ledger, M.A., F.R.A.S., Gresham Professor of Astronomy. The lectures will be delivered at 6 o'clock P.M., and will be free to the public. They will be illustrated by means of a lime light.

As we have announced, the three Parisian telephonic companies have entered into a working arrangement, and are busy settling the details. In consequence of this fusion the subscriptions have ceased to be received, the future common price having not yet been agreed upon. It is certain that it will be dearer than the cheapest, and cheaper than the dearest. According to every probability 600 francs a year for a single line.

THE gold discoveries in the north of New Caledonia are reported to be turning out very valuable.

FROM Japan we hear that the manufacture of sulphuric acid is now being extensively carried on at the Osaka Mint, and large quantities are exported to China.

THREE boa-constrictors, found in the Chinese island of Hainan, have lately been presented to the Botanical Gardens at Hong Kong.

WE learn from a report on the trade and navigation of New York for 1878 that grape-sugar is being largely manufactured at Buffalo, three large factories have been established for the manufacture of glucose in a solid and liquid form, 200,000 to 300,000 bushels of corn being used in them per month. This product has a ready sale and is largely exported to Europe and other countries, and the business is said to be a very profitable one.

THE principal papers in the Thirteenth Annual Report of the Aëronautical Society are on the Flight of Birds, by Mr. Brearey and Mr. H. Sutton.

THE report of the meeting of October 17 of the Eastbourne Natural History Society contains a paper "On the Additions to the Fauna and Flora of the Cockmere District during the past year," by Mr. F. C. S. Roper.

THE additions to the Zoological Society's Gardens during the past week include a Weeper Capuchin (*Cebus capucinus*) from South America, presented by Mr. A. Sargent; a Silver Pheasant (*Euplocamus nycthemerus*) from China, presented by Mr. R. Moon; three Common Boas (*Boa constrictor*) from Bahia, presented by Mr. W. Young; a Bosman's Potto (*Perodicticus potto*) from West Africa, four Pied Wagtails (*Motacilla yarrellii*), British, purchased.

OUR ASTRONOMICAL COLUMN

MINOR PLANETS IN 1880.—In the first half of the ensuing year three out of the four older minor planets, viz, *Ceres, Pallas,* and *Vesta* will come into opposition while not far from perihelion, and consequently their angular diameters and brightness will be about as great as they ever can be, thus :—

Pallas in opposition on	Jan. 12	will be in perihelion on	Feb. 23.
Ceres ,, ,,	Feb. 12	,, ,,	Feb. 18.
Vesta ,, ,,	June 2	,, ,,	June 19.

At opposition the brightness of *Pallas* will be 6·8m., that of *Ceres* 7·3m., and that of *Vesta* 6·0m.

Perhaps advantage may be taken of the favourable conditions attaching to the positions of these planets to ascertain if they do really present measurable disks as has been stated by Lamont in the case of *Pallas*, and by Secchi in that of *Vesta*. Lamont, soon after the mounting of the 11-inch refractor at Munich, on a night of exceptional clearness, found that *Pallas* presented a defined disk, which at the mean distance of the planet from the sun would subtend an angle of 0″·51, which would correspond to 1″·41 at the distance unity. Again, Secchi observing on nights near the opposition of *Vesta* in 1855, noted a disk a little less than is presented by Jupiter's first satellite, or about 0″·8, which at the earth's mean distance from the sun would subtend 1″·01. There is a third instance in the case of one of the more-recently discovered planets, *Iris*, which at the close opposition in the winter of 1866, was measured by Mr. Talmage with Mr. J. G. Barclay's 10-inch refractor at Leyton; he found the apparent diameter 0″·96, or the diameter at distance unity 0″·89. Hence we should have for the real diameters 630 miles for *Pallas*, 450 miles for *Vesta*, and 400 miles for *Iris*, dimensions beyond those which have been attributed to them on other grounds. The south declinations of *Pallas* and *Vesta* will render them fitting objects for examination at Melbourne should Mr. Ellery be disposed to try the powers of his great reflector upon them. *Ceres* will be well observable in this hemisphere.

While writing upon minor planets it may be mentioned that their number has now been increased to 207; a circular from Prof. Peters, of Kiel, notifying the discovery of four new ones at Clinton (New York) and at Pola, by Prof. C. H. F. Peters and Herr Palisa.

THE RED SPOT UPON JUPITER.—Dr. O. Lohse, of the Physical Observatory at Potsdam, who has watched this planet regularly during the last nine years, mentions that on June 5, when his observations of the present year commenced, the red spot was of an intensity of colour to be perceived at the first glance at 15h. m.t., when it was near the eastern limb. The sharp outline and the form of the spot appearing to offer an advantageous opportunity for another determination of the time of rotation, numerous estimations and some measures of its position and size have been made at Potsdam. Dr. Lohse does not refer to any suspicion of proper motion, of which we have heard elsewhere, but, on the contrary, states that, with the rotation-period, 9·9221h., added on to the epoch 1879, September 27, at 9h. 48·3m., Berlin M.T. (or 8h. 54·7m. G.M.T.), the successive times of transit of the middle of the spot over the central meridian may be obtained. From sensible variation in the intensity and tint near the centre and limbs of the planet he conjectures the superposition of very dense gas or vapour. As the spot exhibits remarkable permanence, it may be also observable next year, and thus be the means of fixing the period of rotation with precision. Dr. Lohse further notes that this remarkable appearance upon the disk of Jupiter takes place at the time of recommencement of activity in the solar atmosphere.

A STANDARD CLOCK AT THE OBSERVATORY, STRASSBURG.—Those who give attention to horological matters will note with interest a communication from Prof. Winnecke, Director of the Imperial Observatory at Strassburg, on the performance of a clock constructed for that establishment by Hohwü, of Amsterdam. The observed rates between 1875 and 1878 are exhibited in tabular form, and are compared with rates calculated from a formula which Dr. Schur has investigated, viz. :—

$$\text{Daily rate} = \overset{\text{s.}}{0\cdot000} + \overset{\text{s.}}{0\cdot0125}\,(b - 750) - \overset{\text{s.}}{0\cdot0110}\,(t - 20),$$

where b is the height of the barometer in millimetres and t the temperature in the clock-case expressed in degrees of Celsius. The tabular statement (*Ast. Nach.*, No. 2,282) is much too long to be reproduced here, but we make the following extract showing the observed and computed rates applying to the two-months' interval, May 3–July 3, 1877; in the first column are the daily rates given by the observations, and in the second those resulting from the above formula:—

	s.	s.
May 3–11	– 0·07	– 0·02
11–25	0·00	+ 0·01
25–31	– 0·04	– 0·04
May 31–June 8	+ 0·03	+ 0·06
June 8–15	– 0·04	+ 0·01
15–19	+ 0·20	+ 0·23
19–22	– 0·15	– 0·09
22–26	+ 0·10	+ 0·11
26–29	+ 0·09	+ 0·05
June 29–July 3	– 0·05	– 0·04

Dr. Winnecke remarks that upon the experience in the interval 1875–78 he believes the performance of the clock has not been hitherto excelled, and congratulates himself upon the possession of a work of art.

PHYSICAL NOTES

WHO did discover the attraction caused by the vibrations of sounding bodies? Prof. Guthrie and Herr Schellbach of Berlin, discovered it independently of each other nearly ten years ago. But Guyot had observed the phenomenon before them; and in a paper in the *Philosophical Magazine* for 1849, by Mr. Reuben Phillips, on the "Electricity of Steam," the attraction caused by vibration is recorded as a new fact.

THE transverse vibrations of metallic cylinders open at one end have been recently studied by Herr Fenkner, at Marburg (*Wied. Ann.*, No. 9). The following results were arrived at: The vibration-numbers of the tones of such cylinders are independent of the height of the cylinder. The vibration-numbers of the corresponding tones of two such cylinders are inversely as the squares of the circumferences (or radii), and they are directly as the thicknesses of metal.

PROF. TÖPLER, of Dresden, is well known to physicists by his researches on singing flames and by the induction electric machine which bears his name. Töpler's machine, of which several examples were shown in the Loan Collection at South Kensington in 1876, resembles in form the more familiar machine of Holtz, and is based upon similar principles. Prof. Töpler is at present engaged upon the construction of a larger machine having twenty rotating plates; and which is capable of generating much larger quantities of electricity. This machine bears a close resemblance to the variety of Holtz machine shown before the Physical Society a few months ago by Mr. W. J. Wilson, and to that recently constructed by Mr. Ladd, which also had a number of plates rotating on a common axis.

APPARATUS for projection, like the magic-lantern, always gives inverted images. Most commonly this causes no inconvenience, for one can invert the object; but there are cases in which this cannot be done, and the only resource is to rectify the image. To obtain this result, M. Duboscq (*Journal de Physique*, October) has recently conceived the idea of receiving the rays which would go to form the inverted image on a prism with total reflection. Suppose an isosceles rectangular prism, placed with hypothenuse parallel to the optic axis of the lens by which the rays from the object are made convergent, and so as to receive the cone of rays on one side; refracted in the prism, the rays reach the hypothenuse at an angle greater than the limiting angle, are totally reflected, and sent to the second side of the prism, where they are refracted at the same angle as on entrance, and then go to the screen, forming an image which corresponds in position to the object. As it may be desired to rectify the image in some other plane than the vertical, it is found advantageous to mount the prism in a tube forming part of the projection-apparatus, and capable of being turned round the direction of the ray.

IN a recent memoir on the plasticity of solid substances (*Rev. Scient.* xi. 1879), Signor Marangoni, with reference to Bottomley's experiment dividing ice with a wire, groups plastic substances in two classes. Those of the first class can be cut in two with a metallic wire like ice, and they can also be considerably deformed. Such are plastic clay, fresh soap, camphor, black pitch. Substances of the second group give two lamellæ on the two sides of the cutting wire, which then come out of the slit, become notched and bend over, resembling leaves; to this class belong vegetable Japanese wax, dry Marseilles soap, tallow and stearine, but above all, yellow wax and paraffin. [The occurrence of these phenomena depends largely on the diameter of the wire and on the temperature. For yellow wax, wires of ¼ to 1 mm. diameter, for paraffin ½ to 0·9 mm. are necessary. With the former, the leaves are formed between – 8° and 40°, with paraffin (melting at 43·5°) only up to 15°. To produce the lamellæ, different weights should be hung to the wire in different cases. The lamellæ are very similar to those separated from rails when a locomotive with strong brake applied, goes quickly down a steep incline.

THE forms produced in the phonograph by utterance of the Italian alphabet are studied in a recent paper by Signor Fautrier (*Atti del Aten. Ven.* [3], I., 1879). The vowels uttered in the A note of the violin (435 vibrations) gave generally three-pointed groups, presenting certain differences. With regard to the consonants, it appeared that with the exception of *l*, *m*, *n*, and *r*, which give characteristic impressions, they only modify the form of the impression of the following vowel, and especially at its limits. Signor Fautrier adds some general considerations, especially on the intensity of the "klangs" given by the phonograph, and the theoretical significance of the apparatus.

M. GASTON PLANTÉ, whose researches on voltaic electricity, especially on the construction of secondary batteries and on the phenomena of their discharge have been from time to time laid before the readers of NATURE, has just published the first instalment towards a second volume. The forty pages or so of this *brochure* treat of the effects obtained with M. Planté's rheostatic machine.

DR. KÖNIG, the well-known constructor of acoustical apparatus has just completed a new instrument which promises to be of great interest and importance. Dr. König has long maintained, in opposition to the theory of Helmholtz, that the "combinational" or "difference" tones produced by the simultaneous sounding of two simple tones of different pitch are the result of very rapid "beats." The new instrument, which has not yet been seen outside M. König's *atélier*, is a kind of modified syren which puts the question at issue to a direct and crucial test.

WE learn that Prof. Silvanus Thompson is engaged upon a monograph upon the subject of Binaural Audition, which will embrace the whole existing literature of the subject. The work will not be published before next spring.

THE magnets employed in Gower's form of the Bell telephone are of unusual strength. It is stated that the steel of which these magnets are constructed is made from the iron of Alvarre, which, though a particularly bad iron for most purposes, makes a steel unsurpassed for magnetic apparatus.

THE phenomena which occur when the retina is struck by intermittent coloured light (alternating with total darkness) have been recently studied by Signor Cintolesi (*Ann. di Oftalmol.*, II. and III., 1879). With a certain velocity of intermissions the field of vision appeared at first still and regular in the colour of the active light. The state is gradually changed, and, *e.g.*, red passes by orange, yellow, and green, into a saturated blue-green, after which there is a return by the same colours to red, and so on in periodic change. This phenomenon of a periodic change with the complementary colour the author also describes in the cases of green and blue. The velocity of intermissions must reach 0·11 sec. for red, 0·14 for green, and 0·15 for blue light. In his theoretical views Signor Cintolesi has recourse partly to the Young-Helmholtz hypothesis, partly to Plateau's oscillation theory, and partly also to the photo-chemical properties of the retina.

IT has been noted recently by M. Jannetaz that, if a fine needle be turned round on a cleavage plate of gypsum (1 mm. to 2 mm. thick) so as to produce a small hole, and then be gently pressed into the plate, a separation occurs, surrounded by Newton's colour-rings, and having the form of an ellipse. The major axis of this ellipse makes an angle of 49° with the fibrous fracture, and its length is to that of the minor axis as 1·247 to 1. This ellipse has the same orientation and relative size as that of the propagation of heat in gypsum. Further, the larger axis corresponds with the direction of greatest resistance to bending, and the greatest elasticity.

EDISON'S new electromotor, with which he proposes to drive sewing-machines, watchmakers' lathes, and other light machinery, has an armature resembling that of a Siemens dynamo-electric generator, but placed longitudinally between the limbs of a horse-shoe-shaped electro-magnet. A similar disposition was previously employed by M. Marcel Deprez in the excellent little electromotors shown by him before the French Physical Society last year.

In the latest pattern of telephone transmitter sent by Mr. Edison to this country, the button of compressed carbon derived from paraffin-smoke has been abandoned in favour of another device. A small rod of ordinary hard carbon, of the quality used in producing the electric light, is mounted behind a mica disk and adjusted in loose contact with a light spring faced with platinum. This arrangement is therefore nothing more or less than a *microphone* attached to the back of a disk which receives the vibrations of the voice.

At a late meeting of the Académie des Sciences, M. Wardon made a suggestion to substitute nickel for steel as a material for compass needles. M. Wardon adopts a circlet of the metal of a form similar to that devised by M. Duchemin. When the apparatus was submitted under the direction of the Ministère de la Marine to a comparative trial with that of M. Duchemin, it was found to be decidedly inferior for nautical purposes; for the oscillations of the magnetised circlet are extremely slow, owing to the comparatively feeble intensity of magnetisation of nickel.

GEOGRAPHICAL NOTES

At the last meeting, October 15, of the Russian Geographical Society, the Secretary, M. Sreznevsky, read a detailed report on the geographical work done during the past summer. After having spoken of the gallant geographical feat of Prof. Nordenskjöld, he sketched the results of the expeditions of Col. Prshevalsky, MM. Potanin, Alferaki, and Pyevtsoff, and of the expedition engaged in exploring for the Central Asian Railway. As to ethnography and statistics, the secretary mentions the researches by M. Kuznetsoff in Western Russia, by M. Syrkou in Bulgaria, the anthropological researches of M. Meredlenovsky in the Crimea, M. Polyakoff in the Ural Mountains and Caucasus, M. Kibalchich on the banks of the Dnieper, and M. Miclucho-Maclay in Australia. As to this last, the Society engaged him to return to Europe, for the publication of the very rich results of his explorations, but he prefered to take part in a zoological exploration undertaken by Australian naturalists. The pecuniary position of M. Maclay is a very critical one. After having undertaken his extensive travels without sufficient means, he has received from the Society about 7,000 roubles, which sum was certainly quite insufficient to meet the great expenses necessitated by these travels. Now he has contracted debts for about 15,000 roubles at the Singapore bankers, and the Society seeks private subscriptions, the means for paying these debts, in which it is supported by the opinion of the whole of the Russian press. Finally Prof. R. Lentz made a communication on the labours of the International Conference in the Meteorology of the Polar regions. The Geographical Society will take an active part in the organization of the meteorological stations in these regions.

The *Moscowskiya Vyedomosti* has received the following information as to the Amu-darya expedition, dated Katty-kourgan, October 19. At Termez the expedition was divided into two parts: one has gone in boats down the Amu to Fort Petro-Alexandrovsk, the other through Surkhan and Rafiuaghan rivers to the Vaksh river. The results of the expedition are important: it has explored the Amu-Darya throughout its length, and its two branches, the Vaksh and the Pyandj rivers, for fifty miles above their junction. The topographers have prepared maps of these parts of the two rivers, and completed the maps of the Amu by several details; several latitudes and longitudes are determined astronomically, and zoological collections obtained. A levelling of the Amu is made up to Chardjuy. We notice the appearance of a Russian work by M. Lokhtin, "The Amu-Darya River and its former Connection with the Caspian." It contains a description of the river, a sketch of the historical data as to the Amu, and a review of the hypotheses as to the causes of the changes of its bed; it is accompanied by a map. The third, fourth, and fifth volumes of the "Report of the Amu-Darya Expedition," contain reports by M. Zuboff on hydrographical works in the lower parts of the Amu-Daria; by M. Dorandt, on the astronomical, magnetical, and hydrometrical measurements; and by Prof. Schmidt, on the slime of the Amu River.

The death, from paralysis, in India, is announced, of Major Herbert Wood, author of a well-known work on the Aralo-Caspian Region, on the hydrography of which he contributed several papers to this journal.

The last number of the *Isvestia* of the Russian Geographical Society, contains the proceedings of a meeting of the Society in October, 1878, and several interesting papers:—By M. Prshevalsky, on the observations of Dr. Richthofen; by K. Scharnhorst, on the barometric measurements of heights in Central Asia; by M. Mayeff, on the upper parts of the Amu-Darya, according to the description of Ibn-Dast; and by M. Miclucho-Maclay, on the Agomes Islands. The notes contain information as to the travels of MM. Prshevalsky, Nordenskjöld, and Grigorieff. In the note by Colonel Scharnhorst, on the barometrical measurements of heights made by M. Prshevalsky during his journey to Lake Lob-Nor, the measurements being calculated by comparison with barometrical observations at Nukus and at Omsk, the heights of which above the sea-level are exactly known from geodetical measurements, they are trustworthy, and the error does not exceed 100 feet. The height of Tashkend, calculated by comparison of six years' barometrical observations with those made at Omsk, Kazalinsk, Nukus, Petro-alexandrovsk, Baku, and Astrakhan, is 1,516 feet. The other places of general interest are: Kuldja, 2,080 feet; the passes across the Narat and Yuldus Mountains, 10,370 feet and 10,040 feet; the junction of Khabtragay and Baltangay Rivers, 5,320 feet; the town of Kurl, 3,240 feet; Lake Lob-Nor, 2,500 feet; Lake Sayram, 6,920 feet; and Guchen, town, 2,310 feet.

We are glad to notice the appearance of an "Annuaire for Turkestan" (*Turkestanskiy Kalendar*) for 1880, which contains much useful information as to the mineral riches of the country, its meteorology, financial situation, and statistics, besides a route-map and a map of the general-governorship of Turkestan. We learn from this Annuaire that Turkestan possessed in 1877 only thirty-five schools, with 1,848 scholars.

The November number of the Geographical Society's periodical contains three short papers: Notes on the Topography of the Sierra Nevada of Santa Marta, U.S. of Columbia, by Mr. F. A. A. Simons; Exploration of Oregon in 1878 by the Wheeler Survey; and Pévtsof's Expedition in North-West Mongolia, by Mr. E. D. Morgan. The first-named is illustrated by a map, which is not particularly well lithographed. The geographical notes, however, are the chief feature of the number. The Dutch Arctic Expedition claims the place of honour, and two pages are devoted to Dr. Holub's career. There is also a long account of the native territories south of the Zambesi, abridged from a report to Sir Theophilus Shepstone, which embodies information hitherto unattainable, and the more valuable as it has been revised by Dr. Holub. The exploration of the Swat River by the *Mullah* is recorded. The concluding thirteen pages are taken up with notes on new books and new maps, the map part bearing a close resemblance to a catalogue.

Mr. Stanford has published a new Library Map of the World, on Mercator's projection. The size is 5 feet by 3 feet, and has several new and admirable features. The currents in the ocean are shown by strong blue waved lines. The areas occupied by these currents, which are chiefly caused by the great periodical winds, have an oscillating boundary or limit, as waved lines are better calculated to indicate this, than the firm and sharply defined lines frequently used. A few of the lines in each current have arrow heads to indicate the direction. Figures in blue upon these waved lines, give the maximum and minimum rates in nautical miles per twenty-four hours. These are selected, we believe, from innumerable observations that have been registered and examined by Captains Evans and Hull of the Hydrographic Department, and published in their invaluable "Wind and Current Charts." The drift currents in the Indian Ocean and China Sea change with the Monsoon winds, and in the chart they are shown as they flow during the south-west monsoon, which blows from April to September. The trade and monsoon winds are named over the map in red letters, and the areas over which they generally blow are tinted in colours. The areas over which north-east winds blow are coloured blue, the areas for south-east winds pink; other areas are differently coloured in accordance with the particular direction of the winds which blow over them. A graduated scale at either side of the chart shows the sun's progress to and fro between the tropics; to the left of the chart the sun's vertical action may be traced as he proceeds northward to the Tropic of Cancer, and to the right, his return journey southward to the Tropic of Capricorn. Dates are given at intervals of five days, the intervening days being indicated by small red dots. In spare spaces to the north of the chart, small inset maps have been drawn to give the completion of the geography in the Polar areas, and upon these will be found, indicated by colour, the average summer limit of open water as far as known. The curves of equal magnetic variation are also shown upon these small maps, and the spots known as the magnetic poles are named. The northern limit of woods, beyond which trees are unknown, is shown upon the small map of the Arctic regions. The principal ocean mail routes are shown by broken black lines, and upon the longer lines the names of ports of departure and arrival are named. The number of days, the average of numerous voyages is noted on each line, and the distances in nautical miles from port to port are also given. The submarine telegraph cables are shown by strong black lines with dots at short intervals, and the various cables to the United States are identified by having their dates attached. The land is coloured politically giving the most recent territorial divisions, and a bright red colour is reserved for British possessions, which enables the reader to see easily how frequent are the stepping stones of British territory over the face of the earth. Altogether it will be seen this map is well calculated to serve a great variety of useful purposes; its execution is all that could be desired.

DR. NACHTIGAL has received a telegram from Malta to the effect that Herr Gerard Rohlfs's expedition, having reached and explored the Kufara Oasis, was there set upon and plundered. Herr Rohlfs and Dr. Anton Stecker were consequently compelled to return to Benghazi, though they hoped to receive help and compensation from the Turkish Provincial Government.

TRÜBNER AND CO. will shortly publish a new work on Madagascar, under the title of "The Great African Island: Chapters on Madagascar," by the Rev. James Sibree, jun. The work will contain a popular account of recent researches in the physical geography, geology, and exploration of the country, and its natural history and botany; and in the origin and divisions, customs and language, superstitions, folk-lore, and religious beliefs and practices of the different tribes. It will contain physical and ethnographical maps.

GEOLOGISTS will be glad to learn the appearance of a trustworthy map of mines in Russia in Europe by Prof. W. Möller, "Carte des Gites miniers de la Russie d'Europe."

WE notice in the last number of the *Bulletin* of the Belgian Geographical Society a paper on the colour of eyes and hair in Belgium, by M. Vanderkindere, with maps: on the Zambeze, by M. Wauters; and the quarterly report on the demographical and medical statistics.

THE Church Missionary Society a short time back entertained the idea of establishing a sanatorium on the west coast of Africa, and the matter, it may be remembered, caused some discussion between their adviser, Capt. R. F. Burton, and the Rev. T. J. Comber, a Baptist missionary, at one of the Geographical Society's meetings last session. It was proposed to place the sanatorium on Mount Cameroons, which rises to a height of over 13,000 feet, just in the angle of the Gulf of Guinea, opposite Fernando Po. Two agents of the Society accordingly proceeded thither in the missionary steamer *Henry Venn*, and ascended the mountain to the highest peak. Their report was favourable to the suitability of a spot some 7,500 feet high, known as Mann's Spring, but to build a residence there and cut a road to it would, it appears, cost more than the Society can afford in order to recruit the health of their missionaries.

UNDER the heading of ethnography, a paper by Père Petitot, on the Asiatic origin of the Indians of Arctic America is commenced in the current number of *Les Missions catholiques*.

THE great work undertaken by the Russian Geographical Society under the title of "Works of the Ethnographical and Statistical Expedition to South-Western Russia" is now completed. The whole work consists of seven volumes, in nine fascicules, or nearly 4,800 pages, and it contains abundant most useful information as to those countries which afford so great an interest by the variety of their population.

WE notice the appearance of the following important works recently published by the Russian Geographical Society:—(1) The eighth volume of its *Memoirs* (*Zapioki*), which contains a "General Sketch of a Theory of Constant Marine Currents," by Colonel Schilling, and a "Note on the New Map of Persia," by General Stebnitzky, with the map itself, which is one of the most important acquisitions to the exact cartography of Asia during recent years.—(2) The fourth volume of the translation of Ritter's "Asia," being the description of the Altay and Sayan Mountains within the limits of the Russian Empire, with a very important appendix (far larger than the original work itself), by MM. Potanin and Semenoff, being a *résumé* of all new information acquired from 1832 to 1875.—(3) "The Kashgar Land" (*Kashgaria*), an historical and geographical sketch, of the country, of its military forces, industry, and trade, by M. Kuropatkin, with additions of General Stubendorff and M. Sreznevsky.—(4) "A Journey to the Holy Land of the Prince Radzivil-Sirotka during the Years 1582 to 1584," published and annotated by M. Hildebrandt; and (5) The two first volumes of a "Catalogue of the Library of the Geographical Society," containing books on mathematical, physical, and general geography. The importance of this catalogue will be realised by all those who know what a number of works appear in Russian on the geography of Russia and Asia, and how difficult it is to know them. We notice with pleasure that the catalogue contains detailed indexes of all papers that have appeared in the publications of the Geographical Society. An important work, being the description of M. Potanin's journey to north-western Mongolia is already in the press.

CELESTIAL PHOTOMETRY

THE volume of the annals of the Harvard Observatory just issued is one of great importance to astronomical science, as the new director, Prof. Pickering, has included in it the photometric observations which have lately been carried on with so much vigour. The first chapter is devoted to a description of the forms of instruments—many of them new—which have been employed, and in this notice we shall limit ourselves to an analysis of this part of the volume.

The first instrument employed was constructed by attaching a Nicol to a double-image prism in such a way that it could turn freely around its axis. By a graduated circle and index, the angle could be measured to tenths of a degree. When two bright objects were viewed through this instrument, two images of each were formed by the double-image prism, either of which, by turning the Nicol, could be made as faint as was desirable. Whatever their relative light, the faint image of the brightest could thus always be reduced to equality with the bright image of the faint object. The true relative brightness is then deduced from the angle through which the Nicol is turned.

This form of photometer may be used without a telescope in the comparison of bright stars which are sufficiently near each other, but the loss of light is large. By Fresnel's formula for the reflection of light, each of the four surfaces of the prisms will reflect four per cent. The amount they would transmit, were there no other losses, would therefore be $(\cdot 96)^4 = \cdot 849$. This supposes that the faces of the Nicol are perpendicular to its axis. If made of the usual form, the loss would be still greater. The unavoidable defects of the surface, dust, absorption, and the reflection at the surface of the balsam cementing the prism, reduce still further the transmitted light. About ·80 will remain under favourable circumstances. Since the prism forms two equal images, only one half or ·40 can pass into each, and when the two images are reduced to equality, their brightness will be only ·20 or ·40 of that of the fainter object. For any but the brightest of the heavenly bodies, it is accordingly necessary to increase the light by means of a telescope.

The following general remarks occur on this form of instrument.

"Since the relative positions of the Nicol and double-image prism are unimportant, either might be placed in front of the object-glass, between the object-glass and the field-lens, between the field-lens and eye-lens, or between the eye-lens and the eye. Unless the double-image prism is placed in front of the object-glass, two images of the latter will, in general, be formed, giving two emergent pencils, both of which must pass without loss into the eye. There is danger that on moving the eye one or other of these pencils will be partially cut off, thus reducing the brightness of one of the objects. If the two images to be compared are brought very near together, this is less likely to occur. On the other hand, at least one of the images of a double-image prism is not achromatic; and, if the prism is placed in front of the object-glass, the colour becomes very marked. In this case, also, it becomes difficult to obtain a prism having such flat surfaces that the images will not be distorted, since any irregularities are magnified by the full power of the telescope. If the two images are separated by a distance d, any two stars at about this interval may be brought together, so that any star may be compared with all those on the circumference of a circle having a radius d. With a large prism in which d equalled about $3°$, an attempt was made to compare β and ρ *Persei* and β and γ *Lyræ* by placing the prism in front of the objective of a telescope having an aperture of about 10 cms. A direct measure of the variations in brightness of the above-named variable stars might thus be obtained. This plan was abandoned, owing to the colour of the images.

"There is one other position of the prism, that where the eye-piece forms its image of the objective, in which the emergent pencil will remain undivided. This is, however, the exact point at which the eye should be placed; and, moreover, the

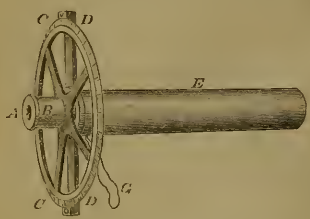


FIG. 1.

interval between the images cannot, in this case, be altered. Good results were obtained by placing the prism a little nearer the eye-piece, as in the first of the instruments described below. The advantage of placing the prism between the eye-lens and field-lens is that it is less likely to reduce the field of view. As this plan is open to the double objection of dividing the emergent pencil and keeping the images always at the same distance apart, it has not been employed in the following observations.

"The fourth position for the prism is between the field-lens and objective. It then separates the emergent pencils by an amount increasing with its distance from the objective, but, on the other hand, the interval between the images is proportional to its distance from the focus. Whatever, therefore, is the interval between the two stars, within certain limits, their images may always be made to coincide by first turning the prism and

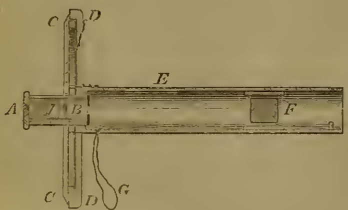


FIG. 2.

then sliding it along the axis of the telescope to the proper distance from the focus. A prism may therefore be used, in which the separation is small, and thus the two images of the objective may be rendered nearly coincident.

"The position of Nicol is comparatively unimportant. Since it must turn without moving the double-image prism, it is more convenient to place it between the latter and the eye. It was, accordingly, sometimes placed between the eye-lens and the eye, and sometimes between the field-lens and eye-lens."

We now come to the instruments.

The first observations were made with an eye-piece having a Nicol between its two lenses and with the double-image prism between this eye-lens and the eye. The observations made with this apparatus are regarded as preliminary; a second photometer was constructed, in which the Nicol and double-image prism were both placed in front of the eye-lens, the Nicol being next the eye. One marked advantage of this instrument, was that the circle instead of the index, turned with the Nicol. The labour of reading was thus much reduced. The Nicol was also replaced by a double-image prism, with the advantage that the field of view was less obstructed. With this form, however, the great number of images formed by successive reflections, when a bright object was observed, rendered it sometimes difficult to determine which should be compared.

A much simpler arrangement was used later. It consisted of two concentric tubes, one carrying a graduated circle, the other two indices. In the first of these tubes, a double-image prism was inserted; the other, which was held next the eye, carried a Nicol. This photometer was used without a telescope

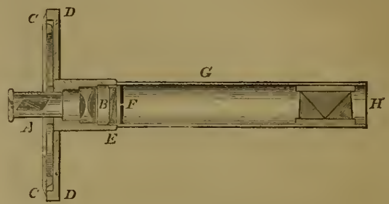


FIG. 3 (Scale [illegible]).

to compare the relative brightness of Saturn and Mars, and Jupiter and Venus. A tube was attached to this photometer, so that the light should always pass nearly normally through the prisms. When the objects were sufficiently bright, and within a few degrees of one another, good results were thus obtained, but the colour of the images, and their want of symmetry, was a serious objection when a great difference in light was to be measured.

After an experience of some months with these instruments, certain improvements suggested themselves, and still another photometer was constructed, represented in perspective in Fig. 1, and in section, on a scale of one-fifth, in Fig. 2. In both figures, B represents the eye-piece, in front of which is

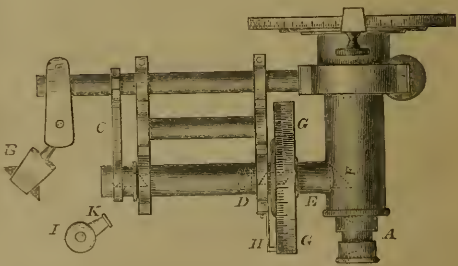


FIG. 4 (Sca le [illegible]).

inserted a Nicol, A. A circle, divided into degrees, is attached, and turns with the eye-piece. The indices D D are fastened to the tube E, which slides into the telescopes. F is a rochon prism, which was used instead of a double-image prism of spar. As it consisted of quartz, the separation of the images amounted to somewhat less than $1°$, so that the emergent pencils overlapped each other by nearly three quarters of the diameter of each. The apparatus had, moreover, the great advantage that the images were precisely alike and nearly achromatic. The prism was placed in a tube, which could be drawn towards or from the eye-piece by a cord G. Attaching this photometer to a telescope, and directing it towards a star, the latter appeared double; and the interval between the components might be altered at will.

These photometers could only be used for comparing objects very near together, as double stars, or satellites. For greater intervals, another device was tried. Two achromatic prisms of small angle were placed in front of the telescope, so as to cover the central portion of its object-glass. Two images of any object would thus be formed, separated by an interval dependent on the angle of the prisms and on their relative positions. By turning one or both of the prisms, the directions of the two images may be altered at will, and their distance varied between the sum and the difference of the angular deviation of the prisms.

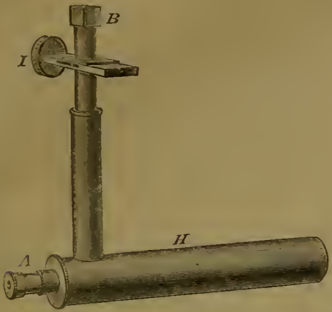


Fig 5

After bringing the images near together, they could be compared by one of the photometers described above. This method was tried with two circular prisms, having a diameter of 4·4 cms., and producing a deviation of about $1^{\circ}\cdot 3$. A telescope was used having an aperture of 10 cms. The light of any objects nearer than $2^{\circ}\cdot 6$ could be measured with this instrument. The constant, or proportion of the light transmitted by the prisms, was easily determined by comparing, by the photometer, the two images of the same object. This instrument, like those previously described, has the great advantage that both objects are seen under the same magnifying power, and therefore closely resemble

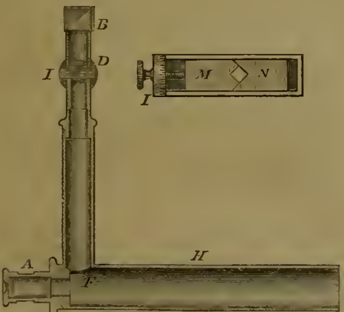


Fig.

each other, even when the condition of the air is not good. This plan cannot be used for large intervals, since, if the angles of the prisms are large, the images will be coloured by the secondary spectrum, and it would also be difficult to find the objects. With a large telescope, the prisms could not be reached easily by the observer, and the large diameter required would be an objection to their use.

The idea suggested itself to Prof. Pickering, that such photometers might be used to compare the colours of the components of double stars, by measuring *the relative light of different portions of their spectra*. A combined spectroscope and photometer, shown in Fig 3, was devised. A is a Nicol, placed in front of the eye-piece B. The graduated circle C C is attached directly to the tube carrying the Nicol; and the indices D D are fastened to the tube G, which slides into the telescope. H is a direct-vision prism, by which the images of the stars are converted into linear spectra. F is a diaphragm placed at the focus, and having a slit in it ·02 cms. broad, parallel to the edges of the prism. It is, therefore, perpendicular to the spectra, and permits a short portion of each to pass through. These appear as two stars, of a colour which may be varied with the position of the objects observed, as regards the axis of the telescope. Their relative light was measured by forming two images of each, by a plate of Iceland spar, E, which was used instead of a double-image prism, since the rays were not parallel. The light was then measured by turning the Nicol.

All of the photometers described above are open to the objection that the loss of light is very great. Under the most favourable circumstances only ·20 to ·40 of the light is used; so that, with the large telescope of aperture 38 cms., faint objects appear no brighter than with a telescope having an aperture of 18 to 24 cms., with a common eye-piece. To remedy this objection which was greatly felt during the observations of the satellites of Mars, a class of photometers of wholly different form was tried.

In these the image of some bright object, assumed as a standard, is reflected into the field of the telescope, and its light reduced by a known amount, until it is no brighter than the object to be measured. An unobstructed view of the latter is obtained meanwhile, with an eye-piece of the usual form. The first of these instruments is represented in Fig. 4.

The image of the faint object formed by the telescope is viewed by the eye-piece A. The light of the bright star taken as a standard, passes outside the telescope, and falls upon the prism B, by which it is reflected through the objective D of a small auxiliary telescope, and falling on the prism F, is brought into the field of view. The faint object is thus seen in one half of the field with the full aperture of the telescope; while the bright standard appears in the other half of the field, its image being formed by the small telescope. C and E are two Nicols, of which E may be rotated, and the light passing through it reduced at will. G G is a graduated circle, attached to the tube carrying D and E, and measuring the reduction of the light by an index H, which is fixed. The whole photometer may be turned around the axis of the large telescope, the tube carrying the prism enables the latter to rotate around the axis of the auxiliary telescope, and, finally the prism may be tipped around an axis parallel to its edges. Either two of these motions enable the observer to bring any object into the field of view of the small telescope. Practically, the second and third motions were used for the purpose. The first of these movements was reserved almost exclusively for the purpose of placing the prism so that it would conceal the bright star or planet with which the faint object was to be compared, when their distance apart was small. Otherwise, its light as seen in the large telescope, would be so intense as to interfere with the proper estimate of the light of the faint object. I is a lamp, by which the half of the field covered by the prism F may be illuminated, so as to render it as bright as the other half of the field. A piece of blue glass, K, served to vary the colour of the light.

Great difficulty was experienced in obtaining good images of bright stars with the small telescope, on account of the Nicols used. Since the rays passing through E are convergent, aberration is caused by the obliquity of its faces, even if they are plane and parallel. Hence the Nicols were removed, and a new form tried. The lenses of a double-image micrometer being taken out, two V-shaped pieces of brass were attached to the slides carrying the divided lens. A square hole, or "cat's eye," was thus formed, whose dimensions could be altered at will, by turning the micrometer screw. This arrangement is shown in M N, Fig. 6. Placing it near the objective D, Fig. 4, the light was varied by changing the aperture of the small telescope. All these instruments, however, were heavy, difficult to adjust, and not easily removed and replaced. These defects were remedied by still another form, represented in perspective in Fig. 5, and in section, on a scale of one-fifth, in Fig. 6. The same letters are used as in Fig. 4, for the corresponding parts. The faint object is viewed with the eye-piece A, while the light of the bright object, passing outside of the telescope, is reflected by the prism B into the object-glass D, whose aperture is varied by the screw I, which moves the plates M N. Finally, the prism F throws the light into the field of A. The whole is attached to the tube H, which slides into the end of the telescope. This photometer is light, can be easily removed, and by a suitable adapter may be attached to any telescope. As it forms a single piece, the adjustments are little liable to be disturbed.

In some observations, especially during twilight or moonlight, errors were apprehended from the comparative darkness of that half of the field covered by the prism F. This prism was replaced in other forms therefore by a piece of parallel glass. They were then called photometers E' and J. The reflected stars they formed were much fainter, and double, one image being produced by each surface of the glass. Still these instruments had the advantage that the field was unobstructed, and the star to be measured might be placed in any desired position, as regards the standard.

The latter class of photometers can be used only in the measurement of faint stars. If the image of the object seen in the large telescope is brighter than that formed by the auxiliary telescope, no setting of the Nicols or micrometer screw will render them equal. This difficulty was obviated by using the photometer shown in Fig. 4, removing the Nicols, and replacing its eye-piece by the concentric tubes referred to in an early part of this analysis. The images of the same object, seen in the large and small telescope, were first compared, and the constant thus found was used in reducing the observations of other objects. The advantages of this photometer are that stars of greatly different brightness and in different parts of the sky may be compared; but the loss of light is great, and the images are seen under different magnifying powers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Board of Natural Science Studies have recommended a new set of regulations for the Natural Sciences Tripos, to take effect as regards the first part of the examination, in the Easter Term of 1881, and as regards the second part in Easter Term of 1882. In effect it is intended to provide for a class list in general natural science honours in June each year, founded on aggregate knowledge shown by candidates in the first part of the examination, provided no credit is given in a subject unless the candidate has shown a competent knowledge of that subject. Each of the three classes is to be arranged in alphabetical order. The general arrangement of subjects and practical work has already been settled, but the details will no doubt invite attention. The working of Regulation 6 is rather curious. "In the first part of the examination there shall be a practical examination, either written or *vivâ voce*, or both, in such subjects as the Board of Natural Science Studies shall from time to time determine, provided that in all those subjects in which there is no such practical examination, one or more of the questions in the printed papers refer to objects exhibited at the examination." Regulation 7 states that there is to be a practical examination either written or *vivâ voce*, or both, in each of the eight subjects of examination in the second part. Regulation 14 proposes that, in arranging the class-list for the second part of the examination, the examiners shall have regard to general knowledge and ability as well as to special proficiency in one or more subjects. No candidate shall obtain a first-class for proficiency in one subject unless he show a competent knowledge of some cognate subject. When Human Anatomy is taken as the principal subject, either Zoology and Comparative Anatomy, or Physiology, be taken as a necessary cognate subject. Regulation 15 includes the following:—In each case of giving a first-class in the second part of the examination, the examiners shall specify the subjects for which the candidate is so placed, or the reason for specially distinguishing him.—A discussion in the Arts School on the proposed regulations for the Natural Sciences Tripos (on October 31), was opened by Mr. Sedley Taylor expressing great doubts about the desirability of giving such a prominent place to human anatomy in an honours examination. He read to those present the opinions of three eminent physiologists and anatomists specially obtained by himself on this point, and they were, on the whole, against the proposed regulation as unnecessary, if human anatomy were to be taught in the only way in which it could fairly enter into the Tripos, for its general and not its professional value, while usually the memory work involved was enormous, and such as to be of quite technical character. Dr. Humphry strongly supported the regulations and the distribution of subjects, as a method of aiding in preserving a scientific study of human anatomy. Dr. Paget dissented strongly from this view, not as a means of discouraging the study of anatomy, but to lessen the strain of constant change by questions which went to the root of the matter. He believed no sufficient settlement could be expected unless or until the Tripos was divided into two—biological and non-biological; it was unwieldy and unmanageable in its present state. Surely it was not impossible to frame some division of subjects which might secure this and be found workable. Mr. Balfour did not agree with the way in which human anatomy was regarded as so far apart from the anatomy of all other animals as to gain such distinctive marks, while no such division was made in physiology. Mr. Trotter thought it would be quite impracticable to enter upon the discussion of the Tripos at present, and that it would be impossible to divide the subjects into biological and non-biological. The geologists would object. Mr. J. N. Langley testified to the difficulty men often found in choosing or combining their subjects. Mr. Bettany strongly supported Dr. Paget's projected division of the Tripos into two, but with this difference, that men who gained a degree in the first part of the Tripos, as now proposed, in the "comparatively elementary" parts of the subjects, should be allowed to gain their final class in either biological or non-biological subjects, without such complex and often uncertain or vague regulations to puzzle candidates.

THERE can be little doubt as to the health of Cambridge being good, and the increasing confidence in Cambridge as a place of education, in view of two facts, viz., that the death-rate during the Michaelmas quarter has been only at the rate of thirteen per thousand, per annum; including only six deaths from the seven principal zymotics; and that the entry of freshmen at the colleges this year is the largest ever known, having increased by at least one hundred. It is the more incumbent on the university or the colleges, to see that space for exercise, recreation, study, and sleeping are fully provided for every undergraduate, and to take an active part in preventing disorderly men from remaining to vitiate others; and it is equally the duty of every wise man not to tempt our youth into overstrain of body and mind.

MR. PATTISON MUIR, Caius Prælector in Chemistry, lectures on the Metals this term, and also on Advanced Systematic Chemistry to Tripos candidates. Professors Liveing and Dewar have issued a notice of great importance to those desirous of prosecuting researches in chemistry. The new rooms added to the Chemical Department will enable them to accommodate a limited number of students who have had the necessary training and are desirous of prosecuting chemical research or of acquiring skill in special branches of chemistry. Applications for permission to prosecute researches must be made personally to the Professors, and all investigations must be subject to their approval. Mr. A. Scott, B.A., Prof. Dewar's assistant, will have the general superintendence of this part of the laboratory.

A COURSE of practical instruction in Experimental Physics will be given in the Cavendish Laboratory during this term. The course will be adapted to the requirements of beginners, and demonstrations will be given daily at times to be arranged with the members of the class. Thus again one of the most necessary classes is to be provided, but we trust Mr. Garnett's energies in this department will not be overtaxed.

OXFORD.—In a congregation to be held on November 18, the amendments to the proposed statute respecting degrees in Natural Science will be considered. As the proposed statute now stands, scholars in the Faculty of Natural Science may offer for Responsions Greek and Latin, or Greek or Latin with either French or German, and shall also be examined in arithmetic, the elements of plane geometry and algebra up the binomial theorem. An amendment has been proposed by Prof. Rolleston to substitute the elements of deductive logic for algebra beyond proportion. In moderations (first public examination), Prof. Rolleston proposes to insert deductive and inductive logic as an alternative for algebra. Candidates will be obliged to offer either Greek or Latin, with either French or German, and will be examined in the theory of logarithms, Euclid, trigonometry as far as the solution of plane triangles, and elementary mechanics. The council have proposed amendments abolishing those clauses granting the rights of Masters of Arts to Masters of Natural Science, since counsel's opinion has given it to be beyond the power of the University to grant such privileges to a new faculty. The council will accordingly propose a decree authorising the Vice-Chancellor to take whatever steps may be necessary to obtain the power of conferring on Masters in Natural Science the rights and privileges at present enjoyed by Masters of Arts.

The statute providing that there shall be two examiners in each of the three branches of the natural science school will come into operation this term. The three new examiners will be Dr. Odling in Chemistry, Prof. Ray Lankester in Biology, and Mr. W. N. Stocker, Brasenose, in Physics.

Dr. Acland, Regius Professor of Medicine, will give a public lecture at the Museum, November 20, on the new hospital at Baltimore, U.S., and its relation to the medical studies at the Johns Hopkins University, and to general medical education.

Mr. C. J. Baker, of Manchester Grammar School, has been elected to the Physical Postmastership at Merton College.

THE Board of Trinity College, Dublin, have elected Dr. Alexander Macalister to the Professorship of Anatomy, and Chirurgery, in Dublin University, vacant owing to the resignation of Dr. B. McDowel. Prof. Macalister still retains his Professorship of Comparative Anatomy, but resigns the Professorship of Zoology and the Directorship of the Zoological Museum. The election to the former of these posts we observe is fixed for an early day in this month ; the nominators are the members of the academic council of the University of Dublin, with a veto on the person nominated by the board. The election to the Directorship of the museum is in the hands of the board, and to this the person elected has always been the professor of zoology. The yearly emolument from both posts is between 300*l* and 400*l*. a year.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 9.—Questions in molecular physics figure largely in this number. Herr v. Wroblewski inquires into the nature of absorption of gases, by a kinematical method, inferring from the phenomena of motion of gases diffusing in absorbent substances, the condition in which they exist in these. The phenomena in caoutchouc are studied, and the author concludes, *inter alia*, that the absorption of protoxide of nitrogen, carbonic acid, and hydrogen by caoutchouc is a purely physical process, and the gases retain, after absorption, their gaseous state and all characteristic properties. The constant of diffusion of a gas depends only on physical properties, and chiefly its specific gravity, being approximately inversely proportional to the square root of this ; but the specifically lighter gases show greater constants than this relation expresses. The constant for protoxide of nitrogen and carbonic acid increases with increase of temperature, and at 10° C. is fifty times smaller than that for carbonic acid in water. A caoutchouc membrane is to be conceived as a porous plate endowed with gas-condensing and rarefying powers (the gas moving through the pores).—M. Chappuis investigates the condensation of gases on a glass surface by a similar method to Magnus's, viz., measuring the expansion between two exactly known temperatures, of a certain volume of gas at constant pressure in contact with a large glass surface, and inferring the original volume of the gas. The numerical results for hydrogen, air, carbonic acid, sulphurous acid, and ammonia, from 0° to 100° and 180°, are given, and utilised in determining the absolute coefficient of expansion at constant pressure (a slight correction of the former determinations being necessitated by the phenomenon in question). Magnus's statement that at 100° there is no condensed gas layer on a glass surface is shown to be incorrect in the case of ammonia.—A paper by Herr Schleiermacher treats of the quantity of liquid condensed on a moistened body. The author rejects Wilhelmy's numerical values for the condensation, and considers that, in determining the specific gravity of a liquid, if one be content with an accuracy of 0·002 per cent., the influence of condensation may be neglected ; in general the coefficients of condensation would be, at the most, of the order of 0·00001 $\frac{\text{g}}{\text{sq. ctm.}}$.—The specific heat of water is anew determined by Herr Heinrichsen, who arrives at the number 1·071 (for 100°) ; this stands about midway between Regnault's result, 1·013, and Jamin's, 1·122. (Stamo got 1·125, and Münchhausen 1·030.)—Herr Koch finds that the oxygen-polarisation of platinum and palladium increases the friction of these metals to a glass surface coated with water or dilute sulphuric acid.—Mr. B. O. Peirce, jun., shows from experiments how greatly the electromotive force of gas elements depends on the nature of the electrolyte.—Herr Edlund, replying to a criticism by Herr Dorn, gives experimental evidence that the electromotive force in passage of liquids through tubes depends directly on the velocity, and not on the pressure ; also that it is inversely proportional to the cross-section ; and explains the facts observed by the unitarian theory.—Herr Fenkner expounds some laws of transverse vibrations of metallic cylinders open at one end.—Remaining papers :—Researches on anomalous dispersion of light, by Herr Sieben.—Researches on the height of the atmosphere, &c. (continued), by Herr Ritter.—On the electromotive force of the Grove element in units of Siemens and Weber, by Herr Riecke.

THE *Journal of the Royal Microscopical Society*, vol. ii. No. 6, October, contains the *Transactions* of the Society.—On a new species of Cothurnia, by John Davis ; with Plate 20. Cothurnia is a genus of stalked infusoria very closely allied indeed to Vaginicola. Mr. Davis's new form is apparently very correctly referred to it ; but if so, his species is not a rotifer, and, we presume, does not possess a mastax. The infusorian is described as much smaller than its lorica, and is so figured when contracted ; this is not characteristic of a rotifer.—On some causes of Brownian movements, by Dr. W. Ord. Observations suggested by the study of *Amphipleura pellucida* mounted in Canada balsam, by lamp-light and sun-light, with various objectives, by Col. Woodward.—On Abbé's experiment on *Pleurosigma angulatum*, by Col. Woodward.—On new species and varieties of diatoms from the Caspian Sea, by Dr. A. Grunow ; translated, with additional notes, by F. Kitton ; with Plate 21.—The Record of current researches relating to invertebrata, cryptogamia, and microscopy. This record forms a most valuable portion of this journal. It occupies over 100 pages of this number, and, as far as one can judge, the notices give a very fair epitome of the papers quoted. The attempt to make this record a complete one of the invertebrates and of cryptogams is praiseworthy, but it seems to us that our yearly zoological and botanical records already do this in a fairly perfect way. Would it not be better that this bi-monthly record should confine itself to those papers of special interest to the microscopist. In this record references to papers of the type of Fischer on *Voluta musica*, Norman on Solenopus, or Pfeffer on Philippine pteropods, might be omitted. Only those who have worked at compiling bibliography know the great labour and skill required to keep up such a record ; and certainly the editor of this journal deserves the special thanks of all workers with the microscope.

THE *Gazetta Chimica* (fasc. vi. and vii.) contains the following papers :—On the chlorides and oxychlorides of tungsten, by U. Schiff.—On a method of preparing economically the bibasic citrate of quinine, by F. Dotto-Scribani.—Researches on *Satureja juliana*, by P. Spica.—Chemical researches on the salts obtained from the mother liquors of the salt works of Volterra, by A. Funaro.—Chemical analysis of a Chilian chrysocolla, by N. Pellegrini.—On a singular decomposition of the chlorhydrate of phenyl-ethyl-amine, by M. Fileti and A. Piccini.—On some neutral ammonia salts (citrate, phosphate, photosantonate), by F. Sestini.—New experiments on resinous substances, by G. L. Ciamician.—On the isomeric nitrosalicylic acids, by U. Schiff and F. Masino.—On the pretended artificial tannic acid, by P. Freda.—On piperidine, by R. Schiff.—On the action of cyanide of potash on the ammoniacal derivatives of chloral, by R. Schiff and S. Speciale.—On the crystalline forms of anglesite from Sardinia, by Q. Sella.—On the forms of crystallisation of some substances belonging to the aromatic series, by R. Panebianco.—On lithofellic acid and some lithofellates, by G. Roster.—Chemico-mineralogical researches on the lavas of the volcanoes of the Ernici in the Valle del Sacco (Rome), by S. Speciale.—On the discovery of nitric acid in the presence of nitrous acid, by A. Piccini.

THE *Rivista Scientifico Industriale* (Nos. 17 and 18).—From these numbers we note the following papers :—On a new method for determining the distribution of magnetism in magnets, by Prof. G. J. Agostini.—On the electromotive forces developed by saline solutions of different degrees by concentration with the metals which form their base, by A. Eccher Dall' Eco.—On the temperature of the voltaic arc and of the positive and negative polar extremities of the carbons during the production of the electric light, by Prof. Rossetti.—On the decomposition of chlorhydrate of ethyl amine by heat, by M. Fileti and A. Piccini.—On the preservation of dragon flies with fading colours, by Prof. Pietro Stefanelli.—On a new hydrometer for measuring the water supplied to steam-boilers, and called "Isaghidrometro" by its inventor, Sig. Massarotti.—On the work which can be performed by the beams of certain aquatic motors, by Cesare

Modigliano.—On a palæontological discovery made at Montegazzo in Fellina (province of Reggio-Emilia), by Prof. A. Ferreti.—On some recent communications made to the Paris Chemical Society, by the Editor.—On the filling of a barometer tube in vacuo, by Prof. Damiano Macaluso.

THE *Archives des Sciences physiques et naturelles* (September, Geneva) contain the following papers of note:—Review of the principal publications on physiological botany during 1878, by M. Marc Micheli.—On xylic acid, its preparation and compounds derived from the same, by MM. E. Ador and Fr. Meier.—Note on the last report of the Council of the Royal Astronomical Society (London), by Prof. Gautier.—Analysis of some recent works relating to the topography and the constitution of the moon, by M. Rapin.—Account of the sixty-first meeting of the Swiss Naturalists' Association, on Aug. 12–14, 1878. The remaining contents of the number consist of mere extracts from papers published in other serials and relate all to chemistry.

La Natura (vol. iii., Nos. 16 and 17) contains the following papers of interest:—On the intensity of electric currents and of extra-currents in the telephone, by G. Farraris.—On the correction of mercury thermometers, by C. Ferrari.—Observations made during the earthquake of August 9 last, by A. Serpieri.—On two new meteorological works, by C. Ferrari.

SOCIETIES AND ACADEMIES

LONDON

Mineralogical Society of Great Britain and Ireland, October 21.—Dr. M. Forster-Heddle, president, in the chair.—The following papers were read:—On the mineralogy and geognosy of the Orkney Islands, by the president.—On a probably dimorphous form of tin, by Dr. C. O. Trechmann.—On some Cornish tin-stones and tin-capels, by J. H. Collins, F.G.S.—Experiments on the elasticity of minerals, by John Milne.—On a peculiar pasty form of silica from Leadhills, Scotland, by Andrew French, F.C.S.

PARIS

Academy of Sciences, October 27.—M. Daubrée in the chair.—The following papers were read:—Notice on the life and scientific works of M. Dortet de Tessan, by Admiral Paris.—On the galvanic oxidation of gold, by M. Berthelot. This refers to Grotthuss's observation of the dissolving of gold-wire when used as positive pole in sulphuric acid traversed by a current. The attack is not due to formation of persulphuric acid, but solely to the influence of the current and contact of the electrode with the electrolysed liquid.—Decomposition of selenhydric acid by mercury, by M. Berthelot. He observed such decomposition when the substances had been in contact with each other a few years.—Note on the development of railways in Brazil, by Gen. Morin. Two maps from the Emperor were shown. The total length of railway in operation in the provinces of Rio de Janeiro, St. Paul, and Minas Geräes, is 2,882 km.; in construction, 1,751 km.; total, 4,633 km. From 1,000 km. to 1,200 km. of the working lines have a broad gauge of 1·60 m.; the rest, for local traffic, a gauge of 1 m. The mountain chain near the sea in Rio de Janeiro presented great difficulties, but beyond, the railways lie in long and fertile valleys.—Critical reflections on experiments concerning human heat, by M. Hirn.—On the gymnastics of M. Zander of Stockholm, by M. Norström. This is a system of mechanical and passive gymnastics, machinery worked by steam being used to move the limbs of the subject in various ways (the force being suitably proportioned). M. Larrey remarked on the complicated and expensive nature of the apparatus, and desired scientific data as to the effects obtained.—Result of researches made with a view to find the origin of estival reinvasions of phylloxera, by M. Faucon. The principal cause he considers to be carriage by the wind (inferred from the result of fixing a sheet of oiled white paper on a board at the top of a post facing the wind). Other causes are passage of the insect on the surface of the ground, and the presence of eggs.—On the appearance of mildew or false American oïdium in the vineyards of Italy, by M. Pirotta.—Determination of longitudes, latitudes, and azimuths in Algeria, by M. Perrier. He shows that the probable error of each definitive result is about one-tenth of a second of an arc.—Specific heats and points of fusion of different refractory metals, by M. Violle. The specific heat of iridium grows regularly with the temperature, and the formula gives 1950° (of the air-thermometer) as the point of fusion. The specific heat of gold hardly varies up to 600°, then gradually increases towards the point of fusion, 1035°. Other points of fusion: silver, 954°; copper, 1032°, palladium, 1500°, platinum, 1775°.—Chloride of lime battery, by M. Niaudet. The positive electrode is a zinc plate in a solution of chloride of sodium. The negative, one of carbon surrounded by fragments of carbon and chloride of lime in a porous vessel. All the combinations produced are soluble, and the battery remains an indefinite time at rest without being used up. The electromotive force at first is over 1·6 volt.—On the combinations of phosphuretted hydrogen with hydracids, and on their heat of formation, by M. Ogier.—On erbine, by M. Clève. He recognises M. Soret's priority, and the identity of the substances he himself called *holmium*, with M. Soret's X.—Complementary note on commercial trimethylamine, by MM. Duvillier and Bursine.—On ordinary cellulose, by M. Franchimont. This refers partly to dehydration of cellulose with sulphuric acid (chloride of zinc did not decompose cellulose).—On glucose, by M. Franchimont.—On the transmissibility of human rabies to the rabbit, by M. Raymond. Two rabbits were inoculated with blood and saliva (respectively) from a hydrophobic person. That inoculated with saliva showed signs of rabies four days after, and soon died. Pieces of its salivary glands (got thirty-six hours after death) were introduced into two other rabbits, who also died (paralysed), but without passing through a violent stage.—Researches on Daltonism, by MM. Macé and Nicati. They aimed at comparative measures of the quantities of light perceived in different parts of the spectrum by the Daltonian and the normal eye. Curves were got corresponding to the three varieties of Daltonian eye. The descent of the curve in the green the authors think they have been the first to prove certainly. No simple relation between visual activity and intensity of light was ascertained.—On the origin of the toxical properties of the Indians' curare, by M. Du Lacerda. None of the vegetable or animal juices often added by the Indians to the product of Strychnos have the effects of curare, and *Strychnos castelnœ*, also, *S. triplinervia*, are found to give curaric effects fully.—Experimental researches on human heat during rest in bed, by M. Bonnat. In all seasons the minimum of the body-temperature (observed in the rectum) is between midnight and 3 A.M. At Nice, in winter, the minimum is rarely under 36°·3; in summer, 36°·4 or 36°·5. From 3 A.M. the temperature rises till 9 A.M. (becoming, *e.g.*, 36°·9 in winter). The maximum is between 2 P.M. and 4 P.M., and from 9 P.M. the temperature slowly falls to the minimum. From 9 A.M. to 9 P.M. in winter the variations do not exceed three-tenths or four-tenths of a degree C.; in summer they may reach six-tenths.

CONTENTS

THURSDAY, NOVEMBER 13, 1879

DEMONOLOGY AND DEVIL-LORE

Demonology and Devil-Lore. By Moncure Daniel Conway, M.A., B.D., of Divinity College, Harvard University, Cambridge, U.S.A. Member of the Anthropological Institute, London. With numerous Illustrations. 2 vols. 8vo. (London: Chatto and Windus, Piccadilly, 1879.)

THESE two volumes carry us back to the period when existing creeds were embryonic, and when primitive man was creating his religion from his environment. The lights of heaven, animal and vegetable life, the elements and natural phenomena supplied the raw material of mythology, and received embodiment as anthropomorphic deities. Mr. Conway premises the inexactness of speaking of the worship of stock and stone, of insect and reptile as primitive. He expresses his belief that these only acquired intrinsic sanctity when the origin of their imputed sacredness was lost—the progress of ideas being from the far to the near, and not from the near to the far. Macaulay has attributed a monotheistic faith to the first inhabitants of Greece. Chalmers has done as much for China, and Mr. Brown, in his great Dionisiak Myth, has stated his conviction that "there is no gradual evolution in human thought, and that the earliest stages of religion and worship were infinitely superior to those which succeeded them." But whilst he endorses these opinions, Mr. Conway must remember that they are not shared by other competent authorities. Dr. Goldziher, for instance, stoutly maintains that religion was painfully evolved from mythology, and that polytheism has been the invariable precursor of faith in a single God. In this conflict of opinion we are as unprepared to decide whether worship rose from the idol to the Deity, or sank from the pure religion of a golden age into the vagaries of a degraded mythology, as we are to determine whether an adoration of the generative powers preceded or grew out of that of the sun. In the present state of our knowledge we must be content to suspend our judgment; but in examining Mr. Conway's work we must remember that it rests upon a theory which at least is not proven.

The undefined pantheism of primitive awe, says Mr. Conway, gradually melted into dualism, and the varying aspects of the Almighty as distributor of good and evil caused his separation into distinct embodiments of these principles. This is doubtless, in a sense, perfectly true: "theism is found side by side with unconscious pantheism, of which it is only an expression," and the Jew had in Jehovah a distributor of the evil as well as of the good before he evolved, or inherited, the conception of Satan. We are, however, inclined to believe that the first supernatural power which forces a conviction of its existence upon the mind of the savage is that of evil, and that the idea of a beneficent being is both subsidiary and of later occurrence. First, the embodiment of evil is feared and propitiated; next, when invoked successfully for the destruction of the worshipper's enemies, he begins to exhibit (to his worshipper at least), an amiable phase of his character, and the conflicting elements which thus come into play form the germs of the rival entities of God and Devil.

The first volume of the work, which is in two sections, deals with the Demon and its development into the Dragon, whilst the second volume is devoted to the Devil. This latter volume is filled with the theological conceptions which originated and developed the personification of abstract evil. These are scarcely suited for discussion in our pages, and for an account of their subtle gradations we must refer our readers to the book itself. The demon, however, is not theological but natural; it is a being the harmfulness of which is not gratuitous, but incidental to the gratification of its desires. It is the embodied expression of the natural obstacles with which savage man found himself obliged to contend, and hunger, heat, cold, wild beasts, the warring elements, darkness, disease, and death were the causes to which it owed its birth. It was to propitiate the hungry demon that sacrifices were instituted: in the hope that such offerings might satisfy the insatiate appetite of the monster to which not only human hunger and privation, but also eclipses were held to be due. Here we may offer an explanation, omitted by Mr. Conway, which throws light upon the character of this devourer of the sun and moon. From the most remote antiquity the two points at which the ecliptic and the moon's orbit intersect each other were called the head and tail of the dragon. As these are the points at which eclipses happen we see at once why astronomers fabled the existence of a monster which devoured the sun and moon. Once started the progress of the myth was easy, and after many varying phases the hunger fiend found its later developments in the form of the ogre and the vampire. Mr. Conway says that the visible consumption of sacrifice by fire in part originated the belief that it was the element of fiends, but it appears—on his theory that the progress of thought was from the far to the near—more probable that the sun having been the primary object of worship lent its characteristic of heat to some of the abstractions to which it gave rise. This class of demon was modified as the painful action of intense heat, in the desert sand, in sunstroke, and in drought, was observed by man. The worship of the sun in heaven would pass easily into the worship of his natural representative of fire on earth. In opposition to light and heat we find darkness and cold personified, and trace in such tales as the descent of Ishtar to Hades and the deaths of Baldur and Adonis the grief of man for the loss of the sun.

A propos of cold Mr. Conway reminds us that hell, which we are accustomed to regard as unpleasantly warm, really means a place of fireless darkness—fire being far too agreeable in northern latitudes to be regarded with disfavour, and he traces the superstitious desire for burial to the south side of a church to a wish for proximity to the happy abodes of Brimir and Sindri—fire and cinders! This passage is instructive, apart from its humour, for it teaches us how in the constant revolution of opinion the god of to-day is the fiend of the morrow, and how, as Mr. Fiske has pointed out, the German Abgott sums up in a single etymology the history of the havoc wrought by the monotheistic idea amongst the ancient symbols of Deity. To this degradation certain later forms of demon were due, and it is thus that the gipsy language retains as the word for God that which we employ as the appellation of the devil.

Mr. Conway passes in review the myths which spring from lightning, as the blasting-eye of Siva, the dart of Rudra, the spear of Odin, and the sword of St. George; and treats of the typhoon caused by the passing of the bob-tailed dragon and the various embodiments of whirlwind and waterspout, of sand-cloud and flood. He next proceeds to deal with the animal demons; and here, whilst we find much amusing folk-lore, we are surprised that he has not worked out that degradation of deities to which he himself alludes, and which might here be so effectively produced. Thus, although we have a suggestion of association between the hare and the moon, due probably to the resemblance of their Sanskrit names, and a statement that the lion is a symbol of majesty and of the sun in his glory reached in the zodiacal Leo, we have no hint of the extremely important change from the worship of the bull to that of the lamb due to the precession of the equinox, which brought a different sign for adoration at the vernal equinox, and which caused, in all probability, the substitution of the Pascal Lamb for the worship of Apis; this feast of the *transit* having its remembrance at the present day in the hot *cross* bun. Similarly we have no explanation of the association of the ass, the cock, and the goat with phallic ritual, though their association with the most holy rites of that creed could not fail to have diabolised them in the eyes of adherents to succeeding faiths. The Pleiades, the Succoth Benoth of the Chaldeans, were represented by a hen gathering her chickens under her wings; and we are surprised that Mr. Conway, who rarely loses an opportunity for startling the orthodox, has not here found a parallel to Christ's lament over Jerusalem. He has an interesting notice of the wehr-wolf, which was seemingly suggested by Mr. Fiske's excellent little work, "Myths and Myth-Makers," a volume to which, if we mistake not, Mr. Conway is much indebted. The animal kingdom thus furnished its quota of demons, and we are shown how every force which could be exerted injuriously in claw, fang, sting, or hoof, was pressed into the service of evil.

Hostile races were demonised of old, just as is the kidnapping white man of to-day amongst the black races of Africa. The varying physique of contending nations may have originated the myths of giants and dwarfs. A small people possessed of superior intellectual powers would scarcely fail to impress their huger opponents; though we must not lose sight of the gigantic features which are so frequently associated with solar heroes, and which may, perhaps, suggest a more satisfactory explanation. With our recent experience of famine in India, we shall have no difficulty in understanding the dread in which its embodiment was held, nor the adoration of the Hindu for the rain-giving Indra. Yet Mr. Conway justly laments that this adoration has taken the form of temple building throughout the land, for the offering of a worship impotent to arrest the famine demon, whose course might have been stayed had the expenditure thus lavished been devoted to observatories—since modern science has pointed out the relation existing between sun-spots and years of scarcity. He at the same time reminds us that we are more intent upon scaring our own people with the hell and devils which we have inherited from our pagan forefathers, than in endeavouring to remedy the demoniacal vice, infamy, and misery by which we are surrounded. We cannot follow Mr. Conway through his long and interesting catalogue of the other natural features which have been demonised—the mountain steep, the gloomy night, the mysteries of disease and of death—this he has worked out with great care, and a *résumé* of these sections would fail to afford an idea of their interest. These natural obstacles personified and demonised by man having played their part, shrunk, as he advanced in civilisation, from their terrible proportions, to make way for more general forms expressing comparatively abstract conceptions of physical evil.

On the one hand stood moral man, on the other unmoral nature. Man had by this time discovered that moral order in nature was represented solely by his own power; the good gods were now respected only as incarnate in men, whilst the active powers of evil remained hateful and hurtful to man, each becoming more purely a demon, and passing on to become a devil. Man in his growing culture gave a more symbolic cast to those representations, which had hitherto been purely naturalistic, and those semi-metaphysical conceptions were evolved which Mr. Conway classes under the general heading of dragon. In this class come the chimæra and sphinx, huge worm and serpent, Behemoth and Leviathan. Finally, the terrible conclusion that evil is a positive and imperishable principle in the universe—the notion of remorseless fate—of arbitrary will to which every human agony is attributable, detached from universal organic necessity, gave birth to the stupendous conception of embodied abstract evil in the person of the devil.

Only those who have attempted an investigation similar to the present one of Mr. Conway can appreciate the patient labour incident to the collection of widely-scattered materials and the mass of varied reading necessary to fit the author for his task, and we are happy to bear witness to the evidences of careful preparation with which these volumes abound. It is to be regretted that his excellent matter is frequently enveloped in rhetorical embellishments which render the comprehension of his meaning difficult. Mr. Conway's style of writing is characterised by recapitulation, want of concentration, and a constant parenthetical introduction of matter only collaterally related to the subject in hand, which render parts of his book far from easy reading. His explanations of the formation of legendary characters and of myths appear to us at times somewhat strained, and he leans unduly upon the metaphysical aspect of the question to the exclusion of those archæological and astronomical explanations which would have so greatly enhanced the value of his work. He has indeed dealt with phases of folk-lore, and has shown how physical and material wants were crystallised as entities, but he has, in our opinion, failed to make out, as he might have done, the genealogy of the infernal powers, and to cite those explanations which a knowledge of the astronomy of the ancients so constantly affords. In illustration of our remark, we may instance his treatment of one of the most important myths, that of Bel and the Dragon. He mentions that Bel is lord of the surface of the earth, including the atmosphere, and quotes long translations from tablets, giving accounts of the conflict as it w known to the Babylonians. He compares Bel's sword with that mentioned in Genesis as turning every way to guard the tree of life; he tells us that the Bel whom Milton saw was Cromwell and the dragon the serpent of English oppression; and that to the Jews the power of Christendom came to be represented as the reign of Bel. But out of all this he obtains nothing further than an identification of Bel with Michael in the Apocalypse. This is sufficiently provoking when we remember the astronomical and cosmical facts which underlie the story. Were we possessed of no further evidence than that afforded by the great pyramid, we should be at no loss to perceive the anxious care with which the heavenly bodies were observed by the ancients. A star-group which specially claimed their attention was the Pleiades. The Pleiades above the horizon were the celestial, and below it the infernal gods. The period of their culmination, typifying appropriately a deliverance from Hades of the departed, has been dedicated, throughout the Old and New Worlds, to the worship of the manes of ancestors. This festival survives in our All Saints Day the accompanying feasts of Hallow-e'en and All Souls, originating in the imperfection of ancient observations. Wanting instruments of sufficient accuracy to determine the exact time of culmination, the ancients, by extending their devotions over three days, secured a due celebration of the sacred epoch. One act of this solemn period was lighting the sacred fire. The *Times* of November 4 records that Her Majesty was graciously pleased to assist at that holy rite, and witnessed the burning in effigy of a witch, personification of the evil power. This fire, the Bealltainn or Beltin, was the fire of Bel, and celebrated his ascension to the zenith, whilst his adversary, the dragon, was cast down to the nadir. In the rising of the Pleiades, at the time that Scorpio sank below the horizon, we may see the victory of Bel over the Dragon—a victory always negatived, as autumn gave place to winter, and ever renewed as winter was succeeded by spring, the alternating success of the combatants being fitly recorded in a joint worship. When we remember the identification of the Cherubim with the Bull, and of the Seraph with Scorpio, we perceive that their continual cry is but another expression of the eternal struggle. Again, in a mystic sense, we must remember that in Babylonian mythology Bel was Saturn, the oldest and chief god, the great spirit of antiquity, the ancient of days, God of Heaven, Life God, Lord of the Cycles, Chronos, Eternal God. His emanation was light, and in his character of sun god he was the creator—Demiurgus and Logos—and in this phase he combats and overcomes Tiamat or evil chaos, as the heavenly spirit in Genesis broods over the abyss of darkness—this idea is reproduced in another Babylonian legend, in which Bel cuts the woman Omorka, or primitive matter, in halves, and forms heaven and earth of the pieces. We can readily understand that on the promulgation of the doctrine that the gods were originally men whose virtue had raised them to the skies, the heroic deeds of Bel were related as those of a giant over natural foes, and that the first of the gods became the first man, equivalent to Adam. And so we find that, in company with his wife Beltis (Eve), he preceded the antediluvian rule of the ten zodiac gods. But Bel was, as the highest abstraction of deity, himself hermaphrodite, and in that sense active heaven and passive earth—light and darkness. He is thus the dragon-slayer and the great serpent itself, a fact which will account for the two personifications being the objects of a joint worship equivalent to the linga-yoni worship of India.

To the getting up of the work we have nothing to object except as regards the illustrations, which, though fair, scarcely reach that standard which the excellence of the text deserves. Debited, however, with any faults which it may contain, a large balance remains to the credit of its learned author, and if he has not succeeded in producing an exhaustive treatise upon his subject, his volumes are undoubtedly a most valuable contribution to Demonology, and we trust they may meet with the success to which they are unquestionably entitled.

OUR BOOK SHELF

Fauna der Gaskohle und der Kalksteine der Permformation Böhmens. Von Dr. Ant. Fritsch, Band i. Heft i. (Prague, 1879.)

THE accomplished professor of zoology, in the university of Prague, publishes in this part, which consists of ninety-two folio pages and twelve beautiful plates, descriptions of the sections of the rocks whence the fossils were derived, lists of the fossils, and a careful *résumé* of the literature of the extinct amphibia, which are usually jumbled up together under the term Labyrinthodontia. The most valuable part of the work is an elaborate description of the new forms which abound in the strata overlying the Silurians, in a region where the Pilsner district may be considered typical. The Gaskohle there yielded a very rich fauna and flora of twenty-one new labyrinthodont species, some Orthacanthoids and species of Xenacanthus, Acanthodes, and Palæoniscus; besides Estheria, portions of Orthoptera and Julus. The plants named by O. Feistmantel were numerous and the few typical Permian forms are:—*Equisetites contractus, Neuropteris imbricata, Odontopteris obtusiloba*, and *Schlotheimi, Asterocarpus Geinitzii, Schützia anomala*, and *Walchia piniformis*. With these are Sigillaria, Stigmaria, Volkmannia, Calamites, Lepidodendra, &c. The new amphiban genus Branchiosaurus is represented by five species in the whole district, Sparodus by two, Hylonomus by the same number, and there is a form called Dawsonia. In noticing the family Branchiosauridæ Dr. Fritsch draws attention to the necessity of allowing the name Stegocephali to replace that of the Labyrinthodontia for the order, as the labyrinthic condition of the teeth is not seen in skulls in which the supra-occipitals are two distinct ossifications, where there are post-orbital and supra-temporal bones, as well as well-developed epiotics, a sclerotic ring being present. The family just alluded to are broad-headed salamander-looking things with smooth teeth with large cavities. They have short ribs, vertebræ with relics of the chorda, and the parasphenoid is in the shape of a broad plate, which narrows in front. The skin is covered with delicate ornamented scales, and the remains of branchial rays are present. One of these, *Branchiosaurus salamandroides*, already described by the author, is carefully illustrated, and is a form well worth studying. Its osteology is plainly given, and the remnants of the breast plate and of the shoulder girdle and pelvis also. The new genus Sparodus has remarkably broad bones, which may be vomers, which carry numerous conical teeth, and the fore part of the parasphenoid is short and broad, and the palatines have a row of teeth on them. Allied to *Hylerpeton*, Owen, and *Batrachiderpeton*, Hancock, Sparodus has about seventeen teeth in the lower jaw on either side and the front ones are double the size of the others. The genus Dawsonia, allied more or less to *Hylonomus*, Dawson, is also one of those broad frog-headed salamandroid-looking branchiate amphibia. The sculpturing of the head plates is remarkable, and there appears to be a new bone interpolated behind the post-frontal. Beneath, the vomers have teeth, and so have the long part of the pre-sphenoid, the outer portions of the pterygoids, the palatines, superior-maxillaries, and the pre-maxillaries. The clearly written book is made all the more valuable by the introduction of Miall's reports to the British Association on the labyrinthodonts, and it is pleasing to note the author's graceful recognition of the assistance, he has had in his work from British palæontologists.

P. M. D.

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.*]

An Account of some Marine Animals met with *en route* to the Cape September 21, 22

I AM commanded by my Lords Commissioners of the Admiralty, to transmit herewith a copy of a letter from the commanding officer of H.M.S. *Crocodile*, giving an account of some marine animals met with *en route* to the Cape, which may be of some interest to the readers of NATURE.

Admiralty, November 10 ROBERT HALL

H.M.S. *Crocodile*, Simon's Bay
September 30, 1879

SIR,—I think the following statement may be of some scientific interest, and have the honour to request that it may be attached to my letter of proceedings of this day's date.

Between the Lat. of $\left\{\begin{matrix} 5^\circ\ 53' \\ 9^\circ\ 48' \end{matrix}\right\}$ S., and Long. $\left\{\begin{matrix} 5^\circ\ 44' \\ 7^\circ\ 32' \end{matrix}\right\}$ E., and between the hours of moon setting and daylight on the nights of September 21 and 22, the condensers were continually heating, and the vacuum gauge suddenly dropping to zero.

On examination of strainers, it appeared that the inlet to the sea-water was choked with a marine animal to an extent that necessitated stopping and clearing four times on the night of the 21st inst., and five times on the night of the 22nd inst.

On referring to Dallas's "Natural History," the description given of the Pyrosoma, class Tunicata, order Ascidia, corresponded in all apparent particulars to the specimens I fished up from alongside and took from off the strainers. Those on the strainers were, of course, much flattened by the pressure, and those that had passed through were much attenuated.

The luminosity of the creatures was very great, and of a most brilliant sapphire colour. I have, &c.,

(Signed) F. PROBY DOUGHTY, Captain

To Commodore Richards, A.D.C., Cape of Good Hope

Easter Island

As the reviewer of Australasia in NATURE, vol. xx. p. 598, I must ask space for a few further words with regard to Rapanui. Mr. Albert J. Mott draws conclusions with regard to the ancient navigation of the Pacific Ocean and a former condition of high civilisation of the erectors of the stone images, which will not be admitted by any scientific ethnologist. The difficulties attending the erection by savages, or very slightly civilised people all over the world, of large stones has been greatly overrated. In the case of the stone images of Easter Island, the latest observer, M. A. Pinart, who has paid great attention to this very question and published the fullest account of the matter, together with a series of excellent illustrations, finds no difficulty in accounting for their erection. He writes as follows:—" L'ensemble de ce vaste atelier de statues gigantesques les unes entièrement terminées les autres à l'état d'ébauche et en voie d'exécution nous permet de nous rendre compte de la façon dont le travail était accompli, et de la manière dont elles étaient érigées et mise en place après leur complet achèvement. L'exécution de ce travail qui de prime abord parait considérable, qui à tout étonné les voyageurs et *suggère de nombreuses hypothèses*, est cependant d'une grande simplicité."

M. Pinart then goes on to explain how the sculptures were always cut out on rocks considerably inclined, and slid down hill to the place assigned, where they were tilted by means of an inclined plane of earth and stones built up, into holes dug deep enough to bury all but the head of each statue. I must refer readers wishing for more detailed information to M. Pinart's paper, "Voyage à l'Ile de Paques," *Le Tour du Monde*, 1878, p. 225, No. 927, for drawing my attention to which I am indebted to the librarian of the Royal Geographical Society, Mr. Rye.

The population of Easter Island was by some earlier voyagers estimated at as high as 1,500. It may have been greater, and as many as 500 men would certainly not be required for the erection of any of the images. There was undoubtedly a good deal of wood in the island in old times, and thus rollers and levers would be made use of. The trees of the island have now been exterminated by the inhabitants. Palmer speaks of a peculiar gesture of the modern Rapanui natives which he compares with certain features in the images. It is the opinion of experts that the general appearance of the sculptured faces is decidedly Polynesian, as far as mode of artistic treatment is concerned. Mr. Mott's conclusion that the existence of these images proves that a nation formerly existed which navigated ships to Easter Island at regular intervals, and kept the place going as a colony, will be regarded as simply absurd by any one who knows anything of the science of navigation. So small and so isolated an island as Rapanui could only be reached by navigators who had a very advanced knowledge of astronomy and navigation, and were provided with instruments of great precision, and who had determined the position of the island on maps with exact correctness. No Chinese, Japanese, Indian, or Arab navigators could have hit on the island except by accident. An exact determination of longitude, as well as of latitude is involved in the matter. A mere knowledge of the compass with even as good information concerning its variations as we now possess would not avail. The island was discovered by Roggeveen on April 5, 1722; in 1764 Commodore Byron, with two ships, sought for the island in vain; in 1766 Bougainville, with two French ships of war, sought for it also in vain; in 1767 Capt. Cartaret made the same attempt with a similar result. It was only on March 11, 1774, that Capt. Cook found the island again, and Mr. Mott would have us believe that persons who were by the undoubted evidence of their artistic capabilities and method of treatment of the human figure in sculpture, savages, were able to accomplish, as often as they wished, a feat of navigation which baffled some of the best European navigators of the eighteenth century. Even at the present day so difficult is the determination of longitude to persons not specially trained as expert navigators that the island of Bermuda, and even the Virgin Islands have been more than once reported as "gone down" by merchant captains who could not find them.

With regard to Mr. Mott's "gentle protest" against my statement that "the accepted scientific position is that primitive man was savage," no protest, whether gentle or otherwise, will alter the fact that such is the case; but it is quite superfluous to enter into a discussion here on the general theory of evolution, in accordance with which that position is maintained.

H. N. MOSELEY

Silurian Fossils in the Curlew Mountains

I BEG to state that the paragraph which occurs in NATURE, vol. xx. p. 641, that Silurian fossils have been found in beds amongst the Curlew Mountains "supposed to be old red sandstone," is not quite correct. It was very well known in this office that the beds containing the fossils were of the Silurian formation—though erroneously included within the boundary line of the old red sandstone in the Survey Map, sheet 76. Since the map was engraved, the district to the north and east has been surveyed, and a large fault was discovered, ranging in the direction of the spot where the Silurian fossils have been found. The occurrence of this fault explains the presence of the beds with Silurian fossils within the area of the tract coloured as old red sandstone. There is, therefore, nothing in the announcement in your paper of the slightest novelty, and I have only to state that if the writer of the paragraph had communicated with myself previously to "rushing into print," he would have received such information as would have prevented him giving publicity to a statement which however literally correct, is erroneous in essence.

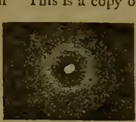
EDWARD HULL,
Director of the Geological Survey of Ireland

Geological Survey of Ireland, Dublin, November 6

[We were indebted for the note to the courtesy of Mr. Kinahan, of the Geological Survey of Ireland.—ED.]

Lunar Ring

WHILE experimenting on the actenic power of lunar light on August 30 last (period of full moon), at 9.30 P.M., I obtained, with a minute-and-a-half exposure, a photographic negative of the moon, which shows a distinct and well-defined ring or glory around it which was not visible to the naked eye on looking directly at the moon in a clear and cloudless sky, nor was there any halo on the ground glass of the camera, nor on the lens, at the time of observation This is a copy of it from the negative.



I used no clock-work arrangement with the camera, but allowed the moon to traverse the plate, and I have since then taken several photographic observations under various conditions. I have taken the moon in all her phases, with long and short exposures, in clear and cloudless sky, and never could get a ring even faintly defined. I have also heated the camera and screwed the cold lens into it, carried it into a colder atmosphere in order to produce condensation of dew. I have placed two small separate openings in front of the lens; on one occasion I dusted puff-ball spores upon the lens; on another I breathed warm breath upon it, but never got anything but decided burr, which was always densest near the limb of the moon and gradually tapered away towards the circumference like a bright light seen through a thick fog, but no appearance of ring. I have also taken observations when scud was passing rapidly over the moon, when perfect prismatic halos were visible to the naked eye, but no ring was ever impressed on the photographs; nothing more than a haze, such as that produced by breathing on the lens. The next full moon (September 29) was totally obscured, so that I failed to get an observation then; but last evening (October 29), at 10 P.M., I was fortunate to get one fine, clear exposure of one-and-a-half minute, and was pleased to see a clear and well-defined ring rise up on the plate during development, similar in every respect to that obtained on August 29, showing clearly that this unusual appearance is dependent upon the position of the moon in her orbit, she being in opposition when she manifests ring-giving power and shows us a crown. But why is this? What is the cause of this unusual, and, I believe, hitherto undescribed, appearance? Why should this ring be invisible to the naked eye and yet give a luminous impression on a photographic plate? Why should it appear only at full moon period and not at any other phase? Can it have any connection with what Mr. Newall saw round Mars through his huge telescope? If the moon had an atmosphere similar to that of the earth, and a star of some magnitude were occulted by the moon at that particular time, it is possible that its light in passing through the lunar atmosphere might be refracted so as to show a corona round the moon; but it is pretty generally acknowledged that there is no atmosphere surrounding it, therefore there can be no refraction.

It might be that the solar rays in passing through the upper regions of the earth's atmosphere are so defracted that the ultra-violet rays (though invisible) are thus rendered visible.

It is also possible that the doubly-reflected lunar light (the ashy light), in passing back to the moon from the earth, encounters on its passage the reflected solar rays from the moon, arresting and nullifying in proportion to its strength, so much of the light proceeding from the moon thereby causing a clear space around the moon-limb, a region of inertia, while the reflection from the disk of the earth, being larger than the moon's reflecting disk, will show itself as a ring on the outer edge of the neutral zone, much in the same manner as two heliographic reflectors would act if they were so arranged as to throw their respective reflections directly into and upon each other, the one being small and the other larger, just as the moon is the smaller and the earth the larger body, the smaller body reflecting a smaller, brighter light, while the larger body would reflect from its broader disk a less brilliant light with a feebler force, yet not so feeble as to prevent it arresting an amount of force equal to itself.

GEORGE BERWICK

Sunderland, October 30

[Dr. Berwick's explanation appears scarcely sound for it involves the assumption that a ray of light meeting another can arrest it; and also it involves the visibility of such rays while traversing space. We would remark that faint halos due to atmospheric causes are often seen almost masked by the brightness of a full moon, and the photograph being over-exposed, so far as the moon is concerned, does not show the relative actinic brightness of moon and halo. Would Dr. Berwick try further experiments with shorter exposures, and also ascertain from a number of photographs how far on either side of full moon a halo can be photographed, and whether it is always present during similar periods?—ED.]

Phosphorescence

A FEW days ago my attention was drawn to the phosphorescence of some fish (haddock) just received from the coast. The light was most brilliant about the fins and inside of the fish, which had been gutted. A spectroscope of low dispersive power showed all the light to belong to the green part of the spectrum. Approximate measures gave 557·5 (mm.) and 488·4 as the extreme wave-lengths, the part from 557·5 to 503·4 being somewhat brighter than the remainder, with a feebly indicated maximum at 527·6.

In the hope of getting a brighter spectrum the fish were washed in as small a quantity of water as possible. This water became highly phosphorescent, and when agitated in a bowl, gave beautiful luminous caustics, but neither in the bowl nor in a glass trough, nor in a tube of half-inch bore, did the liquid give a brighter spectrum than that afforded by the fish.

A large bubble of air was inclosed with the liquid in the tube. When the tube was violently agitated, it became luminous from end to end; if then held vertically, the light rapidly faded except near the top of the liquid, but on suddenly inverting the tube, the bubble of air slowly ascended, causing the whole contents of the tube to phosphoresce very brilliantly. This was a most striking phenomenon. After the lapse of some nine hours, the liquid had almost entirely lost the power of giving light.

The Observatory, Dunecht, Aberdeen, November 5

RALPH COPELAND

The "False Dawn"

FOR some time past certain considerations had led me gradually to infer that the "False Dawn" of the very extensive literature of Islām, whether Arabic, Persian, or Turkish, &c., and whether prose or verse, is another name for the "Zodiacal Light." No dictionary yet published so explains it.

I submitted my ideas and reasons to a number of English and foreign astronomers and linguists. All expressed their concurrence in those views; but direct proof of their correctness was not at once forthcoming. Recently, however, through the kindness of the Hydrographer to the Admiralty, a most obliging effort was made to solve this question by Capt. Wharton, commanding H.M.S. *Fawn*, now cruising in the Sea of Marmora. The method employed by that officer, and its conclusive result, cannot be better described than by giving his own words as follows:—

H.M.S. *Fawn*, Tuzla Bay,
September 26, 1879

Dear Capt. Evans,

For the information of Mr. Redhouse, I have to tell you that I can satisfactorily answer his question as to the false dawn of the Turks.

On the morning of the 20th instant, at 3.30 A.M., I went to a mosque at Buyukdere, and interviewed the Imaum, who, on being asked for the "fejri kyāzib,"[1] at once pointed out the zodiacal light, then brightly shining in the east. . . . There can be no doubt as to the coincideuce of the two.

Yours sincerely,
W. J. L. WHARTON

[1] "Fejri Kyāzib" is the Arabic expression for "the false dawn."

This preliminary philological question being thus irrefragably settled, I wish to bring to the knowledge of English and western astronomers the fact that, though the zodiacal light was first distinctly noticed in England in 1661, and named in France by Cassini, in about 1683, the "false dawn" was known to the Arabians in the days of Muhammad, who is said by the commentators in the 183rd verse of Chap. II. of the Qur'ān, to have there legislated on the subject as follows, when he instituted the diurnal fast of the Ramazan in the second year of the Hijra (A.D. 624):

"And eat and drink until the lighter streak of the dawn shall become distinguishable unto you from the darker streak."

Commentators, and, after them, the most highly esteemed Arabic dictionary, the Sihāh of Jawhari, who died in A. H. 397 (A.D. 1006) explains the expression "the lighter streak," as meaning "the true dawn," and, "the darker streak" as signifying "the false dawn."

Here, then, is incontrovertible proof that the zodiacal light, under its Arabic name of "the false dawn" was explicitly mentioned 650 years, and implicitly, 1,000 and odd years, before western observers had noticed the phenomenon. This is a point deserving special consideration by all who may in future write a history of the progress of discovery in respect to the zodiacal light. To how much older a time than that of Muhammad, a knowledge of the light may be hereafter traced, is a question that I leave with confidence to those who so fruitfully investigate the fragmentary records of antiquity. I should imagine that no one will suppose Muhammad was the first to take notice of an appearance that is, at times, much brighter than the "milky way."

Another suggestion has also arisen in my mind, of a far wider interest, in connection with my discovery. It is this:—

Modern western Sanskrit scholars have inclined to the idea that the high *plateau* of Pamir, which separates Chinese from Independent Tartary, and the Indus from the Jaxartes, was the primeval cradle of the whole Aryan race. Physically and historically, this hypothesis seems to be utterly untenable, though my reasons would be out of place here. The zodiacal light would appear to confirm my objection.

From the latitude of Pamir, the zodiacal light is a very conspicuous object there, and sure to be noticed by a nation of shepherds, nomads, warriors, and commercial caravan travellers. Had the various Aryan races all come from Pamir, they would have brought thence a knowledge of the zodiacal light, as they all brought the word "yoke" with them from the land whence they radiated. How comes it, then, that in ancient times as in modern, no Aryan, not even after Alexander had nearly reached Pamir, and the Ptolemies had reigned in Egypt for centuries, ever observed or mentioned this phenomenon? My conjectural answer is this: The Aryan race came originally from a northern land, where the zodiacal light is rarely and but dimly visible, radiating from thence as they have done all through the historical period, and as their rearmost representatives, the Slavs, are persistently striving to radiate still to climes more favoured than their own. J. W. REDHOUSE

London, November 5

The Caudal Disk

THE following may throw some light on the use of the caudal disk possessed by many of the Uropeltidæ (*vide* NATURE, vol. xx. p. 538):—

When in the Wynaad, in September, 1875, I captured, at the foot of the Nilgiri Hills, a Silybura, referred, I think, by Col. Beddome to the species, Nilgiriensis. This snake I took down to Mangalore, and kept alive until the succeeding March, when it was unfortunately killed by ants. When caught it was working its way through grass by the road-side, and made violent efforts to escape, striking my hand repeatedly with the pointed terminal scales, by throwing back its tail. I am uncertain whether to view this action as defensive or not. It may have been the result of the snake's struggles, but it is noticeable that the movement was vertical and not horizontal.

I had but few opportunities of investigating the matter, for in a few days the snake became so used to being handled that it would make no efforts to escape.

It was kept in a box filled with earth to the depth of some six inches, and during day-time never was to be seen, but at night came to the surface regularly, and was then much less sluggish than in the day. When taken out of the earth, it would at once commence to bury itself by forcing its pointed snout downwards, and alternately expanding and contracting the thick anterior portion of the body. The motion was exactly that of a worm, and the posterior portion of the body and the tail were dragged slowly after by longitudinal contraction, and were not actively used. During the burrowing process there were occasional pauses of that part of the body above ground, but from the movements of the earth it was evident that the snake was still progressing. So sensitive was the skin that the gentlest breath would hasten the withdrawal of the body, but so soon as the caudal disk was level with the surface the snake would retain it in that position for a long time, sometimes half an hour and more. The numerous keels on the scales of the disk carried a certain amount of earth; the disk invariably remained in the same plane as the ground's surface, exactly filling the hole, and it was therefore almost impossible to detect the snake, without close examination.

These facts suggested to me the idea of the disk being protective, and I therefore, on numerous occasions, unearthed the snake and watched it burrow, always with the same result—the steady withdrawal of the sensitive portion of the body, and the retention of the disk at the surface for a longer or shorter period.

I do not know what are the chief enemies of Uropeltidæ, but possibly certain carnivorous birds prey on them. If so, it is conceivable that the earth-covered disk would secure the snake and its hole from observation, until the head had worked sufficiently far underground to admit of the tail being at once withdrawn, beyond reach of beak or claw. This is quite possible from the power these snakes possess of extending themselves, a power well displayed if one of them be held firmly in both hands. E. H. PRINGLE

P. and O. S.S. *Pekin*, Gibraltar, October

Intellect in Brutes

THE Duke of Argyll in his "Reign of Law" was, I think, the first who promulgated the dictum that man is the only tool-making animal. As far as I can ascertain, this assertion is admitted by developmentists, yet it is undoubtedly true that the Indian elephant makes two *implements*, or forms and alters certain things so as to adapt them specially to fulfil definite purposes, for which, unaltered, they would not be suitable.

One evening soon after my arrival in Eastern Asam, and while the five elephants were as usual being fed opposite the Bungalow, I observed a young and lately caught one step up to a bamboo-stake fence and quietly pull one of the stakes up. Placing it under foot, it broke a piece off with the trunk, and after lifting it to its mouth, threw it away. It repeated this twice or thrice, and then drew another stake and began again. Seeing that the bamboo was old and dry, I asked the reason of this, and was told to wait and see what it would do. At last it seemed to get a piece that suited, and holding it in the trunk firmly, and stepping the left fore-leg well forward, passed the piece of bamboo under the armpit, so to speak, and began to scratch with some force. My surprise reached its climax when I saw a large elephant leech fall on the ground, quite six inches long and thick as one's finger, and which, from its position, could not easily be detached without this scraper, or scratch, which was deliberately made by the elephant. I subsequently found that it was a common occurrence. Leech-scrapers are used by every elephant daily.

On another occasion, when travelling at a time of year when the large flies are so tormenting to an elephant, I noticed that the one I rode had no fan or wisp to beat them off with. The mahout, at my order, slackened pace and allowed her to go to the side of the road, where for some moments she moved along rummaging the smaller jungle on the bank; at last she came to a cluster of young shoots well branched, and after feeling among them, and selecting one, raised her trunk and neatly stripped down the stem, taking off all the *lower* branches and leaving a fine bunch on top. She deliberately cleaned it down several times, and then laying hold at the lower end broke off a beautiful fan or switch about five feet long, handle included. With this she kept the flies at bay as we went along, flapping them off on each side every now and then.

Say what we may, these are both really *bonâ fide* implements, each intelligently made for a definite purpose.

S. E. PEAL

A COCHIN-CHINA REMEDY FOR LEPROSY

A NOTE in NATURE (vol. xxi. p. 19) refers to a remedy for leprosy, obtained from Cochin-China, but the origin of which is imperfectly known. Its name is given as *hwang-nao.* In Mr. Consul Tremlett's Report (For. Off. Repts. No. 21, p. 1237) it appears as *hoang-nau.* We have taken a good deal of trouble about this drug at Kew, and the inclosed extract from the Kew Report for 1877, p. 31, contains all that has been positively ascertained about it at present:—

"*Hoâng-nan, a Supposed Remedy for Leprosy.*—Mr. Prestoe, Superintendent of the Trinidad Botanic Garden, has drawn my attention to some accounts given in *Les Missions Catholiques* for 1875, describing the surprising efficacy of a drug, the produce of a plant found in Cochin-China, in the treatment of leprosy and rabies. The plant is known by the name of Hoâng-nan, and the description, which is of the vaguest kind, represents it as a climber, and its bark as the efficacious portion.

"M. L. Pierre, the Director of the Botanic Garden at Saigon, has obtained an imperfect specimen of the Hoâng-nan, and informs me that he identifies it as a new species of *Strychnos*, which he has named *S. gautheriana*, in honour of the ecclesiastic who first gave the virtues of the Hoâng-nan a wider publicity.

"M. Pierre adds some remarks which appear to me worthy of placing on record:—'The bark of *Strychnos nux-vomica* is regarded in Cambodia and Siam as a poison no less certain than that extracted from the seeds. The natives have remarked the fact, which is also believed to hold good in the case of cinchonas, that the bark has the most powerful properties when it has been covered with moss or otherwise protected from the action of light.' In collecting the bark great attention is paid in consequence to the circumstances under which it has been produced." W. T. THISELTON DYER

SOME POINTS IN THE HISTORY OF SPECTRUM ANALYSIS[1]

A PHYSICAL problem begins like a rivulet. At its first introduction it is small and seemingly unimportant—constantly however, as it winds along it receives accessions from various quarters until at length it becomes a mighty river that is finally merged in the unfathomable ocean. This course is followed by all such problems. Each begins small—grows broader and will finally bear us on to the unknown if we trust ourselves to its guidance.

I need hardly remind you that the demonstration of the decomposition of white light was one of the triumphs of the illustrious Newton. But like other problems it had its small beginning. We find in one of the earliest memoirs of the Royal Society, a paper on "The Genuine Method of Examining the Theory of Light and Colours," by Mr. Newton. Here he asks amongst others, the following questions:—

(1) Whether rays that are alike incident on the same medium, have unequal refractions?

(2) Whether rays endued with particular degrees of refrangibility, when by any means separated, have particular colours constantly belonging to them, viz., the least refrangible scarlet, the most refrangible deep violet, the middle sea green; and others other colours?

(3) Whether colours by coalescing do really change one another to produce a new colour, or produce it by mixing only?

(4) Whether a due mixture of rays, endued with all variety of colours, produces light perfectly like that of the sun? and he ends by remarking that the most proper and direct way to a conclusion is to determine such queries by experiment. Then follow some objections to the theory of light and colour, by the Rev. F. Pardies and Mr. Newton's reply to these objections. Into the nature of these however, it is not my purpose to enter. Let me rather adopt Newton's suggestion and bring the experiment itself before you.

You are all, no doubt, familiar with the operations of the photographer, and as a matter of fact you know that when the light from a natural object is made to pass through his lens an image of this object is impressed upon the sensitive plate placed at the focus at the other side of the lens.

If the natural object be a friend's face you obtain his photograph, if it be a tree, you get the image of the tree, if it should be a bright slit of light or a bright wire you would get the image of the slit of light or of the wire. Now here we have a slit which is rendered luminous by an intense light thrown upon it, and if we place a photographer's lens before it we shall obtain an image of the slit. You see the image thrown upon a screen and you see moreover that the light is white; it is in fact the electric light which illumines the slit. For the machine by which this light is produced our college is indebted to the generosity of Mr. Wilde. But my object is not now to discuss the electric light, but to show you that it is white and like the light of the sun—since, as you see, its image on the screen is white. Let us now interpose a prism or train of prisms between the lens and the screen. These prisms will do two things. In the first place they will bend the rays towards the base or thick part of the prisms so that in order to catch the image the screen must be moved in this direction. But in the second place they will bend some rays more than others;—if the slit be lighted by pure red light it will be least bent, if by orange, this will be more bent than the red, if by yellow this will be more bent than the orange, then follow green, blue, indigo, and violet, the latter of which is most bent.

Now if the light behind the slit be a mixture of red, orange, yellow, green, blue, indigo, violet, we shall have a series of images of the slit overlapping one another, and forming a long ribbon of light of which the portion least bent will be coloured red and that which is most bent will be violet. Let us now see what we get from the light we are using. Here you see we have all the colours of the rainbow, red, orange, yellow, green, blue, indigo, violet, and therefore our light must contain all these; but our light was white like that of the sun and thus you see we are entitled to say that white light is composed of a mixture of these various colours.

In fact what we have done by the prism has been to separate these various constituent rays from one another and throw one on one part of the screen and the other on another part. But now if we make these various constituents to dance so quickly before our eyes that we get a united impression of the whole, we shall imagine once more that we have white light. We separated the rays in space—let us now combine them in time—and you see the thing is white. We have thus demonstrated the composition of white light after the way by which the chemist proves the composition of water, first decomposing it by the battery into oxygen and hydrogen, and then causing these two gases once more to recombine. I will now remind you that light consists of waves or undulations given out by the luminous body. These waves take place in a medium called ether, surrounding us all, in which they proceed with incredible swiftness. The light given out by a luminous particle may thus be compared to the note or notes given out by a bell. In solids and liquids however the particles are so closely packed together that they may be likened to a number of different bells all tied together in such a way that the total mass is capable of giving out every, or almost every, variety of note. From an incandescent solid or liquid body, when sufficiently hot, you thus get every variety of light, and

[1] Being an address delivered by Dr. B. Stewart, F.R.S., at the opening of the present session, to the Natural Philosophy Classes at Owens College.

it is particles of carbon, probably in the solid state, that in the electric light afford us every variety of ray so as to enable us to get from them a continuous spectrum. When, however, we go from solid and liquid particles to those of a gaseous nature, we find the various molecules so far apart that each one is unconstrained by its neighbour; it is thus like a bell left to itself, in which case it gives out its own peculiar kind of light just as a bell, left to itself, will give out its own peculiar note. I will now show you on the screen the various rays or luminous notes given out by particles of incandescent vapour of silver.

We thus see what is the spectroscopic difference between solids or liquids, and gases, the former when sufficiently heated giving out a continuous spectrum consisting of all different rays of light, the latter a discontinuous spectrum consisting of only a few different rays.

The next point to which I will call your attention is a very important one. A particle when cold or comparatively cold absorbs those very rays which it gives out when hot. Now it is known that incandescent vapour of the metal sodium, gives out under certain conditions a peculiar monochromatic yellow light, which we call the double line D. This light is so strictly monochromatic that all bodies under its illumination appear either yellow or black, as you will see by the following experiment.

Now suppose we take the electric lamp, the carbon points of which, as you already know, give out all kinds of light, and suppose we place between these points a piece of metallic sodium; while this sodium is in the act of being volatilised, and its vapour comparatively cold, you will see that it will stop one particular kind of light, and will thus cause a black line. When, however, the vapour is sufficiently hot, this black line will be changed into a bright yellow one. You thus see that when we have an incandescent body which gives us all rays, and when between it and the eye we insinuate some comparatively cold sodium vapour, we get a certain definite black absorption line.

Now the curious point is that the sun's light gives us this black line, so that if I could replace the electric light by the sun, I should have a black line thrown upon the screen in the very position where you saw it when the sodium was introduced.

This means that between the source of the sun-light and the eye, we have sodium vapour in a comparatively, remember only comparatively, cold state, and as this vapour is certainly not in the earth's atmosphere, it can only be in the atmosphere of the sun. I need not tell you that although colder than the particles beneath it which give us sun light, it must be in reality very hot. The discovery that there was vapour of sodium in the atmosphere of the sun was due to Stokes, and it has since been found out by Kirchhoff that we have black lines in sun light corresponding in position with the bright lines of iron vapour, the bright lines of hydrogen, the bright lines of magnesium vapour, and the bright lines of many other elements, and we may therefore assume as Kirchhoff assumed, as a first and approximative hypothesis, that the vapours of iron, magnesium, hydrogen, &c., as well as that of sodium exist in a comparatively cold state in the atmosphere of our luminary;—more recent work by Huggings and others has shown that the same remark applies to the atmospheres of many other stars.

You thus see that there are two ways by means of which the chemical composition, or rather perhaps the atomic structure of bodies may be indicated by the spectrum. At a comparatively low temperature this structure will be indicated through the lines that are absorbed or rendered black, while at a comparatively high temperature it will be indicated by the bright lines that are given out.

Thus at a comparatively low temperature a solution which contains blood will indicate the presence of this substance by certain very peculiar black lines. Blood, however, is easily decomposed by a high temperature, and accordingly when such is applied we no longer get the bright equivalents of these black lines, but something very different, namely, the bright lines of iron, and of those other elements into which blood is decomposed as the temperature is raised. In short when raising the temperature of a substance its black lines will be converted into bright ones only in those cases where no molecular change has taken place between the two temperatures. Even in the case of elements like sodium Roscoe and Schuster have shown that the absorption spectrum at a low temperature is different from, and more complex than, the radiant spectrum at a high temperature, and other elements have been tried in this way by Lockyer and others with similar results. We may imagine with much propriety that the molecule of sodium vapour at a low temperature is a larger and more complex structure than it is at a high temperature, where the splitting up or dissociating agency of heat has been freely employed.

We come at last to the important question which it is my object to discuss. Has a study of the spectrum thrown any light on the ultimate constitution of matter, or is it likely to do so?

You are aware that chemists and physicists have begun to speculate as to the possibility that the so-called elements may be in reality nothing more than combinations differing in numbers and in tactical arrangement, of some one kind of primordial atoms.

This idea was first entertained by Dr. Prout, the well-known physician and chemist. He pointed out that the atomic weights of the so-called elements are very nearly all multiples of the half of that of hydrogen, so that the various elements may possibly be looked upon as formed by a grouping together of certain atoms of half the mass of the hydrogen atom.

M. Stas, the distinguished Belgian chemist, instituted a laborious series of experiments with the view of testing this doctrine. He came to the conclusion that the atomic weights of the various elements were not precisely multiples of the half of that of hydrogen, there being greater differences than could possibly be accounted for by errors of experiment. His researches, however, seemed to show that in many cases there was a very near approach to Prout's imagined law. But here we must bear in mind the great difficulty, or indeed impossibility, of obtaining substances absolutely free from all impurities (indeed Dumas showed that oxygen forms part of the silver with which Stas worked), so that we may be excused from imagining that Stas has settled the point in the negative. We are thus driven to look to the spectrum as a likely means of throwing some light on this very interesting and important speculation.

Let us now, therefore, endeavour to realise what would be the behaviour of the spectrum if the so-called elements were not capable of simplification, and also what would be its behaviour if they were, and then find with which of these two hypotheses the true behaviour of the spectrum agrees best. Now if the elements were absolutely simple bodies, we might still expect that the molecule of vapour of an element would be at a low temperature more complex than at a high one, and would therefore give out a more complex spectrum. As, however, the temperature was made to rise we might expect ultimately to obtain a certain spectrum which would represent the simplest mode of vibration of that element, and which would thenceforward remain, however much higher the temperature should be made to mount. Lockyer has written much on this point and given many facts in support of this view.

And again we should have no reason for supposing that the lines of the ultimate spectrum of one element should coincide in position with those of the ultimate spectrum of another element. If therefore we had a mixture of all the elements, and subjected this mixture to a very high temperature, the resulting spectrum under the supposition that each element is really an element, would never be simpler than the combined spectra of the various elements.

On the other hand, if the elements were really compounds of some one primordial atom, we might expect that a very high temperature would split up their atomic structure, and simplify their spectra, so that at an enormously high temperature a mixture of all the elements might nevertheless give us a very simple spectrum. We might likewise expect that different elements might split up into common constituents, so that at a very high temperature the spectra of these elements would have certain lines in common.

It is in the larger masses of the Universe, the sun and stars that we must look to find a mixture of all kinds of matter at very high temperatures, and when we have a brilliant bluish-white star containing a large proportion of the more refrangible rays we have every reason for supposing this star to be at a very high temperature. Now such stars exhibit an extreme paucity in the black lines which appear in their spectra, in which there is hardly anything else than certain prominent lines seen in the spectra of hydrogen, calcium, magnesium, and sodium. Lockyer, who has devoted great attention to this subject, argues therefore as follows. If it be true that as a rule the atmospheres of the whiter and presumably hotter stars contain fewer elements and those of the smallest atomic weight and that as stars diminish in whiteness their atmospheres rise in complexity of structure this undoubtedly tells in favour of the power of high temperature to split up the so-called elements. He has quite recently carried this reasoning into another field. The Fraunhofer lines give us the integration of the absorptions of all the strata of the solar atmosphere. Now spot phenomena occur in a restricted stratum of this atmosphere, and this stratum is low and therefore hotter than the overlying portions. We can tell the spectral lines special to a spot by their widening, and the number of lines widened is small in comparison with the Fraunhofer lines. Here again we have simplicity brought about by high temperature in the low levels in the sun as in the stars hotter than the sun.

Let us now ask whether the spectra of the various elements have or have not certain lines in common. It used to be imagined that they had not.

When, however, they have been examined under great dispersive power there has been found reason to qualify this assertion. There are certain lines in the spectra of each element which appear long and thick, their predominant notes as it were, and it has been found that while such a line for instance is exceedingly prominent in some one element other elements appear to possess it, only not nearly so prominently. Lockyer's argument from this was that, on the assumption that the elements are truly elementary, the line in the other elements was caused by traces of impurity. He has, however, recently had reason to believe that there are coincidences between the spectra of the various elements not of this nature. There are coincidences of lines which are not the prominent lines of any one spectrum and they give no signs of that variability of brightness that might be expected to characterise lines due to impurities. These lines he has called basic lines. As may be readily imagined in a branch of knowledge which is so new we shall have long to wait for facts. Hence we cannot test this conclusion by referring to the spectra of stars. But Lockyer has already shown that we can test it by means of the spectra of sun-spots, and here the facts are certainly in support of it. The basic lines are more prominent in the spectra of spots than in the spectrum of the sun generally, and further they are more prominent at epochs of sun-spot maximum than during times of minimum.

But we must have a clear conception of what we mean when we suppose that the so-called elements are split up at a very high temperature.

If we apply a very powerful source of electricity we obtain certain peculiar lines from the vapour of calcium.

Now if we could (like the Demon of Maxwell) catch hold of and segregate—put into a box as it were all these minute entities that give us this suspicious line at a high temperature, and further if we could keep their high temperature up I think it is probable that we might obtain something which is not calcium, or at any rate, something simpler than the molecule of calcium as this appears at lower temperatures. But we are not yet able, and perhaps we may never be able, at an ordinary temperature to present the chemist with some other substance derived from calcium which is not calcium.

To conclude there seems little doubt that spectrum analysis will, as it advances, throw great light on the ultimate constitution of matter and it therefore justifies the remarks which I made at the commencement of this lecture.

THE SWEDISH NORTH-EAST PASSAGE EXPEDITION

DESPATCHES have been received by Mr. Oscar Dickson, of Gothenburg, from Prof. Nordenskjöld, giving an account of the wintering of the *Vega*, down to April 1; letters from Lieut. Palander and other members of the North-East Passage Expedition have also been published, some of them bringing down the narrative to a later date. From these we gather the following particulars:—

The *Vega* was frozen in on September 28, in 67° 7′ N. lat. and 173½° long. W. from Greenwich, at the northernmost extremity of Behring's Straits. The land in the neighbourhood forms an extensive slightly rolling plain, bounded on the south by gently-rising hills, which, farther into the interior, are said by the natives to reach a considerable height. The plain is occupied to a large extent by lagoons separated from the sea by low sandy beaches. When the *Vega* was frozen in, the ground was covered with hoar frost and frozen, but still free of snow, so that it was possible to form some idea of the flora of the region. Close to the beach, compact beds of *Elymus* were intermixed with carpets of *Halianthus peploides*; next there stretched a poor level gravelly plain, only covered with a black lichen, *Gyrophora proboseidea*, and some few flowering plants, amongst which *Armeria sibirica* was the most common. South of this, again, was a tract occupied by lagoons and small lakes, whose shores were covered with luxuriant vegetation, consisting of grasses and *Carices*. On the neighbouring high ground, where the soil, derived from weathered strata of gneiss and dolerite, is richer, the vegetation is marked by greater variety. Here were thickets of willows, extensive carpets of *Empetrum nigrum*, and *Andromeda tetragona*, and large tufts of a species of *Artemisia*. Here were found also the frozen remains of the red whortleberry, the cloudberry, *Taraxacum officinale*, and other plants peculiar to the high north. In an excursion to the interior on October 8, Lieut. Nordquist observed that on the driest parts of the *tundra* the most common plants were *Aira alpina* and *Poa alpina*; on the lower places, *Glyceria, pedicularis*, and *Ledum palustre*. *Petasites frigida* and a species of *Salix* occurred everywhere, the latter growing in large compact masses covering spots several hundred square feet in extent, the bushes in some places being 3 to 4 feet high.

In the neighbourhood of the *Vega's* winter quarters there were six small encampments, numbering from three to twenty-five tents each, inhabited by Tchuktches to the number of about 200. With these natives there was much friendly intercourse. They were allowed free access to the deck from which, though covered with a multifarious variety of articles, they did not remove the smallest trifle. They were not, however, altogether to be depended on in the statements they made regarding the articles they offered for sale. Thus, on several occasions what were represented to be hares were found to be dead foxes skinned and with the head and feet cut off, and the natives expressed great astonishment at the instant discovery of the deception. When they had acquired a taste for European food, they bartered drift-wood and the bones of the whale for ship-biscuit, and the quantity distributed partly in this way, partly as gifts, was so considerable as to contribute in no small degree to mitigate the famine that threatened to break out among the natives in mid-winter. None of them were Christian, nor could any of them speak any European language, except one or two who could say a couple of words in English or a word of salutation in Russian. Lieut. Nordquist studied their language with such zeal and success, that in a fortnight he could make himself pretty well understood. He has collected materials for a comprehensive vocabulary.

When the *Vega* was frozen in, the sea next the coast was covered with newly-formed ice, too thin to carry a foot-passenger but thick enough to prevent a boat from making any way. On October 3 the Tchuktches walked on board over the ice. Up to the 10th there were weak places between the vessel and the land, and a blue sky in the east still indicated open water in that direction. On the 13th it was ascertained that a belt of drift ice-fields, compactly frozen together, at least thirty kilometres in breadth, lay between the *Vega* and the open sea. The thickness of the newly-formed ice was measured by Lieut. Bruzewitz, with the following results:—

The Thickness of the Ice

On December 1	56	centimetres.
,, January 1	92	,,
,, February 1	108	,,
,, February 15	120	,,
,, March 1	123	,,
,, April 1	127	,,
,, May 1	154	,,
,, June 1	154	,,
,, July 1	103	,,

For a distance of about six kilometres from the shore the ice lay all winter nearly undisturbed, but farther out it was in continual motion. So-called polynia, or open places, says Nordenskjöld, probably occur here all the year round, and in favourable weather accordingly we could see almost constantly a blue water-sky from true north-west to east. A southerly wind in a few days brought the open water within a few hours' walk of the vessel. It then swarmed with seals, which indicates that it was in connection with a sea always open. The neighbourhood of such an open sea probably accounts for the fact that in the fields of drift-ice that surrounded the vessel there was not a seal-hole to be seen. On January 1 Lieut. Bove reached open water by a four hours' walk. From the fact that from a hummock five metres high he could see no boundary to the open water towards the north-east and north, and from the extent of the water-sky in that direction, he concluded that the breadth of the open water was at least thirty-five kilometres. The depth at the edge of the ice was twelve fathoms, the temperature $-2°$ C. The water ran at a considerable speed right from the coast (from south-south-east), apparently a tidal current. The open water swarmed with seals. No polar bear, no walrus, and no birds were seen.

During the long-continued severe cold in the month of January, in the course of which the temperature several times fell below the freezing-point of mercury, the sea appears to have frozen completely for a great distance from the coast. but by February 7 mild weather again commenced, with variable and southerly winds. The same day a faint water-sky was seen at the horizon. Some kilometres to the east the beach was free of ice, and from the heights on land the seamen observed a high sea in the blue streak of water which bounded the horizon. The open water thus appears to have been very extensive. The statement of the natives that it extended to Behring's Straits was perhaps correct.

The temperature during the wintering was as follows:—

	Minimum. °	Maximum. °	Mean. °C.
October	− 20·8 ...	+ 0·8 ...	− 5·21
November ...	− 27·2 ...	− 6·3 ...	− 16·59
December ...	− 37·1 ...	+ 1·2 ...	− 22·81
January	− 45·5 ...	− 4·1 ...	− 25·05
February	− 43·8 ...	+ 0·2 ...	− 25·08
March	− 39·8 ...	− 4·2 ...	− 21·65
April	− 38·0 ...	− 4·6 ...	− 18·93
May	− 26·8 ...	+ 1·8 ...	− 6·97
June	− 14·3 ...	+ 6·8 ...	− 0·60

On two occasions the barometer was uncommonly high, viz.,

December 22, 6 A.M. 782·0 (0°) mm.
February 17, 6 A.M. 788·1 (0°) mm.

The lowest atmospheric pressure observed before April 1 was on

December 31, 2 A.M. 728·8 (0°) mm.

The weather during the winter was exceedingly stormy, and the direction of the wind near the surface of the earth was almost constantly between north-west and north-north-west. But in a stratum of air at no great height there prevailed, to judge from the motion of the clouds, a similar uninterrupted current from the south-east, which when it occasionally sank to the surface of the earth, brought with it heat and comparatively dry air. This is explained by Behring's Straits forming a gate bounded by high hills between the warm atmospheric area of the Pacific, and the cold area of the Arctic Ocean. The winds must here arrange themselves approximately according to the same laws as the draught in the door-opening between a warm and a cold room. The cold stream of air must go below, and the warm above. The mountain heights which the natives say are to be found in the interior of the Tchuktch Peninsula, besides, contribute to the heat and dryness of the southerly and south-easterly winds. For they give to the winds which pass over their summits the properties of the "föhn." The coldest winds have come from south-west to west, that is, from the Siberian Plain. On the existence of two currents of air which, at a certain height above the surface, contend with one another for the mastery, depends again the speed with which the sky in the neighbourhood of Behring's Straits suddenly becomes cloudy and again completely clear.

Nordenskjöld remarks that the fall of snow was not particularly great, but as there was no mild weather of any continuance during the winter, so that the snow was never covered with any continuous crust, a considerable portion of the snow remained so loose that it was carried backwards and forwards by the least puff of wind. With a storm or strong breeze, the snow was carried to higher strata of the air, which was so filled with the fine particles, that it was impossible to distinguish objects at the distance of a few yards. But even when the wind was light and the sky clear, there went on a constant snow-storm a few inches in height along the surface of the ground in the direction of the wind, and so principally from north-west to south-east, carrying an immense mass of water in a frozen state over the north coast of Siberia to more southerly regions, and playing a sufficiently important part in a climatic respect, among others as a carrier of cold to the most northerly forests, to deserve the attention of meteorologists.

The most remarkable observations which the wintering of the *Vega* has yielded appear to relate to the aurora. Our voyage happened in one of the years, writes

Nordenskjöld, of which it was known beforehand that it would be a minimum aurora year. Just this circumstance has, however, allowed me to study, in a specially suitable region, this natural phenomenon under uncommonly favourable circumstances. For here the luminous arches, which also in Scandinavia generally form the starting-points of the ray-auroras, have shown themselves undimmed by the more splendid forms of the aurora, and one could thus devote one's self to collect observations towards a clearing-up of the right nature of these arches undisturbed by accidental accompaniments. Referring for details to a paper he has sent home for publication in the *Transactions* of the Swedish Academy of Sciences, he goes on to say that the aurora, during the winter 1878-79 never appeared with the splendid bands or draperies of rays so common in Scandinavia, but always in the form of faint luminous arches, which remained unaltered in position hour after hour and day after day. They were *constantly* visible when the sky was not clouded nor their feeble light dimmed by the rays of the sun or the full moon. The conclusions Nordenskjöld draws from numerous measurements of the height, extent, and position of these arches are, that our globe, even during a minimum aurora year, is ornamented with a nearly constant corona or circle of light, single, double, or multiple, whose inner edge during the winter of 1878-79, had a height above the surface of the earth of about $\frac{8}{100}$ of the earth's radius, whose centre, the "aurora pole," was situated on the radius of the earth which touches the surface about 81° N. lat. and 80° W. lat. (Greenwich), and which, with a diameter of 0·3 of the earth's radius, extended itself in a plane at right angles to the radius of the earth which touches the centre of the circle. This circle of light stands in the same relation to the ray- and drapery-auroras of Scandinavia as the trade-winds and monsoons in the south to the irregular winds and storms of the north. Its light is never distributed into rays, but resembles that which passes through obscured glass. When the aurora becomes stronger the extent of the circle of light is altered, double or multiple arches are visible, generally lying in the same plane and with a common centre, and rays are thrown out between the different bows. Arches are seldom seen lying irregularly to or crossing one another. The area within which the *common arch* is visible (on the supposition that it can no longer be distinguished when its altitude is only 4° above the horizon) is bounded by two circles drawn upon the earth's surface with the aurora pole as the centre, by radii revolving round it at angles measured on the earth's circumference of 8° and 28°. It touches only to an inconsiderable extent lands inhabited by peoples of European origin (the northernmost part of Sweden, Norway, Finland, Iceland, and Danish Greenland), and even in the middle of this area there is a belt passing over the middle of Greenland, the south of Spitzbergen, and Franz Joseph's Land, where the *common bow* commonly forms only a faint "veil" of light in the zenith. This belt separates the regions where the luminous arches are seen mostly on the southern from those where they are seen mostly on the northern horizon. In the area nearest the aurora pole only the smaller, in the middle of Scandinavia only the larger and less regularly formed coronas are visible. But in the last-mentioned region, as in Southern British America, the aurora-storms and the ray- and drapery-auroras become common. The region where the aurora occurs in its most developed state is to be sought for near the circle which, with the aurora pole as a centre, is drawn on the surface of the earth with a radius at an angle measured at the earth's circumference of about 24°.

The tidal observations, when compared with other series made in the Arctic seas, give important indications regarding the distribution of land and sea in the Polar basin. The greatest range at the *Vega's* winter-quarters was only eighteen centimetres, which shows that the sea north of Behring's Straits forms a marine basin of limited extent, connected with the ocean only by sounds. The variations in the height of the water, produced by winds, were much greater. They amounted nearly to two metres. Still greater irregular changes in the position of land and sea appear to have occurred within the memory of man. For the Tchuktches were at one time afraid that the Swedes would cause inundations along the coast. This appears to show that the sudden changes in the position of the earth which are well known in the volcanic regions farther south had extended so far noth. As most of the Tchuktch villages are situated close to the sea, one of the mighty waves which earthquakes give rise to would completely destroy an immense number of them.

The magnetical observations made during the wintering, in an observatory built of ice and snow, which, being necessarily on land, was at a very inconvenient distance from the vessel, consisted of (1) absolute determinations whenever opportunity offered; (2) observations of the changes in the strength and direction of the magnetic forces made along with necessary absolute determinations every hour between November 27 and April 1; (3) five-minute observations on the 1st and 15th of every month from and including January 15.

With reference to the natural history of the region in which the *Vega* wintered, Prof. Nordenskjöld states that it is very poor in the higher plants and fungi, but lichens are abundant. The number of insects and other invertebrate land animals was very small. Land- and fresh-water mollusca were completely wanting. Of coleoptera only twenty species were found, belonging principally to the families *Carabi* and *Staphylini*, with two *Curculiones* and *Chrysomelæ*, and the other orders appeared to be equally poor, with the exception, perhaps, of the *Diptera* and *Podurida*. On the other hand the sea-bottom, though covered with a stratum of water always about 2° C. below the freezing-point, swarmed with a large number and a great variety of the lower animal types, of which the dredging-boat almost daily made a rich collection in the channel, which opened early in summer in the neighbourhood of the vessel. Prof. Nordenskjöld expected that the same avifauna would be found with little variation in all the Polar lands. Experience has, however, shown that this is by no means the case, the Tchuktch peninsula being quite an exception. Birds here occur in much fewer number, but in a much greater abundance of types than in Novaya Zemlya, Spitzbergen, and Greenland, and the bird-world in its entirety has thus quite a different stamp. The birds common on Greenland, Spitzbergen, Novaya Zemlya, and the coast of North-west Siberia, *Larus glaucus*, *eburneus*, and *tridactylus*, *Harelda glacialis*, *Somateria spectabilis*, *Plectrophanes nivalis*, *Phalaropus fulicarius*, and *Tringa maritima*, the common raven and several other species, are found here. But in addition to these the following uncommon birds are met with:—The American eider, the common eider, *Somateria mollissima*, being absent; a greyish-brown goose with bushy yellowish-white feathers round the neck; a swan-like goose, white with black wing-feathers, a species of *Fuligula* marked in white and green with a fine black-velvet head, the beautifully-marked, uncommon *Larus Rossi;* a little brown snipe with a bill widened spoon-like at the point; several beautiful singers, among them *Sylvia Eversmanni*, which for some days visited the coast in great flocks, probably on their way to breeding-places farther north, or waiting till the bushes in the interior should be free of snow. A portion of the purely Scandinavian species here exhibit some variations in colour-marking and size.

The mammalia are also more numerous than in other places visited by the Swedish expeditions. According to Lieut. Nordquist the most common mammal is the hare. It differs from the common Scandinavian mountain hare by its greater size (its weight often rising to

14 lbs.) and by the nasal bone not diminishing so rapidly in size. The mountain fox (*Vulpes lagopus*, L.) is very common. The common fox (*Vulpes vulgaris*, Gray) appears also to be common. A red fox, shot in October, differs considerably from the common, and approaches the mountain fox in several particulars. The fox's food during winter appears to consist of hares, ptarmigans, and lemmings. Of lemmings three species were met with, *Myodes obensis* (the most numerous), *M. torquatus*, and *Arvicola obscurus*. The Tchuktches state that a little mouse also occurs, which Nordquist supposes to be a *Sorex*. The two lemmings often showed themselves above the snow during winter, which was not the case with *Arvicola obscurus*. The wolf was seen only twice. The wild reindeer was also uncommon, traces of them having been seen only once. Traces of the land-bear were also seen, and the natives stated that they were not uncommon in summer. The marmot (*Arctomys*) occurs in abundance. An animal described by the natives as living by the banks of streams is supposed to be the common otter. Two weazel-skins were obtained from the natives. It is not certain whether the ermine occurs there. Only two marine mammals have been seen during the winter, the Polar bear and the ringed seal (*Phoca fœtida*). The latter is caught in great numbers, and along with fish and various vegetables forms the main food of the natives. Of land birds there winter in the region only three species, viz., *Strix nyctea*, *Corvus corax*, and *Lagopus subalpina*. The last-mentioned is the most common. On December 14 two large flocks of ptarmigan, one numbering about fifty, were seen about ten miles from the coast. The raven is common at the Tchuktch villages. Its first egg was obtained on May 31. The mountain owl was seen for the first time on March 11, but according to the natives, it is to be met with all winter. In open places on the sea there occur during winter, according to the natives, two swimmers, *Uria Brünnichi* and *Uria grylle*. Besides these there possibly winter on the sea a species of *Mergulus* and one of *Fuligula*, a specimen of the former having been obtained on November 3, and of the latter on March 9.

(*To be continued.*)

GALILEO AND THE APPLICATION OF MATHEMATICS TO PHYSICS[1]

TWO hundred and ninety-eight years ago to-day (November 5, 1581) Galileo Galilei, then a boy between seventeen and eighteen, matriculated as a medical student in the University of Pisa. At that time Medicine was perhaps the least satisfactory of scientific studies, and though his family had influential professional connections, the empirical maxims and the semi-metaphysical reasons by which they were supported never caught the young man's fancy or satisfied his intellect. We first hear of him listening outside the door in which Ricci, the Court mathematician of Florence, who happened to be spending some time at Pisa with the Grand Duke, taught the pages a little Euclid. For a couple of months Galileo neglected his medicine, and greedily absorbed his Euclid through the key-hole till he found some chance opportunity of introducing himself to the Professor, who was delighted with his new pupil. Ricci presented him with a volume of Archimedes, and the great mathematician and physicist of Syracuse became the spiritual father of the young Italian student. In spite of the straitened circumstances of his family, and the chances of fortune that awaited him in a decorous prosecution of his regular medical studies, he deserted them, and attached himself to Ricci.

Watching one day the long swing of a lamp hung from the roof of a church, we are told that he noted the times it took in oscillation after oscillation, and found that though the arc through which it swept died down till it was scarcely visible, the time it took from each farthest right hand point to the succeeding farthest left hand point of its sweep was always the same. He applied the knowledge he had gained at once to the more accurate measurement of the regularity of the pulse beats. The observation of the student, and the immediate practical application of it, was the sure forerunner of the greatness of the man. He knew that Science is Measurement three centuries before Comte laid it down as the definition of mathematics, or Marks had been born to caricature the maxim in his diploma picture.

At that time the Peripatetic philosophy was dominant over Europe, and tyrannized in Italy. The followers of Aristotle naturally travestied the errors of their master. In his own time Aristotle was a genuine observer of nature, and, as Galileo afterwards said of him, he would have been the last to dispute a fact because it contradicted his preconceived opinions. His followers, who were not observers, had constituted a universe on high *a priori* principles. They taught that there were two great classes of things perishable and terrestrial, one heavy, tending by an irresistible law of their essential nature to the mathematical centre of the universe, the other light, and tending irresistibly away from it. Things imperishable and extra-terrestrial moved by a like necessity in everlasting circles round the centre of all things. A body of 2 lbs. weight, having more tendency to the centre than a body of 1 lb., must fall faster, and acquire a greater velocity in an equal time. With *a priori* principles like these observation was superfluous. Galileo questioned them and put them to the *examen rigorosum* of experiment. The explanation of the isochronism of the larger or smaller swings of the pendulum lay in the fact that though when the moving lamp started from a higher point it had further to fall—it began to fall more nearly perpendicularly and faster, and it swept through its larger arc with a greater velocity at every point. When he took two such pendulums of equal length, to the end of one of which a lamp weighing 1 lb. was fastened, and to the end of the other a weight of 2 lbs., Galileo found that their times of oscillation were the same.

The Peripatetic dictum of the greater gravity of heavier bodies was in contradiction with this simple fact. Galileo took the two weights to the top of the hanging tower of Pisa, and let them fall. They fell at the same or practically the same instant. Though the simultaneous thud of these two weights on the ground was the death-blow of the Peripatetic assumption, it was not enough to convince teachers who had grown grey in teaching it. But a moment's thought now will serve to show us not merely that it is so, but why it must be so. Instead of the mass of 2 lbs., imagine for a moment that the 2 lbs are made up of two single pound weights, each identical in shape and material with the other mass of 1 lb., and that all three drop together. All three will come to the ground together. If the two pound weights are made to adhere to each other by ever so thin a film of glycerine, there will be no strain on the film, and they will not separate. If an imaginary section is cut through a single mass of two pounds there will equally be no strain or shearing force along that section. The tendency of the two single lbs. downwards is twice as great as that of the 1 lb., but it has to move two masses instead of one. Ten runners who keep abreast of each other do ten times the work of an eleventh runner on the other side of the course. Man for man, each does the same work, and each man's work has the same effect in producing the racing speed of each. An imaginary or real thread might tie the ten together, but there would be no strain on the thread, which would not snap, if their rates of running were the same.

Galileo often returned to the pendulum, and completely

[1] An Introductory Lecture, by William Jack, M.A., LL.D., F.R.S E., Professor of Mathematics in the University of Glasgow, formerly Fellow of St. Peter's College, Cambridge.

established the laws of its motion in ordinary small oscillations. He showed that though the weights at the end of the string have no effect on the times of oscillation the length of the string has, that these times are twice as long for a string four times as long, three times for one nine times as long, and always in the proportion of the square roots of the lengths. In proving this he had to investigate motion along a slope or Inclined Plane, and it was he who first showed that whatever the incline, the speed acquired by a body moving on it depends not on the amount of

The Leaning Tower of Pisa.

ground it has covered on the plane itself, but on the vertical drop between its starting point from rest, and its position at any moment. The pendulum moves along an arc of a circle, and something very like that arc would be got by drawing instead of it small chords of the circle from point to point in it successively. The smaller these successive chords become the nearer the sum total of them is to the arc, and the motion of a heavy particle constrained to move down them is substantially the same as that of the bob at the end of the pendulum. These successive chords are so many inclined planes, and the movement of the weight down the entire series, is identical with the swing of the bob in the arc. More is necessary to establish this completely than Galileo was able to supply. In passing from plane to plane the particle must be supposed to make a slight rebound at each, a rebound which is less for each, according as the change of slope from one to the other becomes less and less, but the number of the planes, and therefore of the rebounds, increases in the same proportion as the slope of each to each diminishes. To reduce the swing of the bob in its arc to the fall of the mass down the planes it is necessary to show that the effect of this great number of small rebounds is negligible, and Galileo had not advanced far enough in the Fluxional Calculus to show it.

The principle that the speed at any point of the downward slope depends only on the vertical drop between the two positions of the particle, is true independent of friction which lowers the speed attained in a constant proportion. But it would have been difficult to establish the truth stated in this way by ordinary experiment. What is the speed attained, and how are we to recognise it? As the body goes downwards it is increasing in speed from moment to moment. It is easy to time a railway train running at a uniform rate. When the first quarter milestone he notices flies past him, a passenger sees, let us suppose, that the second hand of his watch is at 5 seconds, while at the next quarter milestone it is at 20, at the third 35, at the fourth 50. Every one of these equal intervals is swept over by the train in 15 seconds, or a quarter of a minute. The train is going at the regular rate of a quarter mile per quarter minute, or a mile a minute, or sixty miles an hour. Had the intervals of time noted been different, the problem would obviously have been much more complicated. Let us suppose that the two first 5 and 20, are as before, that the next is 40, and that at the fourth the second hand of the watch has again come round to 5 seconds past the minute. In that case the first quarter mile interval is done in 15 seconds, the next in 20, the third in 25. If the rates were uniform for each interval these figures would give us sixty miles an hour for the first quarter mile, forty-five miles per hour for the next, thirty-six miles an hour for the third. The train is slackening speed, and these are the average rates during the time spent in covering each of these quarter miles. But the train does not drop suddenly from one to the other, and nothing in nature does so. Point by point it has a different rate, and the question, What is the rate at any point? is not easily answered. How, then, are we to measure the rate of speed at a point when that rate is constantly changing? We must seek some necessary consequence of any law of change which we suppose, and we must transform the question, the answer of which it is difficult to verify, into one which it will be easy to subject to an experimental test. Galileo appealed to mathematics, and showed that if his theory, that the velocity depends on the vertical drop, be true, the amount of the vertical drop must be four times as great for two seconds, and nine times as great for three seconds, as for one second, and he set himself to compare the real with the theoretic result.

Let us consider what seems a simple thing, a fall in space, where there is no inclined plane at all. What is the amount of fall for so many seconds? The difficulty in answering accurately is that for even a short time the fall is very large. It is of no use distinguishing between a fall of 16 feet, for instance, and one of 20¼ feet, if the times of description, which are 1 second and 1⅛ second, are too nearly the same to be distinguished by our measurement of time. In Galileo's day the measurements of time were only beginning to be a little delicate, chiefly through his own discoveries, and an error of ⅛ of a second in measurement is obviously easy to make, when one of 4 feet is not easy. In the simpler case of free fall, therefore, Galileo could not compare spaces and times conveniently, because his measures of space were so much more accurate than those of time. The experimental test can be more readily applied to the inclined plane because the fall is slower and there is no other vital alteration in the conditions of the problem.

It is necessary to form some hypothesis about the law which the falling body obeys, to deduce the mathematical consequences of that law, to select one of them which admits of an immediate and satisfactory experimental verification. This was what Galileo did. He believed that the force on the falling body was probably due to the mass of the earth, and that it was at least likely that it would be the same all through the motion, as the particle all through it is practically equally far from the centre of that mass. A constant force must be measured by its constantly producing the same effect in the same time, and the first obvious effect of any force on a falling body is, like the effect of getting up steam on a locomotive, the change of speed which it produces from moment to moment. If this be uniform—so much extra speed put on every second—there must be some way of connecting mathematically the easily measurable spaces and times instead of the less practicable but more direct speeds and times, and the question whether the result and the theory at the back of it agree can be tested over and over again by experiment. The two answers do agree, and they agree in every case. The theory, therefore, is right, unless some other theory about the effect of forces can be found to lead to the same result. The hypothesis about the earth force, that when a body falls from rest its speed will be increased by the same amount in every equal time interval, and that the speed of any body will be increased just as much as that of any other, is a true hypothesis. A 10 lb. weight falls neither faster nor slower than a 1 lb. one. If the earth alone be acting on both, a feather falls as fast as a guinea. It is so in vacuum, though in ordinary air, of course, it is different. A force always the same, producing, that is to say, always the same amount of change of speed in the same time, is acting on every equal particle of matter at the earth's surface. To test this theory we can appeal practically to the inclined plane, rough or smooth. The force on a body falling along it at any moment bears a fixed proportion to that in a free fall; a very small proportion, if the plane has only a very slight slope. Obviously the length of the line along such a plane, down which a body runs in a second, is a very small proportion of that of the free fall in the same time. In the latter case, what to Galileo's power of measuring time was an almost imperceptible difference involved a very marked difference in the spaces gone through, so that it was difficult to verify the law. In the former the spaces needed to be measured for experiments lasting even a few seconds become reasonable. In three seconds a body falling freely from the top of a steeple 144 feet high would fall to the bottom, and it would only take five seconds to fall down Tennant's stalk, but it is easy to make a plane such that a body will only fall down 14 feet along it in three seconds.

It was in connection with his investigations of motion on a plane that Galileo laid down the principle that perhaps serves best as the basis of the theory of balancing forces, the principle of what is called Virtual Velocities. Every one is familiar with it, in the ordinary maxim, that what is gained in speed is lost in power. In the board laid across a fallen tree, on which children see-saw, the lighter child is put at the extremity of the longer arm. With a plank, 12 feet long, a child 50 lbs. weight will be balanced against one 70 lbs. weight when the plank rests on the tree 7 feet from the light child's end, and 5 feet from the heavy one's. When they swing, the amount of swing is proportional to the distances from the fixed point. If the plank moves, so that the child at the 7 feet end rises through seven inches, the other goes down through five. In every case like this, where forces are in equilibrium on a system, we can imagine a motion given, every point moving according to the geometrical circumstances. Let us imagine such a motion. When two forces act on a system and keep it at rest, multiply the space through which the point of application of each force moves, referred to the line in which the force acts, by the measure of the force. When there is equilibrium the resulting quantities are equal and of opposite signs. The one child weighing 50 lbs. rises vertically through 7 inches, and we may call the product 350 inch-lbs. upwards. The 70 lbs. child moves in the same time 5 inches downwards, and the product, which is 350 inch-lbs. downwards, is equal and opposite to the other. If there is equilibrium it must always be so; if it is so there must be equilibrium. It was to Galileo that we owe this most fruitful of statical principles. It can easily be extended to the case when any number of forces act at any number of points on a body or a system, but it was not till a century later that John Bernouilli could state it in all its generality, or show how admirably it serves as a sufficient basis for the whole theory of equilibrium.

These laws of falling bodies and of virtual velocities marked the greatest advance in mechanical science since the world began. The nature of the earth's common action on all bodies at its surface had, in fact, been ascertained. The question that had been put directly to nature had been completely answered, and the answer was final.

The Peripatetics had a singular notion of what they called Inertia. According to them, a body had a natural tendency to move at a given speed straight towards the centre of the earth if it were heavy, and straight away from it if it were light. The continuance of that natural motion, in that direction, at that speed was ensured by inertia. Strike the body in that or in any other direction, and an immediate change takes place, but it is a change which disappears if the body is moving in a vacuum. In ordinary air it is kept up, because the air behind, from which the body is suddenly taken away when it is struck, instantly closes up, and strikes it like a spring which has been let go. At every new position it leaves air, and air springs after it to keep it going. As far as it was then possible, Galileo worked out the consequences of this theory and those of his own, which was that stated in Newton's first Law of Motion—that except where any external force operates, motion in any direction at a certain rate will continue indefinitely in that direction at the same rate. The result was that the old theory was proved to be wrong. As with the first law of motion, so with the second. It is substantially this, that when a force acts on a particle in motion, it produces the same effect in changing that motion as it would if, before it began to act, the body were at rest. Suppose a particle moving with a speed which may be described as 10 feet per second northward and 8 feet per second eastward. Let a force suddenly act on it, the effect of which is to change its rate of going to 17 feet per second northward and 13 feet per second eastward. The amount gained is an addition of speed of 7 feet per second northward and 3 feet per second eastward. Imagine the same force acting on a particle identical with the former, but initially at rest. It will make that particle begin to move from rest at the same rate of 7 feet per second northward and 3 feet per second eastward which it gained in the former motion. The effect in changing rate has been the same as if the body had been at rest, and the whole effect on the eastward direction has been the same as it would have been had there been nothing to affect it in a northerly direction.

It was through the combination of these two principles that Galileo was able to solve another and more difficult problem. Until they were verified by the success of millions of predictions founded on them, they were not so much principles as theories or hypotheses. A fulfilled prediction of any complicated phenomenon raises the hypothesis on which it has been explained to the dignity of a probable truth. Let a bullet be started in an oblique direction at a certain speed—we can predict, by applying these two principles, the way in which it will move and the course it will follow. Let us take one which is sent off at a rate of speed compounded of 32 feet per second vertical and 20 feet per second horizontal. At every point of its path, it will keep both these rates except so far as gravity changes them, and gravity will do by it as a moving body just what it would do by a body starting from rest. To the latter it would give a downward speed of 32 feet per second in a second. In a second it will give just enough downward speed, therefore, to annihilate the upward speed of the bullet. After a second, it will have ceased to have any upward speed, but it will go on with the horizontal speed of 20 feet per second. In its first second the bullet has moved away from its starting-point 20 feet in a horizontal direction and 16 feet upward, because a fall of 16 feet from rest is needed to generate that velocity of 32 feet per second downward, which is wanted to destroy the upward velocity of the amount with which it started. At the end of the first second it has reached its new position by a certain path. Till the bullet comes to the ground again another second will suffice, during which it will fall through 16 feet vertically, and acquire a speed of 32 feet per second downward as it started with 32 feet per second upward, and it will move horizontally 20 feet further from the starting-point. When the second second closes, the particle has again reached the ground by a path which is the left-handed facsimile of that by which it rose.

There are thus three measurable things, all consequences of our fundamental laws. Does the bullet rise 16 feet? does it strike the ground 40 feet away from where it started? does it take 2 seconds to do it in? Nature answers that all these things are so. If we take some means of making the bullet record or picture its path on a board or paper we shall have a still completer answer to the question. Galileo's mathematics were enough to show him that if these two laws were true the curve described must be a parabola—except so far as it is slightly modified by the resistance of the air—and the parabola calculated is the parabola described. Such a proof is all but conclusive. Every point in the path really found has thus been predicted as the mathematical consequence of these two laws, and when this prediction is repeated and confirmed in every experiment, doubt vanishes, the laws are securely established, and the secret of nature has been found.

(*To be continued.*)

JAMES CLERK MAXWELL, F.R.S.

JAMES CLERK MAXWELL, whose premature death on Wednesday last week, science has to deplore, was born in 1831, being the only son of John Clerk Maxwell, Esq., of Middlebie. His grandfather was Captain James Clerk of Penicuik, whose two sons were the Right Hon. Sir George Clerk, Bart.. of Penicuik, and the above-mentioned, John Clerk Maxwell. Captain James Clerk was a younger brother of Sir John Clerk of Penicuik, and on the death of the latter Sir George Clerk succeeded to the estate of Penicuik, while John succeeded to the estate of Nether Corsock, part of the Middlebie estate, which had come into the family through marriage in a previous generation with Agnes Maxwell. Along with this estate John Clerk assumed the family name of Maxwell. When James Clerk Maxwell was eight years old, his mother died, and his father, who had been called to the Scotch Bar, but never practised as an advocate, lived a retired life, devoting himself to the care of his estates, and of his son.

James Clerk Maxwell was educated at the Edinburgh Academy, where he gained the Academical Club Medal for Geometry in 1845, and the Silver Medal for Mathematics in 1847. In 1848 his mother's brother, John Cay, of Edinburgh, took him to see William Nicol, who showed him the colours exhibited by polarised light after passing through unannealed glass, &c. This visit seems to have given the first impulse towards his researches in optics. On his return he constructed a polariscope with glass reflectors. The framework of the first was of cardboard, but a superior article was subsequently constructed by him in wood. Small lenses mounted in cardboard were employed when a conical pencil of light was required. By means of this instrument he examined the figures exhibited by pieces of unannealed glass which he prepared himself, and with a camera lucida, and a box of water colours, he reproduced these figures on paper, taking care to sketch no outlines, but to shade off each coloured band imperceptibly into the next. Some of these water-colour drawings he forwarded to Nicol, and was more than repaid by the receipt shortly afterwards of a pair of prisms prepared by Nicol himself. These prisms were always very highly prized by Prof. Maxwell. Once while at Trinity the little box containing them was carried off by his bed-maker during a vacation, and destined for destruction. The bed-maker died before term commenced, and it was only after a very diligent search that they were found among the late bed-maker's effects, which had been set aside as valueless. After this event the prisms were most carefully guarded, and about three weeks ago were deposited, at Professor Maxwell's request, in one of the show cases of the Cavendish laboratory. The study of the figures exhibited by unannealed glass in polarised light drew the attention of Clerk Maxwell more particularly to the equilibrium of elastic solids, a subject on which he has done some very valuable work.

After leaving the Edinburgh Academy James Clerk Maxwell entered the University of Edinburgh, where he soon won the esteem of Kelland, Forbes, and Gregory, under whom he studied and worked. In October, 1850, he came to Cambridge, entering at Peterhouse. At this time his father does not seem to have been very sanguine respecting the advantages to be derived from a Cambridge course, but his opinion of the University rose considerably when in 1854 the examiners showed their appreciation of his son by making him Second Wrangler, and bracketing him as first Smith's Prizeman. Clerk Maxwell's first term in Cambridge does not seem to have been a very happy one. The Peterhouse men were all classics or pure mathematicians, and he could get no sympathy in his physical work. Finding himself comparatively without friends at the end of the term, he consulted his father and his college tutor, and by their advice migrated to Trinity on December 14th, 1850, where, having a much larger number to select from, he not only found congenial spirits, but soon became looked up to as their leader by a set of admiring followers. In 1852, while an undergraduate at Trinity, he stayed for a few weeks at a country vicarage in Suffolk with the Rev. C. B. Taylor, a brother of a college friend. While there he was attacked by a serious illness, and the care and kindness with which he was nursed by Mr. and Mrs. Taylor never faded from his memory; it so impressed him with the power of love that it formed an important factor in the formation of the Christian character which all who knew regarded with an admiration akin to worship.

As above stated James Clerk Maxwell graduated as Second Wrangler and (bracketed) first Smith's Prizeman in 1854, having previously been elected a Foundation Scholar of his College. In 1855 he became a Fellow of Trinity, and in 1856 obtained the Professorship of Natural Philosophy in Marischal College, Aberdeen, which appointment he held till the fusion of Marischal College and King's College, when he, with other Professors, received a pension from the Crown. In 1858 he married Katherine, a daughter of Principal Dewar of Marischal College, thus vacating his fellowship at Trinity. In 1860 he succeeded Prof. Goodeve as Professor of Natural Philosophy and Astronomy in King's College, London, but after the death of his father he retired in 1865 to his estate in Scotland, where he subsequently carried out his father's plans for completing the house and offices at Glenlair. In 1871 he was invited by the Senate of the University of Cambridge to accept the Chair of Experimental Physics which had just been created, and on October 25th, 1871, he delivered his inaugural lecture as Professor of Experimental Physics in the University of Cambridge. At first the most important part of his work consisted in arranging the details of the Cavendish Laboratory which the Duke of Devonshire had offered to present to the University, and the building of which was personally superintended by Prof. Maxwell from first to last. The whole of the arrangements which render the Cavendish Laboratory so admirably adapted for Physical investigations, are due to the care and forethought of Prof. Clerk Maxwell. When the building had been completed and formally presented to the University, the Duke of Devonshire further signified his desire to provide it with a complete equipment of apparatus, and all this was procured under the personal supervision of the Professor. In 1872 he was elected Honorary Fellow of Trinity College, Cambridge.

During last winter Prof. Maxwell did not enjoy his usual health. In the spring he was unable to carry on his work with his accustomed vigour, but when he left Cambridge for Scotland his friends supposed that with mental rest and physical exercise his health would be restored, and did not regard his indisposition as other than temporary. In Scotland, however, his health did not improve, he suffered much pain and was unable to take his usual food. At length by the advice of his medical attendants, and of Prof. Saunders of Edinburgh, one of his former fellow-students, he returned to Cambridge in the beginning of October. Under Dr. Paget's care he at first made considerable improvement and some hopes were entertained of his recovery. He, however, gradually became weaker, and when Dr. Humphry visited him in conjunction with Dr. Paget, it was plain that medical skill could only alleviate his suffering. He died at noon on Wednesday, November 5th, having retained the conscious possession of all his mental powers to the last.

General invitations were sent to all members of the electoral roll of the University to assemble in Trinity College Chapel at 4·30 P.M. on Monday, November 10th, and were numerously accepted, especially by heads of houses (including the Vice-Chancellor), and by professors. About 4·45 P.M., the service was commenced by Mr. Stanford playing the "Dead March" upon the organ. The remains of the late Professor were then carried into the chapel, preceded by the choir and the first part of the Burial Service read. This was followed by the Anthem "If we believe that Jesus died and rose again, even so them also which sleep in Jesus shall God bring with him. . . . . Wherefore comfort one another with these words." After the service the assembly followed the body to the great gate, whence it was conveyed to Scotland to be interred in the family burying-place at Corsock, Kirkcudbright.

Prof. Maxwell was appointed Foreign Honorary Member of the American Academy of Arts and Sciences of Boston in November, 1874; Member of the American Philosophical Society of Philadelphia in October, 1875; Correspondent in the Mathematical Class to the Imperial Academy of Sciences, Göttingen, in December, 1875; Honorary Member of the New York Academy of Sciences in December, 1876; Associate of the Amsterdam Royal Academy of Sciences in April, 1877; and Corresponding Member of the Imperial Academy of Sciences, Vienna, in August, 1877. He was Fellow of the Royal Societies of London and Edinburgh, and of the Cambridge Philosophical Society, and a large contributor to the Transactions of each of these. In 1872 he was created Honorary LL.D. of Edinburgh, and on June 21, 1876, he received the honorary degree of D.C.L. at Oxford.

In 1860 the Rumford Medal of the Royal Society was awarded to Prof. Clerk Maxwell "for his Researches on the Composition of Colours, and other Optical papers." In his address on the presentation of the medal, Major-General Sabine alluded to Prof. Maxwell's calculation showing the connection of the "mechanical strains to which elastic solids are subjected under certain conditions with the coloured curves which those solids exhibit in polarised light." He then alluded to the colour-top of Prof Maxwell, and the colour-equations obtained from it, as well as the light it throws upon colour-blindness, concluding with these words:—"These researches for which the Rumford medal is awarded lead to the remarkable result that to a very near degree of approximation all the colours of the spectrum, and therefore all colours in nature, which are only the mixtures of these, can be perfectly imitated by mixtures of three actually attainable colours, which are the red, green, and blue, belonging respectively to three particular points of the spectrum."

While Professor of Physics at King's College, London, Maxwell was engaged as a member of the British Association Committee in the determination of the Absolute Unit of Electrical Resistance, and it was the comparison of electrical units which attracted a great part of his attention during his tenure of his Cambridge Professorship. He always spo e very highly of Faraday's "Experimental Researches," which he read very early in life, and to which he attributed some of his most useful ideas on electricity and electro-magnetism. In Clerk Maxwell Faraday found a mind constituted after the same plan as his own, but with the advantage of a mathematical training, which has made Prof. Maxwell capable of interpreting Faraday's bold realisations to the mathematical world. For Clerk Maxwell's own views of Faraday the reader may be referred to the article "Faraday," in the ninth edition of the "Encyclopædia Britannica."

It is impossible in a sketch like this to give anything but the most superficial view of a character so noble in all its aspects as that of Clerk Maxwell. As a professor he was wonderfully admired by those who were truly his disciples. He had not the power of making himself clearly understood by those who listened but casually to his pithy sentences, and consequently he was not a so-called popular lecturer; nor was he a most suc essful teacher of careless students. But when he had those about him who could enter into his mind, and, receiving the golden truths from his lips, could alloy them in such a way as to make them acceptable to the ordinary student, no better teacher could be desired, even for the most elementary instruction. His wonderful imagination was of great value, not only in supplying illustrations for didactic purposes, but in suggesting analogies and opening up new fields for research.

The pages of *Blackwood's Magazine* can testify to his talents as a poet; his sense of humour and his ready wit formed remarkable features in his character, in fact he seldom talked for many minutes without provoking at least a smile. (Some of the reviews lately contributed by him to NATURE may serve as illustrations.) He was well versed in all the literature of the day. and seemed to have investigated on his own account every system of philosophy. He took great interest in passing events, though he never indulged in political discussions. As an experimentalist he was too well known to require description; in that region of science which was his *par excellence*, viz., the domain of Molecular Physics, he stands without a rival. But there were other sides of his character which outshone even his scientific attainments. Such complete unselfishness and tender consideration as he exhibited for those around him, and especially for those under his control, are seldom to be met with. During the eight years that he held the chair of Physics in Cambridge, he never spoke a hasty word, even to his attendants. His self-sacrificing devotion to those he loved was the marvel of his friends. Though he never entered into theological controversy, and only occasionally in his scientific writings indicated in a sentence or two the side he took in questions which have recently been brought prominently before the public by some of the more popular men of science, those who had an opportunity of seeing into his home-life knew him to be an earnest Christian. About three weeks ago he remarked that he had examined every system of Atheism he could lay hands on, and had found, quite independently of any previous knowledge he had of the wants of men, that each system implied a God at the bottom to make it workable. He went on to say that he had been occupied in trying to gain truth, that it is but little of truth that man can acquire, but it is something to "know in whom we have believed." His simple Christian faith gave him a peace too deep to be ruffled by bodily pain or external circumstances, and left his mind free to the last to contemplate all kinds of questions of general interest. One day not long before his death he had been puzzling himself for some time in vain endeavours to discover why Lorenzo ("Merchant of Venice," Act v. scene 1), whose character was at least far from noble, says to Jessica—

> "Look how the floor of heaven
> Is thick inlaid with patines of bright gold:
> There's not the smallest orb which thou beholdst
> But in his motion like an angel sings,
> Still quiring to the young-eyed cherubins;
> Such harmony is in immortal souls;
> But whilst this muddy vesture of decay
> Doth grossly close it in, we cannot hear it.'

We may quote one other example illustrating how the speculative character of his mind remained to the last. About five or six days before his death, when he was suffering from such extreme weakness that he could say very little, after lying motionless with his eyes closed for some time, he presently looked up and remarked, "'Every good gift and every perfect gift is from above, and cometh down from the Father of lights, with whom is no variableness, neither shadow of turning.' Do you know that is a hexameter?

'πᾶσα δόσις ἀγαθὴ καὶ πᾶν δώρημα τέλειον,'

I wonder who composed it."

His knowledge of hymns and hymn-writers was very extensive, and he took great pleasure during his illness in reciting from memory some of his favourites among the writings of Richard Baxter, George Herbert, and others.

To attempt to give any adequate idea of his contributions to science in a sketch like the present would be but to mislead the reader. His great work on "Electricity and Magnetism," the second edition of which is now in the press, is the admiration of mathematical physicists. More generally known are his treatise on the Theory of Heat, and his little text-book entitled "Matter and Motion" which was published by the S.P.C K. One of his earliest papers on the "Theory of Rolling Curves," was communicated to the Royal Society of Edinburgh by Professor Kelland, and read on February 19, 1849, when Clerk Maxwell was an Edinburgh student barely eighteen years of age. His paper on the "Equilibrium of Elastic Solids," above alluded to, was read before the same society on February 18, 1850. His paper on the "Transformation of Surfaces by Bending" was read before the Cambridge Philosophical Society on March 13, 1854, about two months after taking his degree. This was followed in December, 1855, and February, 1856, by papers on "Faraday's Lines of Force." In 1857 he obtained the Adams Prize, in the University of Cambridge, for his paper on the "Motions of Saturnian Rings." His paper on the "Theory of Compound Colours, and the Relations of the Colours of the Spectrum," which was chiefly instrumental in gaining the Rumford Medal, was read before the Royal Society on March 22, 1860. His "Dynamical Theory of the Electromagnetic Field," including a brief sketch of the Electromagnetic Theory of Light, was read before the Royal Society on December 8, 1864. The results of Clerk Maxwell's experiments on "The Viscosity and Internal Friction of Air and other Gases," were made known to the Royal Society in the Bakerian Lecture read, February 8, 1866. Then follow his Royal Society papers "On the Dynamical Theory of Gases," in May, 1866, and "On a Method of Making a direct Comparison of Electrostatic with Electromagnetic Force, with a Note on the Electromagnetic Theory of Light," in June, 1868. Lately he took great interest in Graphical Statics, and contributed a long paper "On Reciprocal Figures, Frames and Diagrams of Forces," to the Royal Society of Edinburgh, in December, 1869. Among his most recent papers are a paper on "Stresses in Rarefied Gases arising from Inequalities of Temperature," read before the Royal Society on April 11, 1878, and a paper on "Boltzmann's Theorem," read before the Cambridge Philosophical Society. It would take too long to enumerate his articles and reviews published in the *Philosophical Magazine* and in NATURE. His contributions to the ninth edition of the "Encyclopædia Britannica" include the articles "Atom," "Attraction," "Capillary Action," "Constitution of Bodies," "Diagrams," "Diffusion," "Ether," "Faraday," and "Harmonic Analysis." "Harmonic Analysis" was the last article he wrote.

One of the most remarkable of his works is the recently-published volume of the Electrical Researches of the Hon. Henry Cavendish, of which Prof. Maxwell is the editor. The MSS. are in the possession of the Duke of Devonshire, and are now at Chatsworth. They were entrusted by him to Prof. Maxwell shortly after the completion of the Cavendish Laboratory. Some of Cavendish's experiments were repeated by Prof. Maxwell with all the appliances of modern apparatus, and others were carried out by his pupils.

Most of the apparatus which he employed in his researches has been presented by Prof. Clerk Maxwell to the Cavendish Laboratory, together with many of his books. He always regarded the laboratory with great affection, and the University owes much to his liberality. One of the most interesting pieces of his handy-work now preserved in the laboratory is a plaster model of Prof. Willard Gibbs's thermodynamic surface, described in the fourth edition of "Maxwell's Theory of Heat." All the lines on the surface are drawn by his own hand, many of them being mapped out by placing the surface obliquely in the sunshine and marking the boundary between light and shade. Another valuable model constructed while Prof. Maxwell was at Cambridge is his dynamical illustration of the action of an induction coil in which two wheels represent by their rotation the primary and secondary currents respectively, the wheels being connected through a differential gearing to which a body of great moment of inertia is attached, the rotation of which represents the magnetism of the coil. A friction break represents resistance, and a spring may be attached to the secondary wheel to represent the capacity of a condenser placed in the secondary circuit. Among other valuable pieces of apparatus presented by Prof. Maxwell to the laboratory are the receiver, plates, and inertia bar employed in his researches on the viscosity of air and other gases, his colour-top, portions of the "colour-box," including the variable slits, with the wedge or measuring their width, a polariser and analyser made of thin films of stretched gutta percha, the mechanism for illustrating the motion of Saturnian rings, a real image stereoscope, and the dynamical top, whose moments of inertia about three axes, which are at right angles to each other, can be so varied by means of screws that the axis of rotation can be made that of greatest or of least moment of inertia. When the axis of rotation is the mean axis, the motion of the top is, of course, unstable. When Prof. Maxwell came to Cambridge in 1857 to take his M.A. degree, he brought this top with him from Aberdeen. In the evening he showed it to a party of friends in college, who left the top spinning in his room. Next morning he espied one of these friends coming across the court, so jumping out of bed, he started the top anew, and retired between the sheets. The reader can well supply the rest of the story for himself. It is only necessary to add that the plot was completely successful.

Prof. Clerk Maxwell's papers will be placed in the hands of Prof. Stokes, who is one of his executors, in order that they may be published or catalogued and preserved in such a way as to be readily available to those wishing to consult them.

The death of James Clerk Maxwell is a loss to his University and to the world too great for words. He rests from his labours, but his works will follow him.

WM. GARNETT

NOTES

THE following is the list of officers to be proposed at the anniversary meeting of the Royal Society on December 1:—President—William Spottiswoode, M.A., D.C.L., LL.D Treasurer—John Evans, D.C.L., LL.D., V.P.S.A. Secretaries—Prof. George Gabriel Stokes, M.A., D.C.L., LL.D., Prof. Thomas Henry Huxley, LL.D. Foreign Secretary—Prof. Alexander William Williamson, Ph.D. Other Members of the Council—George Busk, V.P.L.S., Prof. Arthur Cayley, LL.D., Major-General Henry Clerk, R.A., Edwin Dunkin, F.R.A.S., Augustus G. Vernon Harcourt, F.C.S., Sir Joseph Dalton Hooker, C.B., K.C.S.I., D.C.L., John Whitaker Hulke, F.R.C.S., Lieut.-General Sir Henry Lefroy, C.B., William Newmarch, Inst. Fr. Corr., Prof. Alfred Newton, M.A., V.P.Z.S., Prof. William Odling, M.B., V.P.C.S., Sir James Paget, Bart., D.C.L., William Henry Perkin, Sec. C.S., Charles William Siemens, D.C.L., John Simon, C.B., D.C.L., Prof. John Tyndall, D.C.L., LL.D.

A MEMORIAL strongly recommending Lord Rayleigh's election (if he can be induced to become a candidate), to the Professorship of Experimental Physics at Cambridge, is in circulation. Lord Rayleigh's merits for such an appointment are perfectly well known to our readers. We understand that his election will be supported by many of the professoriate.

WE are pleased to hear that Prof. Sir Wyville Thomson is now much better, and able to conduct the correspondence in connection with the *Challenger* work.

THE death is announced, at Florence, of Miss Martha Charters Somerville, the only surviving daughter of Mrs. Mary Somerville, in her sixty-sixth year. Miss Somerville enjoyed a pension of 100*l*. a year, in recognition of the services rendered to science by her mother.

THE Royal Institution Christmas Lectures will be given by Prof. Tyndall. The subjects will be Water and Air.

ON Tuesday night Dr. W. W. Hunter, the Indian Director-General of Statistics, delivered a lecture at the Philosophical Institution of Edinburgh, on the subject of "What the English had done for India." Contrasting the present English condition of the country with what it has become, since we have had to do with it, Dr. Hunter showed that the improvements in the land, and in the lot of the people had been immense. We need not refer here to the purely governmental improvements which have been made, by the substitution of a good government for a bad, or for no government at all. The peace and security which the poorest native now enjoys was unknown before. Much of the improvement which has taken place has been due to the introduction of science and its results into India. As the *Times* puts it in a leader on Dr. Hunter's address:—"A country which, in the natural course of things, seemed fated to be long shut out from the light of civilisation, or to receive tardily a few rays, was admitted at once into the full blaze of noonday. Other nations have been doomed to work out their civilisation with painful striving. But, thanks to her association with the West, India has had no such novitiate to undergo. All that Europe could teach or give has been made free to her without trouble or price. She has had no centuries of painful waiting, but has stepped at once into possession of all the accumulated intellectual wealth of the West. This has already borne fruits, and more must follow. Our Indian fellow-subjects are being rapidly familiarised with our language and books, and they eagerly drink in modern ideas. They study our philosophers, and talk with more or less intelligence of Mr. Darwin or Mr Herbert Spencer. The names of our chief scientific men are as well known at Agra or Poona as in London. Our schools and colleges are the little leaven which will not fail to leaven the whole mass. The old intellectual idols and prejudices are already prostrate or tottering; and even were there no traces of a bridge or a road to tell of our sway, its history would be imperishably written in the intellectual revolution which we have swiftly effected."

DURING the last four years, *Science News* states, very little has been heard of the observatory to be built in California from the gift of Mr. James Lick, and the public has very generally supposed that nothing would come of the project. But there are now signs of a renewed activity on the part of the trustees, and evidence of an intention to carry the project through without further delay. In August last, Mr. S. W. Burnham, of Chicago, the well-known observer of double stars, was invited to spend a month or two on Mount Hamilton, with his telescope, in order to test the suitability of the mountain as a site for the proposed observatory. His reports were so favourable that Prof. Newcomb, on whose recommendation he was chosen for the work, visited the place himself in September. Both these gentlemen speak in the highest terms of the excellence of the astronomical conditions. Not only is almost every night perfectly clear, but, according to Mr. Burnham, bad seeing is almost unknown. Every night is such a one as he would consider superb at Chicago, and would only meet with two or three times a year. He discovered during his stay a number of new double stars, in portions of the sky which are further south than can be thoroughly examined in the comparatively bad atmosphere of stations this side of the Mississippi. The result of this exploration will give both the trustees and the public a new interest in the project, and it is supposed will lead the former to push the work on as rapidly as possible. If, as both the astronomers who have examined the site seem to suppose, its atmosphere is finer than that of any existing observatory, the result will be that the most powerful telescope in the world will be under the finest sky for employing its utmost capacity.

M. FEIL, the Paris glass-founder, has just received an unusual number of orders for large discs for the following observatories:—Pulkowa Observatory, 80 cm. diameter; Nice Observatory (Bischofsheim's gift), 76 cm.; Paris National Observatory, 73 cm.; Vienna Observatory, to be worked by Grubb, 70 cm.; Mr. Hilger for England, 52 cm.; and M. Salmocroghi, of Milan, 52 cm. The Nice Observatory object-glass will be worked by MM. Henry Brothers.

ON Thursday, November 4, took place at the French Ministry of Public Instruction, the first general meeting of the delegates of the Meteorological Commission. M. Jules Ferry was in the chair, and he prefaced the discussion by some remarks on the zeal exhibited by delegates and expressed the confidence felt by the Government in the ultimate success of so many efforts. M. Hervé Mangon, the president of the Council of the Central Bureau, read a report on the work accomplished since the institution was created, and directed attention to a number of useful questions which up to that moment had been too much neglected. All the resolutions proposed which had been discussed in preliminary meetings were accepted. A number of delegates delivered addresses asking for the erection of new stations and the improvement of certain departments.

THE French Minister of Public Instruction has appointed a commission for arranging all the collections now located in the Trocadero, and creating out of these valuable elements an ethnographical museum.

UNDER date Rome, Sunday night, the *Daily News* correspondent telegraphs:—"Galvani in the act of touching with two different metals the lumbar nerves of a vivisected frog; such is the monument, admirably executed in marble, which his native city, Bologna, has this day dedicated in her busiest street to the great discoverer of animal electricity."

IT is stated that the Bell Telephone Company have taken the first steps to bring an action against the Edison Telephone Company for infringement of patent in respect of the microphonic transmitter of hard carbon employed in the latest form of instrument. This transmitter, which is almost identical with the Blake microphone used by the Bell Company, is claimed by Edison, under the name of the *Inertia Telephone*, as one of the earliest forms of his carbon telephone.

THE programme of the Society of Arts for its 126th session has just been issued. It gives a list of the papers and lectures for the session, so far as they have been arranged. The following are the papers to be read at the evening meetings previous to Christmas:—November 26, "Suggestions for Dealing with the Sewage of London," by Major-General H. Y. D. Scott, C.B. F.R.S. December 3, "Apprenticeship: Scientific and Unscientific," by Silvanus P. Thompson, D.Sc., Professor of Applied Physics at University College, Bristol. December 10, "Art Vestiges in Afghanistan; the Results of some Recent Explorations in the Jellalabad Valley," by William Simpson. December 17, "The Panama Canal," by Capt. Bedford Pim, R.N., M.P. The dates of the papers after Christmas are not announced, but the following are among the subjects to be treated:—"Domestic Poisons," by Henry Carr; "Gas Furnaces and Kilns for Burning Pottery," by Herbert Guthrie, C.E.; "The Utilisation of Slag," by Charles Wood; "Art in Japan," by C. Pfoundes; "The Trade and Commerce of the Yenisei," by Henry Seebohm; "Modern Autographic Printing Processes," by Thomas Bolas, F.C.S.; "The History of the Art of Bookbinding," by Henry B. Wheatley, F.S.A.; "Art Ironwork," by J. W. Singer; "The History of Musical Pitch," by A. J. Ellis, F.R.S.; "The Recent History of Explosive Agents," by Prof. Abel, C.B., F.R.S.; "Ireland and its Resources," by C. G. W. Lock: "The Future of Epping Forest," by William Paul, F.L.S. Three courses of "Cantor Lectures" are to be given. The first course is by Dr. Charles Graham, F.C.S., F.I.C., Professor of Chemical Technology at University College, London, on "The Chemistry of Bread and Bread-making;" the second on the "Manufacture of India-rubber and Gutta-percha," by Thomas Bolas, F.C.S.; the third by R. W. Edis, F.S.A., on "Art Decoration and Furniture." The first meeting of the session will be held on the 19th inst., when the opening address will be delivered by Lord Alfred S. Churchill, chairman of the Council.

DR. HINCKS's "History of the British Marine Polyzoa," upon which he has long been engaged, is nearly ready for publication; it will form two volumes, uniform with the same author's "Hydroid Zoophytes," and will be fully illustrated by drawings of all the known British species and more remarkable varieties of this hitherto almost undescribed class. The work will be published by Mr. Van Voorst.

MESSRS. BUNNY AND DAVIES, of Shrewsbury, have published a "Guide to the Botany, Ornithology, and Geology of Shrewsbury and its Vicinity," edited by Mr. W. Philips, F.L.S.

THE freedom of the Leathersellers' Company has been conferred on Prof. Owen.

ON November 3, at 7.45 P.M., a magnificent meteor was observed at Strassburg, in the vicinity of Jupiter, travelling southeastwards. The duration was four to five seconds. The meteor was coloured green, and left behind a luminous track.

IN his just published report on the trade of Newchwang, in Southern Manchuria, Mr. Consul Adkins mentions that he has in his possession a specimen of lead ore found in the neighbourhood, which contains about 90 per cent. of metal, and also one of copper from the same locality which is almost equally rich. An attempt is being made to get authority to work these mines with foreign appliances. There is an abundant supply of excellent coal close to the veins of metal, and were the mining industry once fairly started, the prosperity of Newchwang and the whole province would, in Mr. Adkins's opinion, become remarkable.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. Thos. G. Anderson; a Common Barn Owl (*Strix flammea*), British, presented by Mr. F. Bagnall; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Mona Monkey (*Cercopithecus mona*) from West Africa, a Malbrouck Monkey (*Cercopithecus cynosurus*) from East Africa, deposited; two Moustache Monkeys (*Cercopithecus cephus*) from West Africa, an Axis Deer (*Cervus axis*) from India, a Quebec Marmot (*Arctomys monax*) from North America, a Common Weasel (*Mustela vulgaris*), British, two Boatbills (*Cancroma cochlearia*), two Variegated Bitterns (*Ardetta involucris*) from South America, a Common Night Heron (*Nycticorax griseus*), British, purchased.

METEOROLOGICAL NOTES

IN the *Meteorology of England* for the quarter ending June 30, Mr. Glaisher gives some interesting notes of the cold weather up to that date. The mean temperature of London for the quarter was 49°·5, being the lowest which has occurred during the corresponding period since 1837. The unusually protracted cold weather set in on October 27, 1878, and for the eight months ending June, 1879, the mean temperature was only 41°·6, being lower than any which has occurred in the present century since 1813-14, when the mean temperature of these eight months was only 40°·4. It was during this cold period that the Thames was frozen over and a fair held between London and Blackfriars Bridges. Mr. Glaisher appends a very valuable table showing the mean temperature of the eight months ending June for each year from 1771-72, from which it appears that five colder periods than that of the present year occurred towards the end of last century, viz., 40°·9, in 1794-95, 41°·2 in 1788-89, and 41°·3 in 1783-84, 1784-85, and again in 1796-97. The more frequent occurrence of a higher temperature during the colder half of the year in recent years as compared with what prevailed in the end of last century is pointed out. During the first six months of 1879 the rainfall about London has been exceptionally large, amounting to 17·30 inches, which is larger than has fallen in these months any year since 1815.

IN the *Transactions and Proceedings* of the Philosophical Society of Adelaide, South Australia, for 1877-78, there is an interesting paper by Mr. H. H. Hayter, Government Statist of Victoria, on the infantile mortality of our Australian colonies, based on the statistical returns from 1866 to 1877. During these twelve years the rates per annum of the mortality of infants under one year of age in proportion to 1,000 births were 155 in South Australia, 128 in Queensland, 125 in Victoria, 106 in New South Wales, 101 in New Zealand, and 100 in Tasmania. In each of the years South Australia stood at the top of the list, except in 1877, when the rate of its infantile mortality was slightly exceeded by that of Queensland. From a detailed statement of the causes of deaths of infants in South Australia for the three years 1873-74-75, it appears that of the 3,641 deaths which occurred during these years from all causes, no fewer than 2,249 were occasioned by bowel-complaints and their complications. The whole of this question, which is a vital one as affects the future of such of our colonies as are characterised by high summer temperature, can only be satisfactorily investigated by weekly or monthly statistics of deaths of infants from all causes taken in connection with the mean temperature and humidity of the air during the time. Thus the different summer temperatures and humidities of these colonies explain by far the larger proportion of the differences in the rates of their infantile mortality. All the differences, however, are not to be thus explained, and it is the investigation of these and the tracing of them to their causes which would likely lead to the adoption of improved sanitary and domestic arrangements.

WE have received from the Scottish Meteorological Society a communication from Mr. Thorlacius, their observer in the north-west of Iceland, in which he states that the spring there was stormy and cold, but that, in direct contrast to what has prevailed in the British Islands, the summer had been very fine and warm up to the date of writing (September 23), and the rainfall very small during June, July, and August. Pastures had, in consequence, suffered much, and the hay crop turned out to be generally a very poor one. This has, however, been to some extent counterbalanced by the admirable state in which the hay harvest has been secured, so that most can look forward to the coming winter without uneasiness, even though it should prove severe. Since April they have heard nothing of the Greenland ice, always a subject of no little anxiety in these parts, the ice having fortunately kept away from the coast of Iceland. The Danish man-of-war schooner *Ingolf*, Capt Mourier, cruised this summer close to the coasts of Greenland, but could effect no landing, owing to a belt of ice he could not force his way through, which lay along the shore for a distance of from twelve to sixteen miles. The Captain sailed along the coast, taking several bearings by the way, from Stewart's Island to Cape Dow, or from 69° to 65° 30′ lat. N., thus sailing in a south-westerly direction along the coast of Greenland, which lies opposite the north-west of Iceland, at a distance of about 120 nautical miles. This shore has not been previously explored, no one having probably ever had an opportunity of getting so close in shore before. The strait between Iceland and Greenland was this summer, which very rarely happens, quite open for navigation, except the inconsiderable belt of ice immediately outside the coast of Greenland. Capt. Mourier had special instructions from the Danish government in regard to this exploration, and it is considered likely that the explorations on this little-known coast will be resumed. These meteorological and geographical facts are important in relation to the more southerly course than usual recently taken by our European storms, and the easterly and northerly winds resulting therefrom, to which we owe the all but unexampled cold dull weather of the last twelve months.

THE "Results of Observations in Meteorology, Terrestrial Magnetism, &c., made in Victoria during 1876," under the superintendence of R. L. J. Ellery, have been received. The methods of making and reducing the observations are detailed at length in the preface. The chief feature of the Report is its purely statistical character, there being no attempt to state the outstanding points of interest in the meteorology of the year in this part of Australia. To some extent, however, this want is compensated for by there being given with each month's detailed results the averages for that month of pressure, temperature, humidity, and rainfall, calculate from all previous observations in the office—together with particularly full data of electrical phenomena, hail, snow, frost, fogs, hot winds, storms of winds, and heavy rainfalls of half an inch and upwards within the twenty-four hours at the thirty-eight rain stations over the colony.

These hot winds are not merely of local interest to the colonists, but of general interest in matters affecting the atmospheric circulation of the continent of Australia, and as affording facilities to the meteorologists of that region in the study of whirlwinds and other cyclonic movements, the correct theory of which science has still to propound. The frequency of these hot winds at Wilson's Promontory, the most southern point in Victoria and completely enveloped by the sea, is noteworthy, as also the instance which occurred on March 14, when on the surface the wind was cool and damp, whereas a hot wind was blowing 50 feet high on the lighthouse balcony. The discussion of the wind observations is a valuable piece of work. These show an excess of atmospheric movement in the warmer months and during the hottest hours of the day, the velocity of the wind in summer increasing from 7·13 miles an hour from 2 to 3 A.M. to 15·97 miles from 2 to 3 P.M. During 1876, which was remarkable for the absence of sun-spots, the aurora australis was only seen once, viz., between 3 and 4 A.M. of April 26 at Kyneton.

GEOGRAPHICAL NOTES

THE Germans have so deservedly earned a distinguished reputation as scientific geographers, that it is quite pleasing to catch one very seriously tripping in geographical matters. In Philip Leopold Martius's "Das Leben der Hauskatze und ihrer Verwandten" (Weimar: B. F. Voigt, 1877), in the part of the work treating of the varieties of the domestic cat, appears (s. 61) the following extraordinary statement: "Die schwanzlose Katze von der Insel Man *im stillen Ocean* wenn nicht das *Kap Man auf Borneo* darunter zu verstehen, ist wohl noch nie zu uns nach Deutschland gekommen, obgleich sie auf der Katzenausstellung in London einst vertreten war." The author goes on to express his earnest wish that a pair of these great rarities, Manx cats, may be procured and exhibited at some zoological garden. Manxmen will hardly thank him for placing their native isle in the Pacific Ocean and confounding them with Polynesians, but the suggestion as the result of ponderous research that after all perhaps such a place as the Isle of Man does not exist, but that its mythical development has arisen from a mistake as to a cape of the same name in Borneo is too delicious altogether, and so ingenious and thoroughly German that it must needs be recorded for the benefit of the readers of NATURE.

DR. NACHTIGAL, has communicated to the Berlin Geographical Society full particulars as to the misfortune lately suffered by Gerhard Rohlfs' expedition in North Africa. Rohlfs and his companions, who were plundered and detained while exploring the Kufara Oasis, and compelled to return to Bengazi, were relieved by the intervention of the Foreign Office under assurance that complete reparation would be made them. The explorers' travelling effects, along with gifts sent by the German Emperor for the Sultan of Wadai, require to be supplemented and renewed, though it is almost certain the expedition will still be able to proceed in accordance with its previous plan. Dr. Lenz, it was announced at the same meeting, had lately gone to Morocco on a geological survey, which he would subsequently extend eastwards into the Sahara.

AT the opening of the Geographical Society's Session on Monday last, the Earl of Northbrook, the president, briefly reviewed the work of travellers and geographers during the past few months, and spoke in very eulogistic terms of Prof. Nordenskjöld's great achievement. The most noteworthy feature, however, in the address, was the statement that news had been received that morning from the expedition despatched by the African Exploration Fund Committee to the head of Lake Nyassa. Nothing had been heard of its whereabouts since the death of Mr. Johnston, except a rumour as to its progress, gathered by an Arab from native sources, and lately communicated by Dr. Kirk through the Foreign Office. Mr. Thomson reports that he has arrived, within comparatively few days' march of the lake, in the country of Uhehé. Lord Northbrook read some interesting extracts from Mr. Thomson's journal which will, no doubt, soon be published by the Society. Mr. Clements R. Markham then read a summary which he had drawn up of a paper on the exploration of Central Sumatra, prepared by Prof. P. J. Veth, President of the Dutch Geographical Society. One of the main results of the late Dutch expedition, was the discovery that the Jambi River, which should be known by its native name of Batang Hari, was navigable for nearly 400 miles. It was announced that at the next meeting a paper would be read which had been written by Captain A. H. Markham, descriptive of his Arctic cruise during the summer in the *Isbjörn* and of the work of the Dutch Expedition in the *Willem Barents*. Captain Bruijne, its commander, has kindly promised to attend the meeting. Lord Northbrook also stated that hopes were entertained of Dr. Emil Holub being able to give an account of his remarkable journeys in South Central Africa on January 12.

IN an account which he has sent home to the Church Missionary Society, of the tribes on the road to Mpwapwa, Mr. J. E. Last tells us that the third tribe from the coast is that of the Wanguru. In going from Saadani to Mpwapwa caravans pass through the southern limits of their country. These Wanguru seem to be a scattered people, but they are found in great numbers living among the mountains north of Kwa Masengo, one of their chief villages. There they cultivate the ground on a large scale, growing rice plentifully and all the common native produce; ginger is found in great abundance. They also grow a great deal of tobacco, and three native medicines not known among other tribes. One is the seed-pod of the *mdaha*, in form very like a piece of rough stick, and when ground it is very hot to the palate. The other two are vegetable fats produced from seeds, and are much in vogue as medicines at Zanzibar, as well as on the coast and inland. The French Roman Catholic mission have had a station among this tribe for some little time.

NEWS has been received from Zanzibar that another expedition has started from Bagamoyo for the interior. It is despatched by M. Lavigerie, Archbishop of Algiers, and consists of eighteen Europeans, of whom six are laymen. Their object is to reinforce the Algerian missionary stations at Ujiji and at King Mtesa's capital. The expedition is under the leadership of the Abbé Guyon.

THE new number of *Les Annales de l'Extrême Orient* contains papers on the Belep group and the fauna of the Indian Archipelago, the former of which is illustrated by a map.

THE fame of the newly discovered sapphire mines in Siam is so great that great numbers of Burmese and Shans are said to be flocking thither. The mania appears also to have attacked part of the European community in Rangoon.

THE November number of *Petermann's Mittheilungen* contains a reduced copy of the geological map of India from Medlicott and Blanford's "Preliminary Sketch." The narrative of Dr. Regel's journeys in Central Asia is concluded, and is followed by an interesting account of the trade and industry of Werchojansk and Kolymsk circles, in North-East Siberia, and an eclectic article on the region about the sources of the Santa-Cruz, in Patagonia, with a map illustrating Moreno's journeys in 1876-7. There is also a map accompanying the paper on Dr. Regel's journeys.

AMONG the papers in the September number of the *Bulletin* of the Paris Geographical Society, the one of most scientific value is Commander Perrier's lecture on the measurement of longitudes in France. M. Ed. Cineré describes his journey in South America, mainly the United States of Columbia, in 1875-6. There are two interesting letters on the Oxus question, by M. Woeikoff, with a note by M. Vivien de St. Martin, and a paper by the Abbé Durand on Père Dupayrett's journeys in South Africa. There is also an interesting unpublished letter of Dagelet, the astronomer attached to the expedition of La Perouse.

THE general council of Constantine (Algeria) has appointed a commission for determining the *tracé* of the Transaharian railway. It has been already determined by the commission to publish a *projet*, by M. Peltreau, on the section from Constantine to Juggurt by Biskra and Oued Birh.

IN the last session of the Geographical Society of Paris a very interesting discussion took place on the possibility of using elephants from India in South African exploration. It was considered more advantageous to try to use the native elephants after being trained on the Indian method. It was stated that a number of African elephants had been also sent to India in order to be tamed there. M. Soleillet remarked that elephants can nowhere be met in India except in well-watered places, so that they must be used in Africa, in countries offering some analogy with such regions where they can live without difficulty.

M. PAUL SOLEILLET will leave very shortly for St. Louis (Senegal) in order to proceed on his intended journey to Segou-Sokkoro and thence to Timbuctoo. He has received funds from

M. Ferry, the Minister for Public Instruction, enabling him to take with him a trained botanist. In his last address before the Geographical Society of Paris he entered into many interesting details showing that the negro populations of the region he is to visit were half-civilised races susceptible of intercourse with European nations.

The public subscription for M. Miclucho-Maclay gives very good results. On November 1 the sum had already reached, at the *Golos* office alone, above 2,786 roubles (about 278*l*.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The anniversary dinner of the Cambridge Philosophical Society is to take place in the new hall of Pembroke College on November 29, at 7.15, under Prof. Newton's presidency. The occasion will be clouded by many memories of Professors Maxwell and Garrod.

The Botanic Gardens Syndicate are to obtain plans and estimates for the erection of a curator's house in the Garden.

There is much questioning as to Dr. Power's justification for regarding the coming changes as a "revolution," especially in laying down the office of Vice-Chancellor. A reform in which the University concurs to a great extent can hardly be regarded with such grave anxiety. Dr. Power, in the speech referred to, said that the new comparative anatomy buildings had been for a considerable period in use, although the dispute as to the respective liabilities of the University, the architect, and the contractors for the accident to the roof and floors is not yet settled. The recent addition to the rooms for human anatomy had proved satisfactory. Dr. Power again warned the University of the rapid rate of increase of permanent expenditure and the very uncertain nature of the income, depending so largely on the fees and dues from members of the University. He acknowledged that the department of chemistry had been existing on a starvation allowance, and that some professors and lecturers had been paying heavy expenses out of their own pockets rather than make fresh demands on the already overburdened finances of the University.

Dr. E. H. Perowne enjoys the singular felicity of having become Master of Corpus Christi and Vice-Chancellor in one year. Mr. G. F. Browne, the senior proctor, desires to maintain strongly the college system as against the lodging-house system, especially in regard to discipline. But this would not involve any diminution in the urgent need for more thorough University science teaching, and the more complete recognition as a duty, of banishing the mere schoolboy and the idler, or the mere athlete, to the schools or elsewhere, instead of employing such ability as is here set to lecture in the ABC of subjects.

At Christ's College it is proposed to give open scholarships and exhibitions in natural science for entrance in October, 1880, by examination on Friday, March 19, and following days. He must show that he will probably be able to pass the "Little-go" at latest by the end of his third term of residence. A candidate may gain a scholarship for mathematics or classics in combination with natural science. No candidate will be admitted who has kept any actual terms by residence, but there will be no limitation of age. In mathematics there will be papers in Euclid, algebra, plane trigonometry, and conic sections, geometrical and analytical. Candidates for natural science scholarships must all take chemistry, and also either physics or biology in addition. The principles of spectrum analysis are included in theoretical chemistry, physical measurements and manipulations in physics; also statics, dynamics, optics, heat, and electricity; in biology the conditions are exceedingly well stated, as—*Physiology*: Fundamental principles of the chief physiological processes of plants and animals; general histology of their principal organs; *Morphology*: Fundamental principles of morphology as illustrated by forms representing the principal classes of the vegetable and animal kingdoms; principles of the classification of plants and animals; practical microscopical examination of the various tissues; dissection and description of typical plants and animals. The examinations will be held in common with those at Emmanuel and Sidney Sussex Colleges, as before.

The last Report of the Board of Natural Sciences Studies was to be offered for confirmation to-day (Thursday), at 2 P.M., and it was expected to be non-placeted, although it might be carried on a division.

PROF. BURDON-SANDERSON announces that he will begin a course of weekly lectures at University College, Gower Street, to ladies, on physiology, on Friday the 21st, at 4 P.M. The first lecture will be public.

MR. P. R. SCOTT LANG, M.A., B.Sc., F.R.S.E., who has for some years been assistant to the Professor of Natural Philosophy—Prof. Tait—in the University of Edinburgh, has been appointed by the Queen to the chair of mathematics in the University of St. Andrews.

MR. MARK FIRTH has signified his wish to found a chair of chemistry in connection with Firth College, Sheffield. He proposes to invest a sum sufficient to produce an annual income of 150*l*., and this, together with the fees of students, will amount, it is believed, to a sufficient sum. Mr. Firth proposes that the appointment shall be first filled by Dr. Carnelly, Owens College, Manchester.

THOSE of our readers interested in the higher education of girls may be glad to know that a Calendar of Queen's College, Harley Street, has been published.

THE *Golos* learns, according to the *Times* Berlin correspondent, that the Russian Government intends thoroughly changing the statutes of the University of Dorpat, in Livonia, that strong bulwark of German science and culture. Among the proposed alterations now under consideration in the Imperial Council, the chief one aims at restricting certain liberties hitherto enjoyed by German-speaking students and subjecting them to police surveillance similar to that now in force at all other Russian Universities.

SCIENTIFIC SERIALS

The American Journal of Science and Arts, October.—An examination of the chemical composition of amblygonite, by Mr. Penfield, leads him to give a new and more simple formula for the mineral. He shows that the hydroxyl group in amblygonite is isomorphous with fluorine.—From general geological sections in Iowa, Mr. McGee concludes that residuary clays and others of equal compactness were passed over by a thick ice-sheet with or without serious disturbance, and that the plane of contact between glacial drift and subjacent residuary clay is not always clearly defined.—Mr. Dale describes a peculiar fault at Rondout.—The first portion of a research, by Mr. Gibbs, on the vapour densities of peroxide of nitrogen, formic acid, acetic acid, and perchloride of phosphorus, is given, and the two remaining papers are from English publications (Crookes on radiant matter, and Draper on oxygen in the sun).

The American Naturalist, October.—John A. Ryder, an account of a new genus of minute pauropod myriapod (with figures).—Wm. Barbeck, on microscopical fungi attacking our cereals.—C. L. Herrick, fresh-water entomostraca (describes and figures *Diaptomus longicornis*, n.sp.).—S. K. Lum, notes on the thrushes of the Washington Territory.—John Ford, the leather-turtle.—S. L. Frey, Were they mound-builders?—Recent literature: Proceedings of scientific societies.

The American Quarterly Microscopical Journal, vol. i. No. 4.—Prof. S. A. Forbes, on some sensory structures of young dog-fishes.—Dr. C. L. Anderson, spores with a spore glossary.—Dr. J. J. Woodward, on the oblique illuminator, and on a new apertometer.—F. H. Wenham, on Prof. Smith's apertometer.—John Mayall, on measuring aperture.—R. Hitchcock, aperture, angular and numerical.—J. D. Hyatt, on the tongue of the honey-bee.—Thomas Taylor, on oleomargarine and butter.—W. C. Hubbard, Haeckel *v.* Virchow.—Prof. Stowell, the origin and death of the red blood-corpuscle.—B. Eyferth, on the simplest forms of life.—An announcement from the publishers states "that the existence of the *Quarterly* ceases with this number." The editor found that it would be impossible for him to give the journal the necessary supervision during the coming year, hence the necessity of this suspension.

Journal of the Franklin Institute, October.—Prof. Thurston here publishes an investigation of the strength of American timber, several varieties of which (white and yellow pine, locust, black walnut, white ash, white and live oak) were submitted to testing machines in the Stevens Institute. The results show that American timber has a constructive value equal, if not decidedly superior, to European timber. (The numbers were almost invariably higher than those of Barlow, Tredgold, or

Lastett.) Timber yields, under all forms of stress, to an extent about proportional to the load.—Mr. James Smith sketches a plan for water-supply of Philadelphia, viz., a gravity-supply by aqueduct from Perkiomen.—A modification of Tisley's compound pendulum, by Mr. Queen, of Philadelphia, whereby the motions and figures may be exhibited on a screen to large audiences, is described, and there is an account of the zinc veins and works of Lehigh Valley.

Bulletin of the United States Geological and Geographical Survey of the Territories, vol. v. No. 2, September.—J. A. Allen, on the Coatis (genus Nasua, Storr).—Dr. Coues, on the present status of *Passer domesticus* in America.—Dr. Peale, on the Laramie group of Western Wyoming and adjacent regions.—A. R. Grote, on Lithophane and some new Noctuidæ (describes many new species).—Dr. A. White, Palæontological Papers, No. II., on carboniferous fossils from Colorado, Arizona, Utah, and Wyoming, and on cretaceous corals from Colorado (describes several new species).—F. V. Hayden, the so-called Two-Ocean Pass.—E. D. Cope, on the extinct species of Rhinoceridæ of North America, and their allies.—Dr. Coues, second instalment of American ornithological bibliography.

Bulletin de l'Académie Royale des Sciences de Belgique, No. 8.—M. Plateau here defends, at some length, his theory of the superficial viscosity of liquids in opposition to the theory of Signor Marangoni, who, without denying a viscosity proper to the surface and different from that of the interior, thinks its influence (*e.g.*, in retarding the movement of a needle on the surface) very small in comparison with that of other causes, especially, in liquids which can be inflated in large bubbles, the *elasticity* of a layer of impurity (*imbrattamento*) arising from exposure in the air, while in liquids like water and most saline solutions, changes in tension, through alteration of the surface and changes in curvature of the menisci at the sides of the needle, &c., are operative.—M. Petermann writes on the presence of grains of *Lychnis githago* in alimentary flour, and indicates a method of detecting it.—There is also a paper on the quartziferous diorite of Champ-Saint-Veron (Lembecq), by MM. Poussin and Renard.

Journal de Physique, October.—On the inscription of meteorological phenomena, particularly electricity and pressure, by M. Mascart.—On the rectifying apparatus of M. Duboscq, by M. Bertin.—On a phenomenon similar to Peltier's phenomenon, by M. Bouty.—A regulator of temperature, by M. Benoit.

Cosmos, 5 Heft, August.—Prof. Dr. Schultze, history of the origin of the "Despising" of Nature.—Ernst Haeckel, on the common relationship between the ctenophora and the medusæ, with an account of a form connecting the two groups. This extraordinary form is beautifully figured.—Dr. Mehlis, the barrowfield near Hagenau and its probable epoch.—Henry Potonié, Alexander Braun's attitude towards the theory of descent.—Short notices and criticisms.

THE *Nyt Magazin for Naturvidenskaberne* (Christiania, vol. 24, pt. 4, and vol. 25, pt. 1).—From these parts we note the following papers:—On the geology of the Folge Fon peninsula, by T. Ch. Thomassen.—On the ornithology of Madagascar, by Leonhard Stejneger.—On microline, a new species of triclinic potash-feldspar; its optical, crystallographical, and chemical characters, by A. Des Cloizeaux.—On the insect fauna of Dovrefjeld and the Gudbrands valley, by W. M. Schoyen.—On the changes which some plants undergo in northern latitudes by Prof. F. C. Schübeler.—On the occurrence of iridium in northern minerals, by S. Wleugel.—On dislocation lines in the so-called Skrimfjeld, by O. E. Corneliussen.—Diary of a journey in the Trysil district, by L. Meinich.—Account of a botanical tour in Hardangervidden, by N. Wille.—On some contact rocks of the Christiania Silurian basin, by A. Penck.

THE *Verhandlungen der k.k. geologischen Reichsanstalt* No. 12, Vienna) contains the following papers:—On the miocene deposits at the south-western margin of the Galicio-Podolian Plateau, by J. Niedzwiedzki.—On the tertiary formation at the eastern slope of the Vogelsberg, by H. Bücking.—On the pliocene mammal-fauna of Hungary, by Th. Fuchs.—On the Flysch question, by the same.—On the geological objects exhibited at Teplitz and relating to the Teplitz basin, by R. Raffelt.—On the marginal mountains of the Vienna bay, by Franz Toula.—The number further contains the following eports of geological excursions undertaken by different members f the Reichsanstalt, viz.: by Dr. O. Lenz from Eastern Galicia, by Dr. Edmund von Mojsisovics from Bosnia, by E. Tietze from Eastern Bosnia, and by Dr. A. Bittner from the Herzegowina.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 6.—Prof. Allman, president, in the chair.—Mr. W. H. Twelvetrees (of Orenburg, Russia) was elected a Fellow of the Society.—The President, in opening the session, briefly alluded to the demise of Mr. W. Wilson Saunders and Mr. John Miers, whose scientific and official labours in connection with the Society have been well appreciated.—Mr. W. T. Thiselton Dyer exhibited and made remarks on some photographs of vegetation, including *Cinchona Ledgeriana*, in the Botanic Garden of Buitenzorg, Java.—Mr. D. Morris, recently returned from investigating the coffee-leaf disease of Ceylon and South India, read a paper on the structure and habit of *Hemileia vastatrix*. He supports the Rev. R. Abbay's statements as to the destructive character of the fungus and its evident gradual extension over the coffee-producing regions of the East; he even expresses fears of its ultimately being carried to the West Indies and Brazil;—2,000,000*l.*, the estimated annual deficiency in Ceylon alone, is no mean sum to be debited from the revenue and interests of the planters. Mr. Abbay has described the spores as attached to the inner surface of the orange yellow sporanges (a notion opposed to received ideas respecting free cell formation); but Mr. Morris's observations are opposed to those of the former. The author explains the hitherto puzzling dark brown bodies beneath the sporanges as composed of closely interwoven threads of mycelium. During February, March, and April, both bark and leaves are everywhere covered exteriorly by mycelial filamentous threads which reproduce by germinating spores. In the wet weather these do not enter the stomata. It is in this stage that conidial growth supervenes according to Abbay (secondary spores of Thwaites), but the author has failed to substantiate this phase, though starved plants on glass slides raised conidia. It is during the filamentous stage before penetration that remedial agents—dusting with sulphur and lime, &c.—have a chance of being effective; but a serious disturbing element offers in the large area of abandoned crop still continuing to propagate the fungus.—Dr. F. Day read a paper on the instincts and emotions of fish. Biologists of late have been less attracted by the faculties of fish than of other animals, and even Cuvier's estimate of their total want of intelligence has been quite recently quoted as authentic. The author combats this notion, and, from his own experience and data afforded by other writers, claims evidence of emotions and affections. He shows they construct nests, transport their eggs, protect and defend their young, exhibit affection for each other, recognise human beings, can be tamed, manifest fear, anger, hatred, and revenge, utter sounds, hide from danger, betake themselves for protection to the bodies of other animals, and have other peculiar modes of defence, leave the water for food, and even different families combine for attack and defence. Their faculties, notwithstanding, are greatly subordinated and modified compared with those of higher races of the vertebrata.—The Rev. G. Henslow read a paper on the origin of the (so-called) scorpioid cyme. He pointed out some errors in deducing this from the dichotomous cyme: 1. Opposite pairs of bracts, being successively in planes *at right angles*, the resulting sympode would be a volute, and not a helix. 2. The position of the bracts (when present, as in *Borago*) are not opposite the flowers. 3. There are always *two* rows of flowers, not a single one. 4. The appearance of a flower in the fork between the two branches of the inflorescence (as in *Myosotis*) is not usual, and is due to the adhesion between the terminal and the highest axillary raceme. This has given rise to a false impression of dichotomy. 5. Authors have hitherto confounded the "true scorpioid raceme" (Henslow) with spicate degradations of sympodial inflorescence. He refers it to the indefinite system, and explains its origin by a new principle of phyllotaxis, which he first discovered in *Lagerstromia*, viz., in resolving opposite and decussate leaves into alternate, instead of their lying on a continuous spiral line, the line *oscillates* through three-fourths of a circle, and if a line be drawn from flower to bract, it will represent the so-called scorpioid cyme of Boragineæ.

Chemical Society, Nov. 6.—Mr. Warren De la Rue, F.R.S., President, in the chair.—The following papers were read:—On the transformation products of starch, by C. O'Sullivan. In this paper, which was originally presented to the Société Chimique de Paris on June 18, the author criticises the results published by MM. Musculus and Gruber, pointing out some errors into which they had fallen. He reasserts the fundamental facts of his former paper, viz., that starch splits up under the influence of malt extract in four principal ways. The author also investigates the action of malt extract on the products of the above reactions. He inclines to the belief that the dextrins are not a series of polymers, but rather a series of bodies of the same molecular weight, the molecules being arranged differently as regards one another, the molecules being arranged in groups all dependent on one another.—Note on the formulæ of the carbohydrates, by Dr. Armstrong. The author discusses the various formulæ of glucose, and inclines to that which represents glucose as being an aldehyde and a penthydric alcohol; the cane sugars are probably related to the glucoses as ether is to alcohol. The author discusses the probable arrangement of the molecules in starch, and arrives at a conclusion differing from that of O'Sullivan.—On a new method of determining sulphur in coal, by Teikichi Nakamura of Tôkiô. The author mixes intimately one part of finely-powdered coal with three or four parts of sodium carbonate and ignites very gradually, so that no smoke or odorous gases escape; a white or reddish ash is left, which is treated with water, &c.—On the bromine derivatives of β naphthol, by A. J. Smith.—On the dissociation of ammonia iron alum, by J. S. Thomson. Dilute neutral solutions of ferric salts, when heated, deposit a basic salt; this dissociation can be prevented by the addition of dilute sulphuric acid. By using sulphuric acid of known strength, the author has studied the subject quantitatively. A solution of ammonia iron alum containing more than 1 grm. in 14·37 cc., does not dissociate; this dissociation begins in more dilute solutions, and increases regularly with successive additions of water; ammonia and potash salts increase the dissociation.—On α methyl oxysuccinic acid, the product of the action of anhydrous hydrocyanic acid upon aceto-acetic ether, by G. H. Morris.—Demarçay described an uncrystallisable acid obtained as above, whose baryta salt was unstable. The author has repeated the experiments, and obtained a well-crystallised acid melting at 108°. The barium salt is stable when boiled with water.—On the action of phosgene on ammonia, by H. J. H. Fenton. The author has examined the white amorphous substance obtained in the above reaction, and extracted guanidine and urea quite identical with ordinary urea.—On the rehydration of dehydrated metallic oxides, by C. F. Cross. The author has obtained various anhydrous basic metallic oxides by igniting the hydrates. These oxides, when exposed to a saturated atmosphere, absorb water up to a definite limit of a molecular character. The investigation includes oxides of aluminium, chromium, cobalt, iron, and copper.—On alizarin blue, by G. Auerbach. The author gives the method of preparing and purifying this substance; when pure it forms brown, shining needles, melting 268°–270°. He has also prepared various salts and bromo derivatives; the actions of zinc dust, chlorine, and acetic anhydride were studied. In constitution the author thinks the body must be closely related to the aldehydines of Ladenburg.

PARIS

Academy of Sciences, November 3.—M. Daubrée in the chair.—M. Mouchez presented the last published volume of *Annales de l'Observatoire de Paris*, giving observations made in 1876. He stated that the Ministry of Public Education had decided that a certain number of astronomical students should be admitted to the Observatory for two years' instruction and practice, after which those found fit should be appointed as assistant astronomers in government observatories.—Nautical instructions on the coasts of Algeria, by M. Mouchez. The volume he presented describes first the meteorology, then the physical character of the coast.—Experiments with an inverted syphon having two horizontal branches, capable of raising water without a movable piece to considerable heights relatively to that of waves, or to exhaust at considerable depths relatively to the hollow of waves, when a retaining valve system is added, by M. De Caligny.—On some pathological states of the tympanum, causing nervous phenomena, which Flourens and De Goltz attribute exclusively to the semicircular canals, by M. Bonnafont. Displacement of the tympanic membrane away from or towards the internal wall of the tympanic cavity (*e.g.* in the latter case, by a concretion of wax or polypous excrescence), causes, through the chain of small bones, variations of pressure of the liquids in the vestibule and semicircular canals, with consequent giddiness, staggering, &c.—On the abnormal spectrum of light, by M. De Klercker. Two hollow glass prisms having the same angle (25°) and filled with alcohol, are placed on the stage of spectroscope with their refringent angles in opposite directions; the image of the slit is not deflected. To one prism are then added crystals of fuchsine; the original image then divides into two parts, one going to the right and widening into a distinct regular spectrum of the less refrangible rays; the other remains in the same place without widening, and takes a blue-violet colour. M. De Klercker attributes the effect to the different amount of retardation by molecules of different species in the solution.—On determination of the elements of a vibratory motion; measurement of amplitudes, by M. Mercadier. He uses a (so-called) vibrating micrometer.—Stomachic digestion and duodenal digestion; action of pancreatine, by M. Defresne. Hydrochloric acid in gastric juice is combined with an organic base which moderates its action and changes its properties. The acidity of mixed gastric juice, half an hour after ingestion, is no longer due to chlorhydrate of leucine, but to lactic, sarco-lactic, tartaric, malic, and other acids. The best reagent of this transformation is pancreatine. This difference in acidity of pure and mixed gastric juice becomes still more manifest in artificial digestion of nitrogenised food.—Result of researches into the origin of reinvasions of phylloxera, by M. Faucon. He contends for the superiority of submersion to insecticides, and indicates a method.—On uniform analytic functions in the neighbourhood of a singular essential point, by M. Picard.—On the ultra-violet absorption spectra of nitric and nitrous ethers, by MM. Soret and Rilliet. The known characters of the absorption spectra of metallic nitrates are not met with in nitric ethers. A solution of amylnitrous ether gives six absorption bands between H and R.—On a new stellar spectroscope, by M. Thollon. He uses two compound direct-vision prisms of special form (one in the collimator, the other in the telescope tube), whereby he seeks to reduce the loss of light as much as possible. The larger of the simple (or component) prisms has an angle of 100°, and contains a mixture of ether and sulphide of carbon; and two rectangular prisms of crown glass (one on either side) have faces parallel to each other and to the bisecting line of the angle of 100°.—On the tensions of vapour of saline solutions, by M. Pauchon. The value of coefficient a, in Kirchhoff's formula, varies continually with the concentration, in some cases increasing, in others diminishing.—On an electro-capillary thermometer, by M. Debrun. The principle is that mechanical action deforming a mercury meniscus like that in Lippmann's electrometer, produces a current.—On animal cellulose or tunicine, by M. Franchiment. The difference between animal and plant cellulose, if such exist, is not due to a difference of the groups $C_6H_{10}O_5$ forming it, but to a difference in the manner of their union.—Researches on the different modes of combination of phosphoric acid in the nervous substance, by M. Jolly. In the calf the brain is very rich in phosphorised elements; in the grown ox it is the spinal cord that contains most of them; and after alkaline phosphates, phosphate of iron is the most abundant.—On hairs and hairy glands in some kinds of Nymphcaceæ, by M. Heckel.—On the growth of stems of dicotyledonous trees, and on the descending sap, by M. Guinier. He thinks it is perhaps time to renounce the ordinary theory of descending sap.

CONTENTS

THURSDAY, NOVEMBER 20, 1879

THE DOUBLE STARS

A Handbook of Double Stars. By Edward Crossley, F.R.A.S., Joseph Gledhill, F.R.A.S., and James M. Wilson, M.A., F.R.A.S. (London: Macmillan and Co., 1879.)

Double Star Observations made in 1877–78 *at Chicago with the* $18\frac{1}{2}$*-inch Refractor of the Dearborn Observatory, &c.* By Sherburne Wesley Burnham, M.A. (From *Memoirs* of the Royal Astronomical Society, vol. xliv.)

IT cannot be said that a special work upon the double and compound stars has not been long a desideratum. Of the various branches of astronomical science the study of the double stars appears to have formed one of the most attractive to amateurs generally; so far as the reduction of the observations is concerned it involves little calculation, and the observations themselves are not laborious but admit of being proceeded with at intervals of leisure, with comparatively moderate appliances, at least in a large number of cases. Many of our amateurs have their daily duties and occupations in other lines, and seek relief in their evenings from the monotony of routine; the observation of the double stars upon a well-arranged list perhaps offers as favourable opportunities for rendering themselves really useful and for doing really good work in astronomy without the labour of one kind or another involved in several other classes of observation as it is possible to find.

The branch of astronomy to which we are referring has progressed as rapidly as others, and the observations of double stars and particulars relating to them have been scattered through a large number of astronomical publications, to consult which involves a great outlay of time and trouble, even if they are accessible without difficulty. The main purpose of the volume before us has been to present the great majority of measures of some twelve hundred double stars in a convenient form, with notes bearing upon binary character or other peculiarity, or, speaking generally, to furnish a history of each star. Part I. is introductory or explanatory, containing a brief historical notice and reference to those astronomers who have been most occupied upon the double stars, with particulars of the instruments employed, the adjustments of the equatorial, the micrometer and methods of observing with it, forms for registering measures and similar details. Part II., which possesses considerable value, treats of the calculation of the orbits of the revolving double stars, and in this division of the work the authors have been fortunate in being assisted by Dr. Doberck, who has a greater experience in this direction than any other astronomer of the day, and who has contributed in so important a degree to advance our knowledge of the elements of these revolving suns. Sir John Herschel's graphical process for determining the apparent orbit which is still of such material assistance towards more refined investigation is explained and illustrated (which is better still) by an application to Castor. This is followed by the calculation of an orbit by analytical methods, applied to σ Coronæ, the different steps being clearly defined, but these methods are necessarily much more laborious, and at present we do not seem to get the full advantage in many cases that might be expected from them. It will be no fault of Dr. Doberck's if the computer does not succeed in obtaining elements upon the principles he so well explains, which will continue to represent the motion of the star. Other causes frequently operate, however, which appear to render elements less satisfactory for *prediction* than might be expected, considering the refinement used in their calculation. The comparison of Dr. Doberck's orbit of σ Coronæ with observation affords a very close agreement. In the next three chapters Mr. Wilson enters upon relative rectilinear motion, the effect of proper motion and parallax on the observed angles and distances of a star optically double, and the errors and combination of observations.

Part III., "the Catalogue and Measures," prepared by Mr. Gledhill, is that which will be most frequently consulted. Considerable care appears to have been taken in the selection of the objects, and in the collection of the measures by various observers. A great amount of trouble must have been expended upon this portion of the volume, which is well brought up to date, and few facts of importance bearing upon the history of any object appear to have been overlooked, though such omissions must almost necessarily occur sometimes in a work of this character. There has evidently been the wish to make this part of the work as useful as possible to the amateur. Perhaps in a short supplement to another edition it may be desirable to reproduce the double star measures with the Königsberg heliometer, collected in vol. xxxv. of the Observations at that Observatory, the more especially as these volumes of observations have but a small circulation in this country; we miss most of these measures in the "Handbook."

An appendix contains the positions and measures of two hundred of Mr. Burnham's new double stars, placed at the service of the authors by the discoverer. Part IV. is bibliographical, and supplies a list of the principal works and papers relating to double stars and upon various forms of micrometer.

The volume is one which may be expected to find its way to the shelves of most amateurs and students of astronomy.

Mr. Burnham's important contribution to vol. xliv. of the *Memoirs* of the Royal Astronomical Society, contains (1) a catalogue of 251 new double stars with measures, and (2) micrometrical measures of 500 objects, amongst them some very difficult ones and a number of evident binaries.

At the time the Chicago Astronomical Society was organised in 1862, Messrs. Alvan Clark and Sons had still in their possession an object-glass of $18\frac{1}{2}$ inches aperture, which was then the largest in the world. Steps were taken to secure it, and, thanks to the energy of the Hons. Thomas Hoyne and J. Young Scammon, the latter of whom has been president of the Society from its organisation, the glass was secured for Chicago, and by means of a public subscription 18,000 dollars were raised for its complete mounting, and Mr. Scammon contributed 30,000 in addition for the building. Fortunately an observer equal to the use of so fine an instrument was at hand, and latterly Mr. Burnham has devoted it to the discovery of new double stars and the revision of an extensive list of known ones which appeared most deserving of attention. He remarks: "My work has been wholly a labour of love. During the business hours of every day I have been otherwise fully occupied, and hence my observations have been prosecuted often at the expense of rest, sleep, and recreation. I submit the results to the Royal Astronomical Society as the first contribution of the great equatorial of the Dearborn Observatory." Mr. Burnham had however published, between 1873 and 1877, *nine* smaller lists of new double stars, containing 482 in all; the present catalogue brings up the number to 733; indeed, his energy and success have been alike extraordinary.

In looking over this tenth catalogue of new doubles, many objects are noted which deserve more or less attention. η Piscium, a star of the fourth magnitude, has a companion of the eleventh at a distance of one second, and "there is no known pair among stars of this magnitude or brighter, with so close and minute a companion." Three stars have been found near the celebrated variable, *Algol*, all three closer than Schröter's companion; one of 12·5m. is distant only 10″·6 on an angle of 115°. There are also three new doubles amongst the Pleiades, and a much nearer companion to *Aldebaran* than that observed by Herschel and Struve. In an object in R.A. (1880·0), 21h. 1m. 25s., and Decl. +43° 12′, Mr. Burnham finds the most minute close pair known and terms it "a curiosity in double stars, if for no other reason;" it is too small for Argelander's *Durchmusterung*; the components are about equal and near 11m., distance 0″·4. There are two faint companions to Herschel's "Garnet-star" in Cepheus, and not the least interesting addition is a *comes* of 12·5m. preceding nearly on the parallel, by 0″·7, the star 85 Pegasi, which has large proper motion and a sensible parallax according to the investigations of Prof. Brünnow at Dunsink; as Mr. Burnham remarks the physical connection or otherwise of the faint star should be soon decided.

In the second catalogue, as we have stated above, there are many binary systems, the Chicago observations either confirming previous deductions or indicating new objects in motion. Mr. Burnham doubts the duplicity of *Atlas Pleiadum*, though Struve considered that confidence might be placed in his measures of 1827, an inference somewhat supported by Dr. Hartwig's observation on the occultation of the star by the moon in 1876. An examination of the interior of the trapezium of Orion, afforded not the slightest suspicion of any additional stars, and hence Mr. Burnham concludes that several faint objects supposed to have been seen within it, with smaller telescopes, have no real existence, and he expresses the same opinion as to recent suspected companions of the Pole-star. He shows good reason for inferring that one of the components of Σ 1058 is variable; the brighter star is missing in more than one catalogue where it might be expected to be found, and in 1878 a thorough search did not reveal any double star near its place, but in the early part of the present year he has been more successful and has measured the star on two nights, when the magnitudes were respectively 8 and 11. A reference to Mr. Burnham's notes will afford a number of other objects to which special interest attaches.

OUR BOOK SHELF

The Saidapet Experimental Farm Manual and Guide. By C. Benson. (Madras, 1879.)

THIS volume is published by the direction of the Madras Government, and consists of a Report by the Superintendent of the more important results obtained at the experimental farm since its commencement in 1865. An agricultural college has been recently added to the farm establishment, but this educational work lies beyond the scope of the present volume. Of the value of the work done on this experimental farm there can be no question; the Government money spent on it has been well laid out. If the miserable and profitless native systems of agriculture are to be improved, and the land made capable of supporting the rapidly increasing population, it must be by the adoption of the methods here recommended.

In the native agriculture the soil is stirred to the depth of 3 inches only, manure is seldom employed, and grain crops are generally the only ones cultivated; the land is thus reduced to its lowest limit of productiveness. Irrigation is also most wastefully conducted. Eight to twelve feet of water are consumed in the production of a single crop of paddy, the ground being turned into a swamp, and frequently becoming a source of disease to the surrounding population.

The improvements recommended are in the first place a deeper cultivation of the soil, by which its porosity and water-holding power would be increased, and the root development of the crop favoured. An English plough is said to cost twenty-five times the price of a native implement, but the work done is so superior that the increased outlay will be repaid during a single year's cultivation of twenty acres. Many soils also require draining. The rainfall in India is at certain times of the year extremely heavy (16 inches have been recorded at Saidapet in twenty-four hours); on such occasions undrained land becomes for a long period unworkable, and much precious time is lost. Judicious drainage will not diminish the water holding power of heavy land, but rather increase it by promoting the disintegration of the subsoil. Drainage is also greatly needed in many cases for irrigated land; without this the water may become stagnant and its good effect greatly diminished.

The next improvement demanded is the adoption of a proper rotation of crops, in which fodder crops should hold an important place. The experiments have shown that a large number of excellent fodder crops exist, which can be cultivated if need be all the year round. The fodder crops most strongly recommended are cholum (*Sorghum vulgare*), and guinea grass (*Panicum jumentorium*). Sugar cane, where well manured, affords an immense amount of excellent fodder. Paddy may also be often usefully cut while green, and a good supply of fodder thus obtained when the quantity of water available is too small to carry the crop to maturity. Horse gram (*Dolichos uniflorus*) may also be grown with advantage as a fodder crop, and four or five cuttings may be obtained in the year. Being a leguminous plant, rich in nitrogen, it is of great use in bringing poor land into condition, and may be ploughed in as a green manuring with excellent effect.

One great object of the growth of fodder crops is to enable the farmer to raise the condition of his soil by applications of organic manure; to increase the amount of humic matter in the soil is a most important step towards amelioration in such a climate as that of India. The fodder crops should be consumed by cattle, kept, at least during the night, in loose boxes, and the manure thus obtained returned to the land. Other manures recommended are steeped cotton-seed, salpetre, bones, and lime.

Until the condition of the land is raised by proper cultivation and manuring, a large number of improvements must remain impossible. Superior grain crops, and superior varieties of rice and cotton, can only be grown on good soil; on poor soil they at once deteriorate. The same may be said of live stock: the miserable native breeds are accustomed to starve during a part of every year; such treatment would be fatal to better animals. Until good fodder crops are grown, any permanent improvement in the breeds of farm animals is impracticable.

We might easily extend our notice of this useful volume; it is full of practical information, and must prove of great value to all engaged in agricultural operations in India.

R. W.

Grundriss der chemischen Technologie. Von Dr. Jul. Post. Part ii. (Berlin: Robert Oppenheim, 1879.)

WE have already noticed the first part of Dr. Post's excellent manual of chemical technology (see vol. xvi., 83), which made its appearance towards the end of 1876. Unfortunately, the completion of the work has been delayed by the severe and prolonged illness of the editor. The first portion was mainly confined to a description of the modes of manufacture of crude or intermediate products; the second part treats of the finished or final products. Objections might, doubtless, be raised against such a mode of treatment, but we question if, on the whole, a more systematic method of dealing with so complex a subject as chemical technology could have been devised. The entire work forms unquestionably one of the most, if not *the* most, complete repertorium of the existing processes of industrial chemistry that we know of in any language, and as such we can confidently recommend it to the notice of our chemical manufacturers. Dr. Post has been assisted by an excellent band of collaborators, many of whom are recognised as authorities on the subject of their respective communications. A due amount of space is usually devoted to a consideration of the theory of the various processes when this has been at all worked out; and the description of the mode in which these processes are actually carried into operation is facilitated by numerous diagrams and plans. Dr. Post is to be congratulated on the completion of an exceedingly useful work.

LETTERS TO THE EDITOR

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

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

The November Meteors

THE cloudless sky from the morning of the 12th to the 15th, with the total absence of moonlight, afforded a most favourable opportunity for the observation of the meteors of the season. A constant watch was kept up at this observatory from 10 P.M. until daybreak of the 13th, 14th, and 15th, and the results show that the Leonids were considerably in excess of what they had been during the last few years.

The total number of meteors observed was 309, and out of these 104 radiated from the Lions, and 56 clearly indicated five principal radiant points. Four of the radiants were situated near the stars ϵ, γ, δ, and η Leonis, and the fifth was just below (31) Leonis Minoris. The position of this east point was very clearly marked by a stationary meteor of the 1st magnitude. Eighty-six of the meteors were of the 1st or 2nd magnitude, and nine others were brighter than 1st magnitude stars. The largest number of Leonids seen during a single hour was fifteen, from 4 to 5 A.M., on the 14th. S. J. PERRY

Stonyhurst Observatory, November 18

The Platysomid Fishes

I AM very sorry to find that my esteemed friend Prof. H. Alleyne Nicholson has, in the new edition of his "Manual of Palæontology" (vol. ii. p. 138, *note*) committed the mistake of quoting me as his authority for elevating the Platysomid fishes to the "rank of a distinct division of Ganoids." No such proposition occurs in the unpublished paper to which he refers, which was written to follow up the views which I expressed in my account of the structure of the Palæoniscidæ (Palæontographical Society, 1877), as to the abolition of the sub order "Lepidopleuridæ," necessitated by the demonstration of the fact that the Platysomidæ as a *family* are not really allied to the Pycnodontidæ, but are on the other hand so closely linked by ties of structure to the Palæoniscidæ, that, wherever the latter family is placed, thither the Platysomidæ must follow.

My paper on the "Structure and Affinities of the Platysomidæ" was read before the Royal Society of Edinburgh on May 5 of this year, and will in a few weeks appear in the forthcoming fasciculus of that Society's *Transactions*. Prof. Nicholson's mistake as to my views is obviously due to his having only had, and that on one single occasion, a very hurried glance over my proof-sheets. R. H. TRAQUAIR

8, Dean Park Crescent, Edinburgh, November 12

Voice in Fish

THE question as to whether fish have any so-called voice or means of intercommunication having some interest for your readers, I may relate that about six years ago, while engaged in a survey of the Disang River in Eastern Asam, I had occasion to sound by a line the depth of a pool called the "Deo Dubé" (or deep of the Demon).

While seated in a small *Rob Roy* canoe and very slowly drifting on the pool, I became aware of a number of large Mahsír (*Barbes macrocephalus*) moving about in the water below and around me. Sitting perfectly still I had the pleasure to see them gradually approach the surface and move about me at a foot or so distant, passing alongside, under and round the canoe carefully examining it, bow and stern specially. It may not be easy to guess a fish's *thoughts*, but from the manner in which they examined my symmetrical and grey coloured canoe they appeared to think it might possibly be a huge fish, and dead of course.

While watching their movements I was aware of a peculiar "cluck," or percussive sound—frequently repeated, on all sides, and coming from below, but close to me. Eventually I found that this was made by the Mahsír, and one—passing close along on my right, by itself, made several *distinct* sounds as it went on—that seemed answered by others to the left. If seated, say on the bank, the sound would be loud enough to be heard at 40 feet distance.

A large bivalve also is common in some parts of Eastern Asam that sings loudly in concert. A small *ant* also makes a peculiar thrice-repeated noise by scraping in unison on the dry leaves of its nest if it is disturbed. S. E. PEAL

Silurian Fossils in the "Lower Old Red Sandstone" of the Curlew Mountain District

YOUR correspondent in NATURE, vol. xxi. p. 32, on the above subject has evidently misunderstood the notice (NATURE, vol. xx. p. 641). The rocks in question, though belonging to what is generally known as the "Old Red Sandstone," contain Silurian fossils, which confirms the opinion of myself and others that the lower Old Red should be regarded as the upper part of the Silurian formation. G. HENRY KINAHAN,

President of the Royal Geological Society of Ireland

Dublin, November 17

The Paces of the Horse

A GOOD many ingenious contrivances have lately been invented by which to find out the true movements of the feet of the horse in its various paces, notably that described in "A Study on Locomotion" which appeared in NATURE, vol. xx. pp. 434, 468, 488.

My object in writing this letter is to challenge the assumption of all these experimenters that their diagrams should constrain artists to correct their representations of animals in motion.

When, for instance, Prof. Marey says of his diagrams, "these pictures are correct as regards the position of the members; it would be the artist's duty to add elegance of form," it is apparent to me that such a division of labour would never produce a picture. Take Fig. 16, for instance, representing the true position of the legs in galloping, and I venture to say no amount of elegance added would convey an idea of what the animal was doing.

I submit that the error which leads the experimenters so far is forgetting that the mechanism of the human eye has as much to do with the matter as the movements of the horse's feet.

Confining my argument to the gallop, I contend that the conventional extended attitude is true artistically, though it never actually takes place whilst the horse is at this pace. The eye (as is sufficiently proved by the need of machinery for finding out the actual motions of horses' feet) does not obliterate and receive impressions sufficiently quickly to trace the three paces in the gallop; but it can note the fact that at some moment during each bound, each of the four reach this extreme point. Now the feet are twice as long at this point as at any other, that is to say, the passing out over and returning along the last inch is for the eye a pause at the extreme. It is no more doubtful that a galloping horse should be painted as it usually is, than that a swinging pendulum can only be suggested by drawing it at one or other extreme of its excursion. An artist could no more use Prof. Marey's diagrams in the way it is assumed he should, than he could represent a rolling wheel if he took no liberties with the apparent position of the spokes; but confined himself by remembering their true places and numbers, which of course are the same as when the wheel is at rest.

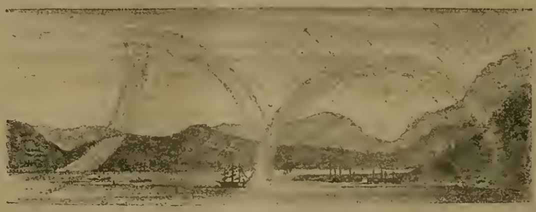
It is true that a galloping horse might also be represented with all its legs gathered under it, but this is not done, because, as I agree with Prof. Marey, "it is the artist's duty to add elegance of form;" whilst I dissent from him when he allows himself to be convinced that "the greater part of the horses [of Phidias] are represented in false attitudes" because the odograph says so.

W. G. Simpson

Edinburgh, November 12

A Curious Rainbow

I send you a rough sketch of a curious rainbow group seen in Gareloch about 8.25 A.M. on October 20. I would have written sooner but I delayed till I had obtained sketches from several different sources. I only saw the junction of the two bows at C, that being the only part of Row Bay visible from my standpoint, but several observers saw the whole group as I have drawn it. The sea was quite glassy, so that the inverted rainbow A must have been formed by the sun's rays reflected from the water. The wind was just beginning to rise and some scudding showers were passing up from the Firth of Clyde from the south-west,



Road to Kilcreggan. Roseneath. Row Point. Pier. Row.
A B C D

but the bay was quite calm. The bow D was perfectly full and bright, while B died away at its highest point. I can only imagine that B was formed by light reflected by some bright cloud, but I did not observe any bright enough. The view is nearly north-west. As I have never even among our Scottish hills seen such a combination of rainbows, I think the description may have some interest for some of your readers. The hill to the right is Knapps Hill, and is 2,000 feet high and three and a half or four miles distant.

J. B. Hannay

Woodbourne House, Helensburgh, November 4

How Snakes shed the Skin

In Nature, vol. xx. p. 530, Dr. H. F. Hutchinson, amid some interesting facts about snakes, says: "I have never witnessed the process of skin-shedding, nor, I believe, has any observer." The Doctor then ventures an ingenious, though incorrect, hypothesis of his own. In the *American Naturalist* for January, 1875, *i.e.*, vol. ix. No. 1, under the title, "The Pine Snake of New Jersey," I gave an article embodying the results of several years' study of *Pituophis melanoleucus*, in which the process of exuviation is described as witnessed by myself. Herewith is an abstract. The few words interpolated for the sake of clearer exposition are put in brackets.

Near the close of September, 1873, at 1 P.M., looking into the box, I saw that the female snake had started the skin from her head. It was a little torn at the snout, and I found that the head and a little of the neck were denuded. The denuding process was going on, but very slowly. Doubtless the chief difficulty was in starting the skin, and I felt sorry that I did not see the start. The neck was very slowly becoming divested of the old cuticle, which, at first glance, had a sort of back-creeping aspect. What surprised me was the fact that there was not the least friction in the process; that is, there was no rubbing against any exterior object. It really did look as if an invisible power was drawing the skin back upon itself. [Looking closely, I caught the secret. There was a systematic alternate swelling of the body at the neck of the skin, thus stretching it, and making a shoulder in front of the neck, each swelling pushing the loosened skin a little backward.] The old skin at this time is very moist and soft, and any swelling of the body stretches and loosens it. So soon as the exuviation has reached the part of the body containing the larger ribs, this doffing of the old suit proceeds more rapidly, and with a singular system. It is done just in this way: Exactly at the place where the skin seems to be moving backward, a pair of ribs expands. This action enlarges or puffs out the body, and by stretching loosens the skin at that place. In this movement both ribs in the pair act at the same time, just as the two blades of the scissors open together. Now comes a second movement of this pair of ribs, in which action the two ribs alternate with each other. One of them—say the one on the right side—is pushed forward and made to slip out of and in front of the constriction made by the swelling, when it immediately works backward, that is, against the neck of the double receding skin. Now the left rib makes a like advance, and in a similar manner presses backward. [Thus for every increment of exuviation, or backward movement of the inverting skin, three actions occur with rhythmic method; the expanding of one pair of ribs, the intumescence of the body at that spot, and the pushing back of the skin by the alternate action of each rib.] Thus the final action of each pair of ribs is not synchronous, but alternate, and has a notable sameness of movement and result with that of the alternate hitching of each side of the mouth when swallowing a large prey. Indeed, swallowing, with a serpent, is a misnomer, for that laborious hitching is not more a pushing of the prey down the gullet than a drawing of the body over it. The Western man said he always felt better after getting himself round a good beef-steak. With the serpent this is a literal fact; it puts itself outside of its victim. So with that singular costal action it seems to push the skin backward; but this is an illusion, for it actually pushes itself forward, pulling the skin out as itself advances out of the skin, thus with each movement or advance lengthening the inverted cuticle behind; that is, the old hose everts or evolves itself forward, though it appears as if by some occult force to be pulled on itself backward.

The ribs of a serpent, which extend nearly throughout its whole length, are very much smaller near the neck and near the tail. At both these parts exuviation is much slower than where the larger ribs have play in the process. This rib action produced an automatic movement of the snake on the floor of its box, and across the folds of its companion, which kept as still as if it were dead. This involuntary movement of the reptile's body was almost imperceptible. All told, it might have been through two feet of linear space. But the exuviated skin was nearly six feet long. This movement seemed much greater than it really was. It was emerging from a tubular case, which was doubling upon itself for a while, the inner or unevolved part shortening as it moved forward with the body; the outer, or evolved part lengthening as it moved backward from the body. The cast-off skin is presented inside out, so that every scale is now seen on its under or concave side, and this is also true of the eye-scales. To all this there is one exception: the last scale of the tail is a hollow pyramidal or four-sided spike. This, for plain reasons, is not everted. When the shedding has reached this scale a sharp shake of the extremity is sufficient, and the unverted spike is left inside of its everted skin. The entire process of exuviation, allowing five minutes for the part that I did not witness, took thirty-five minutes.

Let me add that in poor health a snake has a hard time in getting off its old coat. I could detail an instance wherein the process took three months. The old skin adhered stubbornly to the new one, and was only removed by friction and by tearing off mere bits at a time.

SAMUEL LOCKWOOD

Freehold, New Jersey, U.S.

The "Hexameter," Πᾶσα δόσις ἀγαθὴ . . .

THERE is an obstacle in the way of regarding this passage (James i. 17) as a hexameter quoted by the Apostle from some poet, as the late lamented Prof. Clerk Maxwell is reported in Mr. Garnett's interesting notice of his life, work, and, not least, his character, to have suggested. The final syllable of δόσις is short, as the accentuation of πρᾶξις and similar verbal nouns proves. *Arsis*, as in "Βέλος ἐχεπευκές," Il. α, 51, can hardly be pleaded.

J. J. WALKER

University Hall, W.C., November 17

THE SWEDISH NORTH-EAST PASSAGE EXPEDITION[1]

DURING the wintering of the *Vega* large quantities of the bones of the whale were found on the beach. These at first were supposed to be the remains of whales that had been killed by the natives or by American whalers. On examination it was found that they must be sub-fossil. This was confirmed by the natives, who stated that no whale had driven on land in the memory of man. The remains were found to belong to four or five different species, of which *Balena mysticetus*, or a nearly allied type, was the most common.

Prof. Nordenskjöld investigated the formation of the strata of frozen earth several hundred feet thick which occur in Siberia as in Polar America. Along the coast of Siberia there is a stratum of water resting on the bottom of the sea which is several degrees below the freezing-point, so that a flask of the comparatively fresh surface water, when sunk into this stratum, begins to freeze. Stuxberg observed that the trawl-net often froze fast to the bottom. This was accounted for by the freezing of the fresh water which the net carried down with it from the surface. Nordenskjöld thinks that the mud carried down by the rivers into the sea as it sinks to the bottom carries with it fresh water adhering to the minute particles, and that this fresh water, like that carried down by the net, freezes at the bottom, forming thus a frozen stratum, which increases year by year until it reaches an enormous thickness. He is of opinion that a portion of the earthy layers of Siberia was formed in this way, although, he adds, he by no means considers this the only way in which such formations arose.

Along the whole coast, from the White Sea to Behring's Straits, no glacier was seen. During autumn the Siberian coast is nearly free of ice and snow. There are no mountains covered all the year round with snow, although some of them rise to a height of more than 2,000 feet. With one exception there were no rocks along the coast precipitous enough to be suitable breeding-places for sea-fowl, but a large number of these birds were seen during spring flying farther to the north.

During the voyage of the *Vega* from her winter quarters through Behring's Straits and farther south, Nordenskjöld searched for a tribe called Onkilon, said to be allied to the Eskimo, but without success. He found only reindeer-owning Tchuktches, and supposes that the name Onkilon, given by Wrangel to the old tribe inhabiting the coast and driven out by the Tchuktches, is probably related to the name Ankali, given by the reindeer-owning Tchuktches to the coast Tchuktches. Nordenskjöld states that English authors who refer Eskimo and Tchuktches to the same origin are mistaken. It was found that the inhabitants on the American side are pure Eskimo, with whom it was possible to carry on barter by means of the list of Eskimo words published in "Arctic Geography and Ethnology," London, 1875; but that the language spoken by the Tchuktches, of which Lieut. Nordquist collected about 1,000 words, is quite different, and probably allied to that of the Iranian races. On the other hand there is a complete correspondence between the household furniture of the Tchuktches and the Eskimo. It may be safely affirmed, he says, that these two neighbouring races have a greater number of identical articles in their tents than of common words in their languages.

The hills at Cape York on the American side were found to consist of crystalline schists without organic remains. Among the natives, who were Eskimo, there was a Tchuktch woman who said that Tchuktch tribes were settled on the American side between Point Barrow and Cape Prince of Wales. The Eskimo used, along with breechloaders, revolvers, and axes obtained from the Americans, bows and arrows, bone boat-hooks, and various stone implements. They were friendly and agreeable, and less given to brandy than the Tchuktches. There did not appear to be any chief among them. Complete equality prevailed, and the standing of the women did not appear to be inferior to that of the other sex. Among the stone implements were found arrow-heads and other articles of a species of nephrite so closely resembling the well-known nephrite from High Asia, that these implements were supposed to have actually come from that region.

A warm current, as in Europe, was found to flow along the north-western coast, and to create there a far milder climate than that which prevails on the Asiatic side. The limit of trees therefore lies a good way to the north of Behring's Straits, while the whole of the Tchuktch Peninsula appears to be devoid of trees. This is the case also with the land along the coast at Port Clarence, but a short distance inland there were bushes two feet high. Vegetation was generally luxuriant, and a great number of species were identical with, or nearly allied to, those of the Scandinavian north, among others the *Linnea*. Notwithstanding the luxuriance of the vegetation, the land invertebrates were much poorer in species than in the north of Norway. Thus only from ten to twenty kinds of beetles could be found, principally *Harpali* and *Staphylini*, and of land and fresh-water mollusca only seven or eight species. The avifauna was also rather scanty, and the dredgings in the harbour at Port Clarence, on account of the unfavourable nature of the bottom, yielded only a small number of animal and vegetable species.

The *Vega*, crossing to the Asiatic side, anchored in Konyam Bay on July 28. On the north shore of this Bay Dr. Kjellman added seventy species of flowering plants to the collection he had previously made. Here, too, were

[1] Continued from p. 40.

found the first land mollusca on the Tchuktch Peninsula. Nordenskjöld considers it probable that on the southern part of this peninsula there was in former times a little inland ice. On July 31 the *Vega* was anchored at St. Lawrence Island. Drift ice was seen for the last time. The quantity of ice carried by the Polar current through Behring's Straits is very inconsiderable, and it has evidently been for the most part formed along the coast. Not a single iceberg was visible, the whole of the ice seen being level and rotten "year's ice." St. Lawrence Island is inhabited by Eskimo, who having frequent intercourse with the Tchuktches, have adopted some of their words. The prevailing rock is granite, weathering readily, and thus giving origin to a very fruitful soil. Vegetation was exceedingly luxuriant, and rich collections of land and marine animals, lichens, and algæ were made.

The *Vega* next anchored off Behring Island on August 14. This island belongs to Russia, but the American Alaska Company has acquired the right of hunting, and maintains a station where skins, principally those of the *Otaria ursina*, are purchased. Between 50,000 and 100,000 of these animals are killed yearly on this and the neighbouring Copper Island. They yield the brown "sealskin" so much in fashion in recent years. Behring's Island is supposed to have been visited first by Behring, who, after being shipwrecked, died there in 1741, survived, however, by many of his companions, among others, by the talented naturalist Steller, who described the natural history of the island in a masterpiece that has seldom been surpassed. Since Steller's time great changes have taken place. The *Canis lagopus* then occurred in incredible numbers. Now they are so uncommon that not one was seen, and those that remain are not dark blue, but white, the skins being of little value. On the neighbouring Copper Island dark blue foxes are still found in considerable abundance. In 1741-42 Stellar and his companions killed here about 700 sea-otters. This animal, famous for its precious fur, is now quite extinct on Behring's Island. Of the sea-lion (*Otaria stelleri*), formerly abundant, only single specimens are to be found along with the sea-bear (*Otaria ursina*) on the rocky shores of the island, and the great sea-cow, the most remarkable of all the mammals formerly belonging to Behring's Island, is now completely extinct. Steller's sea-cow (*Rhytina stelleri*) was of a brownish colour, covered with hair which grew on a hide resembling the bark on an old oak. Its length, according to Steller, was sometimes as much as thirty-five feet and its weight nearly 50,000 lb. The female yielded abundance of milk, which, along with the flesh, resembled, and were even, according to Stellar, superior to those of the cow. The sea-cow fed on the abundant algæ along the coast in great herds. According to Middendorf, the last sea-cow was killed in 1768. Nordenskjöld, however, found a "creole" of mixed Russian and Aleutian blood, whose father had come to the island in 1777, and remembered the killing of sea-cows while they fed on seaweed at low water for the first two or three years (1779 or 1780) after his arrival. Nordenskjöld also found two men who had seen, about twenty-five years ago, a large animal corresponding to Steller's sea-cow. He also obtained two complete skulls of the animal and a quantity of bones sufficient to fill twenty-one large boxes and barrels. The sea-bear (*Otaria ursina*) is the only large animal that exists on the island in about as large numbers as in Steller's time. It is "preserved" by the Alaska Company, only a limited number being killed yearly.

The vegetation on Behring's Island was found to be exceedingly luxuriant, and the sea in its neighbourhood one of the richest in algæ in the world. Forests of algæ, sixty to a hundred feet high, grew in favourable situations, rendering dredging exceedingly difficult. Some of the algæ are used by the natives as food.

The small streams swarmed with a number of different kinds of fish, among them a species of *Coregonus*, a little *Salmo fario*, a middle-sized salmon with nearly white flesh and a purple skin, and another of the same length, but very thick, and with a hump on its back. Other species of salmon with deep red flesh are found in the larger rivers. Leaving Behring's Island on August 19, the *Vega* reached Yokohama on September 2 in good order and with every man on board in excellent health. There had not been a trace of scurvy during the whole voyage.

GALILEO AND THE APPLICATION OF MATHEMATICS TO PHYSICS[1]

II.

In dealing with the falling body I had to ask you to think what is the speed at any moment of a body which is changing its speed every moment, every half moment, every hundredth part of a moment or what we call continuously. It is easy to see that it has *some* speed at every point, and that the speed at every point is quite definite. I indicated a way in which we could fix this approximately, by taking the average speed over short intervals. A similar question is raised in considering the path of the projectile. Its direction changes from point to point. The bullet is shot towards the east, and, for the sake of picturing its path, I imagine the lines vertically upward to be called northwards, as on a vertical map. At first the particle starts off, let me say, in a direction N.N.E. When it has reached the top of its path it is going horizontally—due east—when it has got back to the level the Northing has been turned into Southing, and it is going S.S.E. In its upward motion it changes continuously from N.N.E. to E. At a certain position it is half a point more to the east and less to the north; further on, a point more; further on again, the Northing has disappeared. The path has curved away; it is curving away at every point of it. A particle moving at a uniform rate in a circle changes its direction; but at every point the amount of curvature or immediate bending away from the direction in which the particle moves at any moment is the same. In a small circle the curve bends away faster than in a larger one from the line which represents the direction of motion at any point, but in each separate circle the measure of bending must at every point be the same. How will it be in a different kind of curve, such as an ellipse, or the path of a projectile, a parabola? As the speed of falling changes from moment to moment continuously, the curvature changes from moment to moment.

In solving the problems of falling bodies and of projectiles, Galileo was essentially applying the principles of the Differential or Fluxional or Indivisible Calculus. If pure mathematics had attracted him as strongly as its application to physics, he would have thought these problems out, and would have founded the Fluxional Calculus, which is the glory of Newton and of Leibnitz. No doubt the world saw more in his great astronomical discoveries; in the telescope, which brought the moon thirty times nearer, and showed its mountains and the jagged edges of its gibbous side; in the discovery that Venus waxes and wanes with phases like the moon; in the four satellites of Jupiter, the famous Medicean stars, which showed the most restless activity of revolution round their central orb—an activity unprecedented in celestial bodies and discomposing to the Peripatetics, whose stately order of the heavens could not tolerate stars which behaved like sky rockets—of the curious double satellite of Saturn, which sometimes was even more bewildering, and went out altogether. It was the Ring, and Galileo gave what we now recognize as a very fair picture of it. No wonder that the man who first made the

[1] An Introductory Lecture, by William Jack, M.A., LL.D., F.R.S.E., Professor of Mathematics in the University of Glasgow, formerly Fellow of St. Peter's College, Cambridge. Continued from p. 43.

telescope a practical instrument could not lay it aside till he had exhausted what it had to tell him, or that his whole thoughts were turned from the mathematical and apparently abstract entities which we have been describing to discuss the system of the universe in the new light he had brought to bear on it. Yet the choice he made has proved to be wrong. It was through the door of mathematics—not through the tube of the telescope—that the discoveries of the true system of the universe were destined to pass. Galileo's facts made it practically certain that the Copernican theory was right, and that the sun was the centre of the orbit of each of the planets. Kepler enlarged these statements, establishing, by a patient industry that was never surpassed, that the orbits are ellipses nearly circles, with the sun in one focus—that the line drawn from sun to planet sweeps over equal areas in equal times—that the square of the time taken to describe a planet's orbit, divided by the cube of its mean distance from the sun, is a fraction which is the same for every planet of the system. Till Newton appeared to interpret them, these results were only statistical facts; and Newton himself could throw no light on them till he had invented the Fluxional Calculus and discovered the properties of an abstract fluent quantity, such as a speed or a curvature, which is continuously changing.

And yet how near Galileo came to the secret! We have seen that he was in fact compelled to deal with the fundamental problems of the Fluxional Calculus in discussing falling bodies and projectiles. It was his famous scholar Cavalleri whose Calculus of Indivisibles foreshadowed the Fluxional Calculus of Newton. It is difficult to say how much of Cavalleri's views were developed out of the note-books of his master's lectures and out of his own consideration of the problems that master had triumphantly solved. Like many of Galileo's pupils, he had published works of his own, in which it was doubtless difficult to separate what was original from what was borrowed. From about 1592 till about 1638—forty-six years—Galileo had published scarcely anything except on the planetary system. The inclined planes, the falling bodies, the pendulums, the cycloids, were so many problems worked out in his youth—during the early years of his professoriates at Pisa and Padua—scattered in students' note-books, and germinating in students' minds throughout the world. It was so with his theory of projectiles; and Cavalleri, who was one of his old students and his successor at the University of Padua, published the theory of projectiles without referring it to its real author. Challenged by Galileo, he allowed his obligations frankly, and their friendship was not interrupted. Cavalleri published his theory of indivisibles in Galileo's old age (1635), calling it "Geometria indivisibilibus continuorum nova quadam ratione promota," after he had apologised for his former awkward error. The shape of the new theory was Cavalleri's own—the impulse came almost certainly from the discoverer of the true theory of falling bodies and of projectiles.

We owe the theory of indivisibles to Cavalleri, and not to Galileo, partly, no doubt, because for the greater portion of his manhood his astronomical discoveries, and the discussions they brought with them, filled Galileo's mind almost exclusively; partly because for the last five-and-twenty years of his life most of his thought had to be spent on his relations with the Church, to which he was sincerely attached. In 1616 he was warned that the Copernican hypothesis was to be considered as false. Religious persecutions were not then unknown in Protestant countries, and people were tortured for witchcraft as well as heresy. But it was reserved to the Catholic Church in Italy to erect the Aristotelian doctrines and the Ptolemaic system into an article of faith. A century after Luther shook the world at Wittenberg, had brought dreadful days for mathematicians, physicists, and reformers, in Italy. When Galileo was a youth of twenty-three, two years before he was called to be professor at Pisa, Barozzi, who had occupied himself at Venice with the discussion of the asymptotes of curves, was believed to be guilty of dealing in sorcery and witchcraft, of casting lots, and of causing the drought which reigned in the Island of Cyprus. He was condemned by the Inquisition in 1587, partly because he had a great number of curious books and a wonderful collection of astronomical and mathematical instruments. Porta, the famous author of the "Magia Naturalis"—the reputed discoverer of the *camera obscura*,—was summoned to Rome to give an account of his opinions. Giordano Bruno was burned at Venice in 1600, hardly less for his daring speculations in religion than because he had attacked Aristotle and adopted the system of Copernicus. The aged Archbishop of Spalatro, de Dominis, to whom Newton attributes the successful explanation of the colours of the rainbow, died in 1624 in the prisons of the Inquisition, and all that death had left to the mercies of his persecutors was publicly committed to the flames. The skies of Italy were black with the smoke of these burnings, the air was heavy with suspicion and terror. The Inquisition tried men for heresies which had been denounced by unknown enemies, and the processes of moral and intellectual torture to which it subjected those who were brought before its tribunals were only more oppressive because the secret of their details was closely kept. Galileo wrote a letter to his friend and pupil the Jesuit Castelli, in 1614, copies of which were privately circulated, but which was not printed till twenty years later. In that noble writing he lays down with equal firmness and clearness the broad lines with separate scientific and religious thought, and shows himself deeply penetrated with religious as with scientific faith. A Jesuit father denounced it, another preached against him as a witness for the Copernican system. Though the great works he had hitherto published, that on the Solar Spots and the "Nuncius Sidereus" had neither of them committed their author to the Copernican theory of the universe, the Church resolved to anticipate and to forbid the support by the most illustrious of living astronomers of doctrines, which, whatever else might be said of them, were clearly fatal to the authority of the Peripatetics.

Galileo went to Rome (in 1616) to struggle for as much liberty as could be saved, but he was deeply disappointed with the result. He retracted nothing, because he had neither been tried nor convicted, but the officers of the Inquisition waited on him, and left him an official warning that it was not permitted to teach that the sun was the fixed centre of our system, and that the earth revolved around it. Silence was imposed on him; and it was only after the new Pope was appointed, who, as a Cardinal, had opposed the promulgation of this warning, that he ventured again to think of publishing his views. The book in which they appeared in 1632 was a three-cornered dialogue between a Ptolemaist and a Copernican, with a third person acting as a kind of half intelligent chorus. The arguments of the Ptolemaist were, of course, the weaker, as in Galileo's hands it was impossible that it should be otherwise. To secure the *imprimatur* of the censorship, he prefixed this statement to the book—"Within the last few years a salutary edict was promulgated at Rome, in which, in view of dangerous scandals, silence was enjoined on the supporters of the Pythagorean doctrine of the movement of the earth. Some have been rash enough to say that this dogma was not arrived at after a judicious examination, but was promulgated in passion and in ignorance, and it has been asserted that people utterly without practice in astronomical observations ought not to attempt, by a premature prohibition, to clip the wings of speculation. Hearing these complaints my heart burned within me, and I could not keep silence. Having been fully informed of this wise decision, I resolved to appear publicly before all the world, and to testify to the truth. I was at Rome at the time. I was listened to and praised by the most eminent prelates, and was at once acquainted with this decree. My purpose in this book is to show foreign nations that in Italy, and especially in Rome, as much is really known about these matters as anywhere else. I have gathered together my speculations on the Copernican system to show that all these things were known before the condemnation, and that we owe to Italy not merely doctrines for the salvation of their souls, but ingenious discoveries to delight the minds of men." The elaborate and somewhat overstrained courtesy of this preface availed as little to save its author from the terrors of the Inquisition as the imprimatur of the Papal censorship which he had procured beforehand. The Pope looked on the *soi-disante* hypothetical presentation of Copernicanism as a mere pretence. I need not repeat the well-known story of the great man's sufferings. After long months of mental torture, he was dragged before the sacred tribunal, and compelled to confess that he had been criminally negligent in stating too cogently the arguments for the Copernican system in the eagerness of intellectual debate, and in not sufficiently guarding the hasty reader against the force of arguments for what the Church had pronounced to be dangerous heresy. At the age of seventy the greatest discoverer—the most distinguished man in Europe—was threatened with torture to extract from him, if possible, the confession that he had had a malicious intention of unsettling men's faith in divine truth. It had been privately decided by the Pope that if the threat of torture failed, the Inquisition was not to proceed to the last extremity. Galileo knew nothing of this, but the threat did fail. For his rashness he was sent to the prisons of the Inquisition. He was released in a few days, but he was ordered to confine himself within four walls and his successive places of seclusion were marked out for him. His visitors were noted, and he was warned that an imprudent word might bring him back to the dungeons from which he was only respited on his good behaviour. Private orders were given to the censorship throughout Italy that he was not to be permitted to publish anything, not even to re-issue the treatises which first made him illustrious. It was a living death to which his judges had consigned him, and he was reduced to permit his friends to publish surreptitiously across the Alps the book which summed up the long work of his life in Mathematics, in Mechanics, in Hydrostatics, in Physics, so far as Physics were then possible. His greatest work, the "Discorsi e Dimostrazioni Matematiche," "on two new sciences," appeared in France, and, to save him from the risk of torture, the miserable pretence had to be put forward even there, that the manuscript had been taken away by one of his friends. In 1637, in his seventy-third year, he lost his eyesight; in 1641 he died.

The eight years during which the broken-hearted old man, from whose outward eyes the light of that universe, which he had done more than all his predecessors to reveal to men, was fast fading, were the most memorable in the history of modern science. Much of the work he published in them had previously been scattered over Europe by his pupils, but none of them all had his mighty sweep of thought, his noble style, his all-illuminating insight. Had his enemies succeeded in silencing him, had he been handed over to the rack at seventy, or prevented, as they meant he should be, from speaking once more *urbi et orbi*, for fear his words might shatter the system of Ptolemy or put an end to that worship of a traditional philosophy which he had conquered, and which was struggling to strangle him in its death throes, the world might have waited a century longer for Torricelli and Pascal, for Newton and Laplace. In these last years he is greater and maturer than ever. Banished from the skies by the jealousy of philosophers and priests, he comes back to earth and lays deep and sure those foundations of mechanics without which it was impossible to carry further the science of the heavens. His watchword was that phenomena must first be measured before the attempt to explain or to co-ordinate them. Physics and Astronomy can rest only on mathematics, and the secrets of that hand which laid the foundations of the world in measure are only to be learned by patient and exhaustive observation, and by thought built upon and not preceding it.

Let me give you one last illustration of his method in his invention of a heat measurer. Every one seems to know what is heat and what is cold. They are among the most familiar of our sensations. But my sensations may differ from yours. I may pronounce a body hot which you may call cold; and before Galileo's time there was no apparent way of settling the dispute except by declaring it a matter of taste, and agreeing to differ. He invented a measuring instrument—the progenitor of our thermometers. Imagine a flask with a bulb blown out at the end of it, and a long tube of uniform bore for a neck, such as we see in a thermometer. Let the bulb be partly filled with coloured water. Put the finger at the end to keep the water in; turn the tube upside down so that the bulb is at the top and the tube vertical. Plunge the end of the tube in a vessel of water, and then remove the finger. All the coloured water will not flow down into the vessel. If the bulb is surrounded by something warmer than itself, the level will fall till it nearly reaches the water in the basin; if it is surrounded by something colder, the level will rise. Galileo had found a phenomenon accompanying an increase or diminution of heat as unvaryingly as a shadow follows its substance. Like the shadow, this new phenomenon is measureable, and though it was too soon to say that the rise or fall in the tube was in any exact proportion to the diminution or increase of the surrounding heat, it was easy to establish the fact that a rise always meant a diminution and a fall an increase. It was not given to Galileo to discover those properties of air and gases which turn the thermoscope into the air thermometer, the most sensitive and accurate of heat measurers. Had he known them, he was far enough in the way which his pupil Torricelli followed to have discovered the barometer also, and to have measured the weight of a column of that great atmospheric ocean at the bottom of which man lives as the Bathybius is supposed to live at the bottom of the watery deeps. Even there his sagacity had divined the necessity of applying measurement to that horror of a vacuum which before his time had only been a philosopher's name for our ignorance of a cause.

I have certainly failed in my object to-day if I have not conveyed to you two truths which lie at the basis of modern science. It is the *first*, perhaps, with which I have most to do as a teacher, and you as students of pure mathematics. The sciences of measurement, the methods of measurement—sciences and methods which are abstract in form, but which are constantly applied to concrete things,—are the true keys to the sciences of experiment. It was in the apparently intricate abstractions of continuous change of velocity and of curvature, in the apparently curious considerations of the science of indivisibles, the beginnings of which we owe to Galileo, that Newton found that secret of the universe which transformed the life-long labours of Kepler, the great statist of astronomy, into the law of gravitation. The fascinations of astronomy, and the fatal chains which hung about his later life, like those which Samson had to bear when he made mirth for the Philistines, combined to deprive Galileo of the honours which awaited Newton. But that lesson need not be lost to us. My *second* lesson is that measurement—measurement even in its simplest form, mathematics, or, if you choose, arithmetic,—lies at the root of all our knowledge of nature.

If I have one word more to say about the great Florentine to my students, it will not be of the pity of it all, of the terror and the tragedy in which his life closed;

it will be to ask them to remember that he proved, what the greatest men have always proved, that it is possible to conciliate the most magnificent knowledge of mathematics or of any abstract science with all the culture of the time. Galileo was an admirable writer; he was a great musician; he studied Ariosto and Dante with intense love; he amused himself with comedy; he distinguished himself in painting. It is the commonplace of the history of great men—a commonplace better illustrated perhaps by the great names of Italy than by those of any other country—that greatness is scarcely compatible with a narrow concentration of intellect, even to one great family of subjects. Many of her great mathematicians were sculptors, painters, poets, masters of expression. But if the story of Galileo's life should guard you from falling into the Scylla of the eager student who thinks that he must dwarf his nature if he hopes to attain to eminence in a special subject—an error to which the pressure of our times renders him more and more liable—it is equally certain to save him from the Charybdis of the *dilettante* who forgets to choose that one of the objects attainable within the little compass of a man's life which is most suited to his faculties, and in attaining which he is most likely to succeed. Galileo repressed none of his great powers, and denied himself none of the intellectual delights which few men of his day were so able to enjoy. But the obstinacy with which he followed after mathematical and physical truth, from the day when he first listened, as a truant medical student, at the key-hole of a lecture-room to the professor of mathematics teaching the Grand Duke's pages, to that, nearly sixty years after, when the worn-out shell which had suffered so much was laid in that last darkness of the grave, warns us that greatness is never, and, I may add, success is seldom, won without an unfaltering perseverance in the pursuit of the main object of life. The last wish of the venerable old man, whose heart suffered as much from the cruelty which had cut him off, in a sense, from the outward communion of the faithful, as his intellect did when he was compelled, on his knees, to deny what he had proved to be the true system of the universe, was refused him. The Church below refused him burial in the Santa Croce at Florence, but it could not prevent the eyes that old age and suffering had blinded to the delights of his Italian earth from opening on the splendours of an immortality which no man has better earned.

WHO WAS PRINCE ALUMAYÛ?

SOME of our contemporaries, referring to the recent death of King Theodore's son, Prince Alumayû, speak of him as if he were an African of the ordinary Negro type. This is perhaps on the whole a fair gauge of the popular ideas still prevalent regarding the natives of the Dark Continent. Yet, though the standard is not of a high order, it must be confessed that in the present case some little confusion might well be pardoned, considering the many difficulties attaching to the subject of Abyssinian ethnology. Indeed it would be no easy matter even for a sound ethnologist to answer the question off-hand, who was Prince Alumayû? To do so accurately implies a clear knowledge of a very complicated problem, to the elucidation of which a few lines may be welcomed by the readers of NATURE, in connection with an event of some political importance and presenting a very striking parallel in more than one respect to the death of the late Prince Louis Napoleon in Zululand.

It may at once be stated that, whatever else he may have been, the young "Ethiopian," as he has been called, was in no sense an African Negro, and that matters will be much simplified if the "Negro question" be dismissed altogether from the present discussion. There no doubt is some true Negro blood in the lowlands, especially towards the south-west frontier bordering on Senaar; but in the Abyssinian highlands proper the Negro element seems never at any time to have been present, and at any rate King Theodore of Amhara was no more of Negro stock than are the Rajputs of Northern India. The types have nothing in common except the outward element of colour, though even here great differences prevail, and many of the Abyssinians, especially the women, are very fair. In all other respects—physique, language, mental qualities—the divergence is fundamental.

This statement applies not only to the ruling peoples of Tigré, Amhara, and Shoa—the "Habesh" proper—who are intruders, but also to the true aborigines whether settled or nomad, and who may, for convenience, be here collectively grouped as Agaü, the 'Αγαῦ of Cosmas (about 520 A.D.). The Habesh belong to the Himyaritic branch of the great Semitic family, and must have found their way into the country from the south-western parts of Arabia many hundred years before the Christian era. The Agaü are a section of the Hamitic family intermediate between the Gallas and Somâli of the south, and the Bisharas or Bejas and Egyptians further north. But Semite and Hamite, both originally no doubt one, are themselves mere varieties of the great "Caucasian" type, of which the Aryans are a collateral branch. It follows therefore that Abyssinia is peopled exclusively by races fundamentally distinct from the African Negro, and remotely allied to the fair European stock. Hence Prince Alumayû's affinities are, not with the black inhabitants of the Dark Continent, but with the light, swarthy, and dark peoples of Europe, South-Western Asia, and Northern India.

It will now be more easy to determine his position in the Abyssinian family itself. Although in this area the fundamental elements, as shown, are two only, Hamite and Semite, the intermingling of these elements, continued during a period of probably not less than four thousand years, and taking place under ever-varying conditions, has resulted in no little confusion, and the perplexity has in this case been further intensified by the elements of speech and religion. Thus, the Amharic people, for instance, are usually classed as "Habesh" proper, because of their language; for Amharna, notwithstanding many serious differences, is no doubt fundamentally related to the Tigrâi, the purest representative of the old Ghêz (Himyaritic), extinct since the fourteenth century. But it might not be difficult to show that the bulk of the Amharic[1] nation are ethnically of Agaü stock, though now speaking a modified Ghêz dialect imposed upon them by the conquering Semites from the north. At the same time the dominant race in Amhara is no doubt still more akin to the Semites than to the subject race. Hence the late Prince Alumayû, belonging to the royal blood of Amhara, must, on the whole, be regarded as of Habesh (Himyaritic) stock as well as speech.

Religion has been mentioned as a source of confusion, and an obvious case in point are the mysterious Falashas, who, because professing the Jewish faith, are popularly supposed to be of Hebrew nationality. Fortunately, Mr. Edward Hine has not yet got hold of them, and they have consequently not yet been identified with any of the lost tribes. Nevertheless, their position is sufficiently curious and interesting, though it may now be stated with some confidence that they are neither Jews, Israelites, nor Semites. In speech and physique they are a distinct branch of the Agaü (Hamitic) family, and can no more be converted into descendants of Abraham by the practice of maimed Abrahamitic rites than the adoption of Islám can transform the Chinese Panthays into Koreish Bedouins.

The subjoined scheme of the various races now in possession of the Habesh highlands may help to clear up

[1] The very word *Amhara* has been identified with the *Hamra*, the chief Agaü nation in the Takazzé valley and province of Lasta, Tigré.

the obscurity attaching to the subject of Abyssinian ethnology:—

Table of Abyssinian Races

Hamites. (Agaü Stock.)	*Mixed.*	*Semites.* (Himyaritic Stock.)
Aghagha, prov. Aghaumêder.	(Hamites & Semites.)	Tigré, N. and E. of River Takazzé.
Hamra, prov. Lasta, S. Tigré.	Bogos, extreme N.E.	Samhar, on coast near Massowah.
Falasha, mainly in Semyen.	Gongas, about Gojam.	Shoho, S.W. of Massowah.
Kwara, W. and N. of Aghaumêder.	Gurâgwe, extreme S.	Menza, N. of Hamasen.
Khamant, chiefly in Dembea.	Kunama, N.W. towards Taka.	Habab, Bediuh, Takwé, Marea, Barea, } N. & N.E. frontiers Tigré.
Fighen, S.W. from Lake Tsana.	Shoa, S.E. corner.	
Zalan, chiefly in N. Amhara.	Amhara, between the Takazzé and Abai.	
Witos, about Lake Tsana (?).	King Theodore.	
	Prince Alumayû.	

Of the languages three only are of any literary or political interest: *Ghêz*, still surviving as the language of the liturgy and Sacred writings, though scarcely understood even by the clergy; *Tigrâi*, its purest modern representative, current throughout the kingdom of Tigré and generally north and east of the Takazzé; *Amharna*, spoken with considerable dialectic variety in Amhara and Shoa. All are written in a peculiar syllabic character showing certain affinities to the Himyaritic rock inscriptions of Marah and other parts of South Arabia. Amharic employs seven additional letters for sounds not occurring in Ghêz or Tigrâi, making with the vocal modifications a total of 249 distinct symbols. This was the language of Prince Alumayû.

A. H. KEANE

COLOUR-VISION AND COLOUR-BLINDNESS

AS the notices of these subjects which have recently appeared in NATURE appear to me to do scant justice to the received theory, will you permit me to call attention to a portion of the evidence on which this theory rests?

The *Philosophical Transactions* for 1860 contain a paper by Prof. Clerk Maxwell, in which actual measurements are given of the quantitative relations between various colours, some of the observations having been taken by persons of normal vision, and others by a colour-blind person. The instrument of observation consisted of a species of spectroscope with three parallel slits, the widths of these slits, and also the distances between them being variable at pleasure. By this means three overlapping spectra are obtained, and any three spectral colours can be mixed in any proportions. The observations showed that any four colours as presented to the eye in a given spectrum are connected with each other by a definite colour-equation, such as—

$$3A + 4B = 2C + 6D,$$

which means that if the four colours A, B, C, D, as they exist in the given spectrum, are increased in intensity threefold, fourfold, twofold, and sixfold respectively, and then mixed two and two, the mixture $3A + 4B$ will present exactly the same appearance as the mixture $2C + 6D$. This is only another way of saying that colour as seen by normal vision contains three independent variables, or requires three numbers for its specification. Any three colours of the spectrum will serve as the three specifying elements; for example, if we employ A, B, and C to specify D, the specification will be—

$$D = \tfrac{1}{2}A + \tfrac{2}{3}B - \tfrac{1}{3}C.$$

Here we have one coefficient (that of C) with the negative sign. The three primary colours are defined to be those which will always have positive coefficients when they are employed as the specifying elements. In plainer words, all other colours can be exactly imitated by mixtures of the primaries, whereas, in the above example, the colour D cannot be imitated by a mixture of A, B, and C.

The points of the spectrum at which the three primary colours are found, will not necessarily be the points which most strongly excite the three elementary colour-sensations respectively. On the contrary, as a matter of fact, the two extreme sensations (called by Maxwell the *red* and the *blue*) are very feebly excited at the parts of the spectrum where they are purest, namely, at the extreme ends of the spectrum; and the middle sensation, which is largely adulterated with the other two even at the point where it is purest (namely, at a point in the olive green, which is, accordingly, one of the three primaries), has not a maximum of intensity at this point, but increases in intensity as the brightest part of the spectrum is approached, and attains its maximum (for the solar spectrum obtained with a flint glass prism), somewhere between the fixed lines E and D. The determination of the position of the middle primary in the spectrum, was made with considerable precision in the paper referred to; but the faintness of the two extremities of the spectrum rendered wide slits necessary in examining these regions, and thus introduced inaccuracy in determining the positions of the two extreme primaries, which in later publications Prof. Maxwell places at the very extremities of the spectrum.

The latter part of the paper of 1860 consists of a postscript containing observations made by a colour-blind person. The colour-equations found by direct observation are given, and are shown to agree with the supposition that the observer's vision was dichroic, the sensation corresponding to the extreme red being absent. The curves of intensity for each of the two elements in the vision of the dichroic observer are given, side by side with the three curves of intensity for the vision of a trichroic observer, all these being directly calculated from the observations, and the two dichroic curves appear to be practically identical with two of the three trichroic curves.

Dr. Pole's objection to the received theory appears to me to have no force except in so far as it is an objection to a name. The colour which the colour-blind see in the less refrangible half of the spectrum appears to be due to the excitement of the middle one of the three elementary sensations of trichroic vision. Persons of normal vision never get this sensation without large adulteration, and hence ordinary language contains no appropriate name for it.

Prof. Hering's theory of colours, as expounded by Dr. Pole (NATURE, vol. xx. pp. 479, 480) seems inconsistent with the fact (established by the observations of Prof. Maxwell, Lord Rayleigh, and other competent observers) that there is one definite colour-equation between any *four* colours. For Prof. Hering's theory assumes four elements of colour-sensation, R, G, B, Y, such that

$$R + G = 0, \quad B + Y = 0.$$

It would follow that, with the help of the minus sign, all colours could be specified in terms of R and B, and hence by writing down the specifications of any three colours, and employing the ordinary processes of elimination, a colour-equation could be obtained between the three colours. Prof. Hering's theory then leads to the result that there is a definite colour-equation between any *three* colours; in other words, that when any three colours are given it is possible to imitate one by a mixture of the other two. This result is so utterly opposed to fact, that a theory which leads to it cannot stand for a moment.

J. D. EVERETT

SOME OBSERVATIONS ON FLEUSS'S NEW PROCESS OF DIVING AND REMAINING UNDER WATER

I HAVE recently had two opportunities of seeing a new process of diving and of remaining for a long time under water, called, after its inventor, Fleuss's process. The peculiarity of it is that the diver takes down with him such a good and wholesome supply of air-food, that he is quite independent of any supply from above, so that there is no pumping required, and, indeed, no help whatever, except a signal-man and cord.

The experiment is being shown daily at the Royal Polytechnic Institution, and I am indebted to the managers for giving me the earliest notice of it, and for offering me every facility for observation. I am equally indebted to Mr. Fleuss for his readiness to carry out my wishes, and I am sure the readers of NATURE will be interested with the facts I have now to offer them.

Mr. Fleuss, the inventor of the apparatus, is a young Englishman, twenty-eight years of age, who has served, I believe, as an officer in the P. and O. Company's service. He has constructed the apparatus himself in a skilful but not very ornamental fashion, and he is his own diver. He went down in the apparatus, like a brave man, first himself, and he only, up to the present, has been down in it. He is a short slight man, of fair complexion, and very pleasing expression. He has a quiet and resolute enthusiasm which is quite refreshing.

The dress in which he descends under water is like an ordinary diver's dress. A helmet, a breast-plate, and the common water-tight armings and leggings. He bears on his shoulders a weight of 96 lbs., and his boots are weighted to 20 lbs. At twelve feet depth he moves comfortably in the water under this pressure. From the helmet there proceeds a light cord for signalling to the signaller above.

Before the helmet is fixed and the mask closed, it is seen that he wears, firmly tied over his mouth and nose, an ori-nasal mouth-piece, from which a breathing-tube of an inch bore proceeds downwards. This mouth-piece is, in appearance, just like the chloroform mouth-piece invented by the late Dr. Sibson, and afterwards added by Dr. Snow to his chloroform inhaler. For many years I used invariably the same kind of mouth-piece for administering volatile anæsthetics, but Fleuss's fits much closer, and is fixed more firmly.

When he is on the floor of the tank, Fleuss moves about as he pleases, apparently without any impediment whatever. He can pick up coins, he can sit down, and he can even lie down and get up again, a feat, I believe, entirely novel in diving. He breathes, he assures me, just as easily as when he is in the air and quite as freely, and from what I observed when he came out of the water from a long immersion, I have no doubt as to the correctness of his statement. He has some means of disposing of the products of respiration as well as of getting a continuous supply of air for respiration, since there is no escape of expired air from him into the water.

On the first occasion on which I witnessed the experiment Mr. Fleuss remained in the water twenty minutes. He came out quite free of any oppression. His pulse was steady, his breathing free, and his complexion natural. This was considered a short experiment, and on Saturday last, November 15, therefore, I asked to see it prolonged to an hour and to be allowed to follow it through all its stages. The request was immediately granted.

The diving-dress was adjusted on Saturday, at 6.33 P.M., and then Mr. Fleuss began to breathe from the apparatus. At this time his temperature was quite natural and his pulse was beating steadily at 68 per minute; the pulse was of good strength and tone. The temperature of the air was 51° F.; of the water, at the upper surface, 49° F. Fleuss said it was colder lower down, but the difference was not determined. He descended at 6.40 and remained under the water, at a depth of twelve feet, precisely one hour, namely, until 7.40 P.M. He walked about the greater part of the time, picked up pennies, and once or twice partly reclined on the floor of the tank. At the end of the hour he gave the signal to come up, the cold of the water having caused great numbness in his hands; he walked up the steps, carrying the heavy weights (116 lbs.) briskly, and was relieved, after a short delay, first of his helmet and then of his mouth-piece. At this point I found his pulse to be beating at 120 per minute and somewhat feeble, but the face was clear of any sign of asphyxia, though it was a little pale. His breathing was quite free. He attributed the quickness of the pulse to the labour of carrying the weights up the ladder, and no doubt correctly. Seven minutes later, the dress having been removed and warm clothing put on, I found the pulse to be ninety per minute, and the temperature of the body, taken from the mouth, to be 94° F., rather more than 4° below the natural standard. At twenty minutes later, that is to say, at twenty-seven minutes after release from the water, the pulse was eighty per minute, while the temperature had risen to 96° F.

At this stage I took an observation of the pulse with the sphygmophone. The three natural sounds were perfectly clear and in regular order, but the first or percussion impulse sound was extremely tremulous; the second or recoil sound was slightly tremulous; the third was clear.

I next took a sphygmographic reading of the pulse, in which all the events belonging to the natural pulse were distinctly marked. The impulse stroke was short, as was also the first descending stroke; the second ascending stroke was decisive, and the intervening lines between the third and the recurrence of the percussion stroke were shorter than is natural to Mr. Fleuss, as will be seen from the comparison of the two annexed sphygmographic tracings, 1 and 2.

1. Pulse tracing after one hour's immersion in water at 49° F. Temperature of mouth 96°, pulse beat 80 per minute. November 15, 8.15 P.M.

For the sake of comparison I took a subsequent tracing of Mr. Fleuss's pulse on the morning of Monday, November 17, after breakfast. His pulse was at 68 per minute, the same as it was on Saturday just before he entered the water. It will be seen to be a pulse naturally slow and steady, but not very powerful.

2. Tracing of pulse in its natural or ordinary condition under the same pressure. Beats 68 per minute. November 17, 10 30 A.M.

At fully seven minutes after his release from the water the pulse had come down to sixty-eight beats per minute, and the temperature had risen to 97° F. Ten minutes later still the temperature was 97°·6 F., eight-tenths of a degree below the natural. At this time my observations ceased.

The facts above narrated prove that, without assistance from above, a man who has had no previous experience of diving or of remaining under water can take down with him sufficient oxygen to live there easily for an hour. Mr. Fleuss assured me—and I see no reason to doubt him—that but for the cold he could have remained another hour and a quarter, and that he could easily arrange to remain four hours. Depth would make, he said, no difference as to breathing within the apparatus.

The mode by which the breathing is effected remains a secret, but is, he says, extremely simple. At my first observation, when he was under water twenty minutes only, I thought it possible that he carried down sufficient compressed air to live upon, and that he had a means for allowing the expired air to escape into the water. The later experiment shows me that this view was wrong. He could not carry down in the dress sufficient air to last him over an hour, and he does not seem to give out the expired air. I have no knowledge from him or any one how he breathes in the dress, and although I see how it could be effected, I think it right to leave it to Mr. Fleuss himself to describe the principle of his invention whenever he thinks, from his experiments, the fitting time has arrived.

In whatever way Mr. Fleuss gets breathing-room under the water, he has, without a doubt, achieved a great practical success. He has learned how to live independently for a long time shut off from all external access of air. He has learned, if I may so say, to become artificially amphibious, and if his plan succeeds, the cumbrous diving-pumps are done away with and the art of diving is vastly simplified.

Again, if he can live so long on the small reserve which he carries down with him in his dress, he has only to enlarge the dress, to expand it, that is to say, into a submerged vessel, to be able to go anywhere under the sea and do with intelligence what is now left to unintelligent mechanism. What such an intelligent direction might do with torpedoes it is not at all pleasant to contemplate.

The plan may be used for the purposes of deep-sea exploration, and the suggestion I made respecting my Salutlanders, that they sought for discoveries on the floors of the great oceans, may be so much nearer to accomplishment than the time which I assigned to it, that I may haply live to have the return laugh at what was called "the most visionary of speculative fancies." It is equally probable that the aëronaut may be able to rise much higher than he has yet done in this dress, or in a car specially constructed on a similar plan.

The apparatus may almost certainly be applied at once to another service very different in kind and on land instead of water. When a man can move about with an air-supply in his pockets, so to speak, he can go into fire as well as water. In a fire-proof non-conducting dress, provided with Fleuss's breathing apparatus, a fireman could enter a burning house, and without danger of suffocation go wherever the weight of his body could be borne.

Lastly, in wells charged with foul air, or in mines charged with choke-damp and other poisonous gases, the Fleuss apparatus will, I feel certain, prove of the greatest practical service, and I am happy in being the means of introducing it at length to the notice of my *confrères* in science.

BENJAMIN WARD RICHARDSON

NEW GUINEA[1]

BEFORE us lies one of the earliest published maps in which New Guinea is laid down. It belongs to Huygen van Linschoten's book of East Indian voyages, and was published in the year 1595, being derived largely from Portuguese sources. The map is turned on one side as compared with our present ones, so that at the top, on one hand, appears Japan, strangely shaped, and with the names of the cities curiously spelled, Meacum (the capital, Miaco, Kioto) and Tochis (Tokio?): whilst on the other hand lies New Guinea. At the foot of the map are Sumatra and the Bay of Bengal, and on the left hand China stands prominently upwards from the base of the map, with a camelopard walking about in its midst, regardless of the rules of geographical distribution. The north point lies to the left hand of the map, and the south to the right. New Guinea is represented as a very large and elongate island, the south coast being drawn without definite outline as unexplored, but with the Aru Islands duly shown lying off it. The great island is marked "Os Papvas," and at its eastern corner is the inscription "Hic hibernavit Georgius de Menezes." Although Antonio d'Abreu and Francisco Serraõ possibly sighted the New Guinea coast in 1511, Dom Jorge de Menezes must be regarded as the actual discoverer of the island. He was driven by the prevailing monsoon out of his course far to the eastward, when attempting to reach the Moluccas, from Malacca, by a new route round the north of Borneo in August, 1526. Having thus reached an island lying off the coast of Papua, he had to "winter" there, that is to say, to wait for the periodical change of the monsoon. According to Oscar Peschel, the island at which he remained, and which was called Versija, was very possibly one of those lying off Geelvink Bay. It is remarkable how very slowly our knowledge concerning New Guinea grew through the explorations of successive voyagers, since the time of Menezes until within the period of the last ten years, and even now it is quite startling to pick up a small octavo volume and find it jauntily entitled "A Few Months in New Guinea," as if New Guinea were as familiar and accessible a place as say Iceland or Norway, about which such little books are commonly written by enthusiastic tourists.

We are sorry, indeed, that Mr. Stone's book is so little, and would have been glad if it had been three times as long, and he had given us further details of all kinds

FIG. 1.—Vahu, a Motu youth.

concerning his most interesting sojourn amongst the Motu people of the coast, whose God dwells out over the sea, and the mountain-dwelling Koiaris, who believe the dread "Vata" inhabits the mountain summits.

It is close to the east end of New Guinea, and on its southern shore beneath the Owen Stanley range of mountains that the Motu country lies. Mr. Stone first made an excursion from Cape York, in the small mission steamer *Ellengowan*, up the Maikasa or Baxter River, the mouth of which, on the New Guinea coast, lies due north of the Cape, just on the opposite side of Torres Straits. The river was traversed for sixty-four miles, but then forked, and since both channels were too narrow for the steamer to turn in, further progress was stopped. At this distance even from the river's mouth, native plantations of yams, sugar-cane, and tobacco were found. A further distance of twenty-six miles was traversed in a small boat, and large numbers of the recently-discovered species of Bird of Paradise, *Paradisea raggiana*, were met with. The bird does not croak like the Great Bird of Paradise of the Aru Islands, "wauk wauk," but utters "a peculiar whistle resembling that of a man to his dog," and must

[1] "A Few Months in New Guinea." By Octavius C. Stone, F.R.G.S. (London: Sampson Low and Co., 1880.)

thus in its note come very near its more distant ally, the Rifle Bird of Cape York and New Guinea (Ptilorhis). As the small boat returned to the steamer it was greeted by the sweet strains of a "barrel-organ," brought in the hope that it "might please some of the natives." It is really appalling to realise that a "barrel-organ" has penetrated sixty-four miles up a river in New Guinea; and though we heartily wish the organs and their grinders were all in New Guinea, yet, did we regard matters from a missionary and philanthropical point of view, we should

Fig. 2.—Burning pottery in Anuapata.

have thought twice before attempting to demoralise the musical ears of the poor Papuans with such an instrument; or, perhaps, knowing the high ability of the Papuan race, we should have expected such a course to evoke hostility rather than to conciliate. But the missionary charm did not work; the natives kept well away from the barrel-organ: only one was sighted, and he promptly fled.

After a return to Cape York, Mr. Stone, with three assistant natural history collectors, Messrs. Hargrave,

Fig. 3.—Trading canoe or lakatoi.

Petterd, and Broadbent, proceeded again to New Guinea in the *Ellengowan;* and after touching on the way at Roro or Yule Island, where the natives cultivate fields of from five to thirty acres in extent, inclosed by fences six feet high; and at Purok on the main land, where the natives have a large circular market-place cleared of grass and trees, and periodically used by surrounding tribes, arrived at Anuapata (Port Moresby) amongst the Motu people on October 29, 1875. The arrival of the white men was not greeted with pleasure by the natives, because many of them had lately died of the measles introduced by the missionaries. The party at once erected their tent, and, proud of their nationality, and apparently taking a leaf out of Mr. Stanley's book, hoisted a union-jack at each end of the roof, and on a pole in front a banner with "Excelsior" upon it, thus apparently intimating that they intended to climb the neighbouring mountains if they could. They were soon beset by the natives, whose constant cry, corresponding to that of "bacshish," or the Fuegian "yammerschooner," is "kuku lasi"—"Won't you give me some tobacco?" The Motu people have an insatiable appetite for *trade* tobacco. In the evening there was a tremendous hubbub round the tent, and a hostile demonstration caused partly by a Polynesian Christian teacher, who, left in charge of the tent, had pointed a gun at would-be intruders, but also partly because the natives were not pleased at the white men persisting in remaining in their country contrary to their wish, and very naturally so, after the experience of the measles. But the natives were luckily afraid of the dark, and were frightened into submission by a display of rockets and of the power of dynamite. As a sort of set-off for thus frightening them almost out of their lives, great care was taken that they should not be corrupted by Sunday trading.

The natives have dogs which, like the Australian dingo, do not bark. The author wishes he had had a bulldog with him, for he describes the natives as "expert thieves, inveterate liars, and confirmed beggars," and feels sure

Fig. 4.—Native cradle.

that a dog which could bark would frighten them out o their wits. They ran away from a sheep landed from the *Ellengowan.* They have strict commercial instincts, and would "see you starve before they gave you food." Everything has to be bought with "trade gear." The natives are not cannibals, but were evidently acquainted with cannibalism, for, being firmly persuaded that all the tinned meats consumed by the white men consisted of human flesh, they expressed great disgust at the cannibal practices of their visitors. It is delightful to find the Papuan thus turning the tables on the pioneers of civilisation.

The Motu people seem on the whole very much bored by the presence of the missionaries, excepting when a chapel is formally opened, and there is a big feast in consequence. As they cannot dispose of their teachers in the usual way, perhaps in secret they pray for help to the cassowaries of which the author saw the foot-prints in the neighbourhood, for these voracious birds are, as the naturalist knows, far more at home in New Guinea than at Timbuctoo; but possibly even New Guinea cassowaries would require the traditional condiment, and matters have not as yet reached the hymn-book stage in Papua. A very amusing account is given of a missionary religious service at Anuapata. It appears that there are bold and contumacious sceptics amongst the Motu people who refuse to assimilate the Jewish cosmogony, and do not mind expressing their opinions freely in public.

"The service was held beneath a roof thatched with grass, supported on posts, open on each side, and fitted at one end with a low stage and reading-desk. Previously to the present occasion not more than two or three natives had ever attended, but, attracted, no doubt, more by curiosity than by any religious feeling, no less than three hundred, including men, women, and children, were now present, three-fourths of whom were compelled from want of space to remain outside. They appeared to know they ought to be quiet, and some of the eldest seemed to be listening, but the greater part were looking around them and evidently inattentive, apparently taking no interest in the proceedings. The small boys amused themselves by flinging pebbles at one another, making grimaces, or pulling a stray dog's tail, and sometimes the word koi-koi, meaning 'lie,' would be heard in reference to something the missionary was saying."

The Motu people express surprise in a curious and interesting way, namely, by drawing in their lower jaw and clicking their upper teeth with the thumb-nail of the right hand, very much the same gesture as the old European "biting of the thumb." They also express surprise by smacking their lips. The women are expert makers of pottery. The clay is worked into shape by hand over an earthenware mould, of course without any wheel appliance. The upper and lower halves of a vessel are made separately and afterwards joined. The pots are baked in an open fire on the sea-beach. They are of a brick-red colour when baked, and are made of three forms—the "ura," or cooking-pot, the "hordu," or water-pitcher, and the "nao," or bowl.

The natives start in every November with large cargoes of this pottery on a trading expedition a distance of two hundred miles up the coast; three or four of the largest canoes are lashed firmly side by side with rattans, and the compound craft thus produced is termed a lakatoi; some of these lakatois are propelled by a dozen square sails and others by a single huge elliptic-shaped sail, which is extremely picturesque in app.arance, but the cause of the peculiar form of which seems very uncertain.

In return for the pottery the natives receive sago, yams, taro, sweet potatoes, betel-nuts, and sugar-cane. The record of the undertaking of systematic long voyages, such as these by savages, is a very valuable fact, and helps to account for a rapid spread of cultivated plants, such as tobacco, for example, which doubtless originally reached New Guinea from America through Europeans. Whilst waiting for a start at Anuapata, the crews of the six lakatois from the neighbouring villages, composing the trading fleet, held regattas almost every day to while away the time and get into training. A terrible wailing was made by the womenkind on the day of actual departure, and many embraces between husbands and wives took place upon the beach, and there was much rubbing of noses; the women escorted the lakatois some distance in single canoes.

The mothers rock their babies by swinging them in a net bag suspended from a beam beneath the verandah, and the babies are often carried in these bags.

We cannot follow the author further in his account of the Motus, nor cite any of his interesting experiences amongst the Koiaris. The book is well illustrated throughout, and at the end is a short Motu dictionary, and shorter tables of eight other Papuan languages. The Motu people have a name for every different plant and bird, and for all the conspicuous stars. Numerals are given up to a million. We should almost be inclined to doubt the Motu conception of so high a number; possibly there may be some mistake in the matter. In the Koitapu language the numerals for eight and nine appear to be formed by subtraction from ten, and to mean (ten) less two and (ten) less one, as in the Admiralty Island language. The personal names for women are amusing indeed, the first two are probably intended as complimentary, but the remaining three can hardly have such a meaning; those cited by the author, when translated, mean "pig," "thief," "hungry," "frightened," and "bad."

A list of birds drawn up from the author's important collection by Mr. Bowdler Sharpe closes the book. The author seems to have little or no knowledge of natural history, since he repeatedly speaks of a Dugong as "a large *fish*," and further describes it as a "finny monster," and he imagines that the pig was introduced into New Guinea by Capt. Cook. His descriptions of birds, insects, and other animals seen are, however, interesting throughout the book. He gives some valuable information about the pigs. Some are kept tame by the natives, and some of them are very fine and fat; when young they are striped longitudinally, yellow, brown, and black, every other stripe being black; the stripes blend to a general dark brown tint as the animals get older. It is interesting to find that the Papuan pig exhibits the same markings as the European young wild boar so plainly. The natives have an ingenious way of catching the wild boar. When the boar charges, after being slightly wounded with a spear, a net with a very wide mesh set on a hoop-like frame is pushed over his head as he rushes forward. He gets his neck into one of the meshes, and with the large hoop about his throat, is helpless, and then easily killed.

We commend Mr. Octavius Stone's book to all classes of readers: there is not a dull page in it.

VERTICAL SHAFTS IN THE CHALK IN KENT

THE deep caves in the chalk in Kent while preserving a general form in a limited area, present certain differences amongst themselves, which enable us to trace something of their history as to time and object.

Those now most easily examined are the latest and best constructed. Though they are not dug at the present day here, there are many old ones that have been worked for chalk. These are distinguished by their irregular shapes and very wide shafts.

But there are fine examples now open of which North Kent has many having these general characters—a deep shaft, penetrating the soils (Woolwich pebble beds, Thanet sands and gravels) above the chalk, then the chalk itself from 2 to 5 feet, and widening out into a cave in the latter, mostly without effort at burrowing laterally, and when doing so keeping the shaft in the middle and the general shape of the cave as it were one area, with a due regard for the permanence of the roof. Some had pillars for this purpose left in the chalk, and there is one with four of them which are elegant in form and rounded. This cave being an excellent example of the kind, may be more particularly described. The shaft is 3 feet 3 inches in diameter (a common average), and passing through sand reaches the chalk at 51 feet; then penetrating it 2 feet widens out into an area of 49 × 38 feet, the sides cut into bays. Two pillars are left, one on each side of the shaft, and in continuation of it, still 3 feet apart, and there are two other pillars in the eastern part. The western part having no pillars has fallen in, and there is a large mound of sand and rubbish in the centre—but the height of the cave is 20 feet, perhaps 22 feet.

In this case the access to the chamber is perfect: the shaft is provided with foot-holes from 6 inches to 20 inches (occasionally) in lateral depth; these pass from the surface to the bottom of the central pillars at about 18 inches apart and opposite to each other, and it was easy a few years ago to descend and ascend without assistance, unless perhaps with that of a stick across the mouth of the shaft. Some of the shafts have foot-holes only to the point where they widen out below, when recourse was had to a pole or rope, of course.

Most of the caves are simpler than this, and the commonest form is a mere beehive sort of widening.

All these open caves appear to have been dug with iron picks.

At Greenhithe one has been lately found containing a large quantity of Romano-Brit'sh pottery, but it was dug with metal implements, probably of iron.

There are two caves at Crayford within 3 feet 3 inches of each other; they are exposed in the side of a chalk-pit connected with the brick-fields. One of them measured, from the surface to the chalk, about 18 feet; thence to the floor, 17 feet 6 inches. The floor was of flints, about 6 inches thick, which had been taken up at one part and piled in a heap on the other side of the cave; about a quarter of the area, an irregular oval of 18 feet diameter, had been so treated. From this floor rose an obtuse cone of sandy clay 6 feet high, washed in very slowly and evenly by the rain. In the cone were found flint flakes, and one worked scraper with a rough core, from which flakes had been chipped, but no pottery. Above this, coarser soil and lumps of chalk, with several sorts of broken pottery, very coarse, black, spongy pot, scarcely baked, containing a large quantity of crushed shells not calcined, and a few pieces of pot made with coarsely-pounded chalk—all these either without ornament or only finger-nail marked; then finer pot of Roman moulds, and fine black ware, with a Samian plate. All were accompanied by large quantities of the bones of domestic and food animals for about a foot, then coarse earth and bones to the surface.

From about the period of the Roman deposit until now we know the value, and it would not be excessive to date the commencement of the deposit of mud and the abandonment of the cave perhaps at half that period earlier.

On the walls of this cave there are no marks of the implement by which it was excavated, and the conclusion is that the blocks were prised out.

The cave adjoining this fell in early and was soon obliterated.

Before knowing of these caves flint flakes and two "pot boilers" were found on the surface.

Clusters of these pits are either huddled into small areas sometimes or are spread out into lines, and they are frequent in spots which, from the supply of water, must have been thickly wooded, and so difficult of access, or from the bleakness of the situation unlikely to be noticed.

There is a cluster at Bexley of thirty-five in about three and a half acres, and another of forty-four.

Some pits which are mostly filled up now, in the woods, are part of a system and are connected by banks and ditches, and the same banks with earthworks which are of a late stone age, and also with clusters of hut circles, and there is great probability that they served two uses—retreat and storage, and as pitfalls, as to the last with an ingenious contrivance in one instance for driving animals down a deep covered way, either past a pit or, by an arrangement of a simple barrier, shunting them into it for the use of the camp.

F. C. SPURRELL

PROF. GEIKIE ON THE GEOLOGY OF THE FAR WEST

ON Monday the 10th inst. Prof. Geikie reopened the class of geology in the University of Edinburgh by giving an account of his recent exploration of the western territories of North America. There was a large attendance of students and others.

The Professor, in the outset, reminded his students that last session he pointed out the remarkable lessons to be learned from the geology of the western regions of North America, more particularly in reference to the changes which had taken place on the surface of the earth from ordinary atmospheric causes. It was with special reference to those changes that he took a journey to the West. Had geology begun in those western territories, instead of among the old broken, gnarled, and contorted rocks of Europe and the east of America, its progress, at all events in some departments, would have been far more rapid than it had been. He had three objects in the expedition:—(1) To study the effects of atmospheric and river erosion upon the surface of the land; there being no region where these lessons could be learned with more wonderful impressiveness than in those great plateaux and table lands. (2) To mark the relation which the structure of the rocks underneath bore to the form of the surface. In this country and in Europe generally one was continually brought face to face with evidence of dislocations, protrusion of igneous rocks, contortions, and other complicated forms of geological structure which, save to experts in the subject, made it often difficult to realise how much of the present irregularity of the surface should be attributed to unequal waste by ordinary atmospheric causes, and how much to the direct effects of underground movements. The Western States and Territories of North America over which the strata, for thousands of square miles, retained their original horizontality, presented remarkable facilities for the investigation of this subject, and had already, in the hands of King, Hayden, Powell, Dutton, and others, furnished ample materials for satisfactory discussion. (3) To watch with his own eyes some of the last phases of volcanic action. He had been familiar with the phenomena of active volcanic vents as displayed in Italy and the Lipari Isles; but he was anxious to see some of those marvellous evidences of the gradual decay of a vast volcanic area so well displayed in the famous region of the Yellowstone. The Professor went on to give a brief account of his journey. He stated that he was accompanied throughout by a former student of the class, Mr. Henry Drummond, F.G.S., whose constant hearty co-operation had been one main element in the success of the expedition. His route first lay westwards by railway into Colorado. In crossing the prairies towards the Rocky Mountains he noted, in the few sections that occurred, soft grey cretaceous or tertiary clays and marls. Getting down at some of the stations, and looking at the ant-hills and burrows of the prairie dog, he found that the surface of the prairies was veneered with a thin coating of a pinkish, fine-grained sand, sometimes approaching to gravel, its colour being due to the presence of a great many small pieces of fresh felspar. It was clear that this mineral, as well as the quartz and occasional fragments of topaz, which he saw, did not belong to the strata on which they lay. In going west, the grains of sand, getting coarser, assumed the form of distinct pebbles, till, when he reached the mountains, they became huge blocks and boulders, evidently derived from the heights beyond. The cause of this wide diffusion of sand and gravel over the prairies was constantly present to his mind during the rest of the journey, and he took occasion on returning eastward to halt and make a more detailed examination of the subject.

The term "Rocky Mountains," he remarked, was a singularly unfortunate designation, under which had been included a great many independent and totally distinct mountain ranges. On most maps of North America a continuous line of lofty ridge was inserted down the axis of the continent and marked "Rocky Mountains." But no such ridge existed. The great plateau had been wrinkled by innumerable meridional folds which, dying out, were replaced by others. Some of these folds formed notable ranges of mountains with wide basins or plateaux between them. It was thus possible to cross the axis of the continent without traversing any mountains, rocky or otherwise. The line of the Union Pacific Railroad followed one of these natural routes. At its highest point (upwards of 8,000 feet), so little did the landscape suggest the altitude, that it had been found desirable to erect there a wooden placard with the title "Summit of the Rocky Mountains."

Crossing the Missouri River at Kansas City, and striking westwards to Denver, the Professor said he halted for a little while on the flanks of the great mountain range that formed the colossal bulwarks of the parks of Colorado. As seen from the prairies they rose in a picturesque line of peaks, visible in the clear atmosphere of these regions at an incredible distance, and looking at first like mere low islets, the greater part of their bulk being still hidden beneath the sea-like surface of the prairie. Composed of crystalline rocks these crests had been pushed as a great wedge through the cretaceous and tertiary rocks of the prairies, and had carried those rocks up with them in a grandly picturesque curve along their flanks. An excursion into some of the gorges or cañons by which the flanks of these mountains are trenched, brought to notice some interesting facts connected with the surface erosion of the district. He then found the source of the pink felspar sand of the prairie ; it had been borne down from this region, where great masses of pink granite, grey gneiss, and other crystalline rocks formed the core of the mountains, and were visibly crumbling into the same kind of pink sand and gravel. He found that the mountains had been covered with glaciers which had gone out into the plains and shed their huge horse-shoe shaped moraines where now everything was parched and barren.

Having crossed the watershed of the continent, he struck westward into the Uintah Mountains, one of the few ranges in that region that had an east and west direction. This range had been visited by Hayden, had been mapped by Clarence King and his associates, and its eastern end had been carefully examined by Powell. It formed one of the most remarkable elevations in North America. Unlike the other mountainous high grounds it possessed no great central core of crystalline azoic rocks, but consisted of a vast flattened dome of red sandstones, dipping steeply down beneath mesozoic rocks on either flank. The precise geological age of these sandstones had been a matter of dispute. King had regarded them as carboniferous. In their lithological characters they much resemble some of the old red sandstone of Scotland, while some of the more compact portions, recalled the red Cambrian sandstones of Applecross and Assynt. One feature of surpassing interest in the Uintah Mountains was the evidence of enormous denudation, continued through a protracted cycle of geological time. The horizontality of the strata along the central parts of the range was such that terrace above terrace could be traced by the eye for miles around any commanding peak. The rocks there had escaped crumpling and fracture to a remarkable degree. It could therefore be seen that the deep gullies and clefts, the yawning precipices and cañons, the wide corries and vast amphitheatres by which the surface was so broken up had been produced not by underground disturbances but by erosion at the surface. Most of this tremendous denudation had doubtless been effected by ordinary atmospheric action. The speaker described the disintegrating effects of the remarkable daily vicissitudes of temperature in this region, the action of wind, as well as of melting snow, and occasional torrents of rain. But he showed that the mountains had also nourished large glaciers, and that these, filling up the main valleys had protruded into the plains beyond. They had left behind them numerous lake basins, some ground out of the horizontal sandstones, others dammed up by fallen moraine *débris*.

Striking into one of the valleys, he found it crossed by beautiful horse-shoe moraines that had once formed a succession of lakes, of which the sites were now occupied by meadows. In these and other high grounds, however, it was the beaver, which, by its dams, converted even the small streams into a succession of shallow lakes. In most of these valleys there were hundreds of acres of bog land entirely due to the damming of the water by the beavers. The Uintah Mountains were flanked by ranges of low and sometimes fantastic hills, *mesas* or terraces, and isolated *buttes* or outliers, included under the general term "mauvaises terres" or "bad lands." This designation referred to the fact that the ground was everywhere crumbling down under the action of the weather, and nothing would grow upon it. The strata of these bad lands were flat or nearly so, and showed their lines of bedding with singular precision along the faces of the crumbling cliffs and slopes. They had an arid and almost ghastly aspect, grey, verdigris green and yellow, as they rose out of the sandy wastes at their base. It was from these strata that Prof. Marsh had obtained some of the marvellous reptilian and other forms which he had described from the eocene and cretaceous rocks of the West. Prof. Geikie narrated a ride through the forest lands of the mountains, and gave an account of how the party, benighted away from camp, had to pass the night without food on the bare ground, and how the forest around them caught fire.

The journey to the Yellowstone region was one of great tediousness and discomfort. Having letters from the Secretary of War and the Quartermaster-General of the United States, the party received every attention at Fort Ellis, where a pleasant day or two were spent, examining with the officers of the garrison the geology of the district. From this point the journey was performed on horseback and with a pack train of mules, the officer in command at Fort Ellis having furnished an outfit, scout and escort. The Professor gave a narrative of the traverse of the Yellowstone country, dwelling specially on the evidences of former successive periods of volcanic eruption, and on the proofs of intense glaciation to be observed in the ascent of the valley of the Yellowstone River. The tokens of a long period of volanic activity contemporaneous with the operations of the river, resembled those of Auvergne, but on a much larger scale. The mountains around consisted mainly of crystalline rocks such as gneiss, schist, and granite. The volcanic action appeared to have been chiefly confined to the valley. Sheet after sheet of lava bad been poured out, and these, one after another, had been cut through by the river. The edges of some of the lava plateaux could now be seen crowning the summits of steep slopes or even cliffs far above the level of the stream below. So great had been the general erosion that no distinct craters remained now visible. But what appeared to be the stumps of some of these, filled up with a coarse volcanic agglomerate, were here and there observed. The lavas offered a vast and tempting field of investigation, presenting as they did a great number of petrographical varieties. Some of the obsidians were particularly interesting in their pumiceous and spherulitic characters. The Grand Cañon of the Yellowstone, cut out of these volcanic masses, was described as perhaps the most marvellous piece of mineral colour anywhere to be seen in the world. It had been cut out of tuffs and lavas, showing sulphur yellow, verdigris or emerald, green, vermilion, crimson, and orange tints, so marvellous that, if transferred to paper or canvas they would be pronounced incredible and impossible ; the lecturer said he had spent a day in making a careful water colour study of this cañon, but he hardly expected to get any of his friends to believe in the truthfulness of his colouring.

During the ascent of the Yellowstone Valley the evidence of former extensive glaciation was abundant and conclusive. The party had hardly been in the valley a quarter of an hour when they descried, not far above the upper end of the first or lowest cañon, a large block among some mounds in the centre of the plain. This proved to be an erratic of coarse granitoid gneiss, lying among many others of smaller size. The mounds, manifestly moraines, curved in vast crescents across the broad plain of the Yellowstone. Further mounds and scattered blocks were noted in the ascent of this great expansion of the valley. On reaching the entrance of the second cañon, the Professor found it most exquisitely glaciated from bottom to top. It reminded him of the wonderful ice-polished precipice on the left bank of the Aar glacier, above the Grimsel. It was clear, therefore, that not only was this second cañon old; it was older than the glacial period; it had supplied a channel for the glacier that ground its way out from the mountains. Endeavouring to estimate the minimum thickness of the ice, he traced with the eye the glaciated surfaces up to the summit of the declivity—a height of at least 800, perhaps 1,000 feet,—and they evidently went still higher. In going further up the valley, he found that the blocks of granite and gneiss, dropped by the glacier as it melted, went far above 1000 feet. He got them on the shoulders of one of the great hills overlooking the valley 1,600 or 1700 feet above the plain. The ice, therefore, must have been not less than 1,600 or 1,700 feet thick, and must have passed across intervening ridges into adjacent valleys. It thus appeared that not only did glaciers occupy the valleys of this region, but that some of them were of such thickness as to deserve the name of ice-sheets, covering the whole surrounding region.

Leaving the Yellowstone Valley, the party struck through the forest, and after a two days' ride reached the Upper Fire-Hole Basin of the now famous geyser region. Prof. Geikie gave a general sketch of the aspect of this district, and described the operations of one or two of the geysers which he witnessed. After the long ride through an arid region and dusty wastes, he tried hard here to get a pool to wash in, but could find nothing below 212°, and the only chance of getting a warm bath was to find some hole where the water had had time to cool after flowing out of the hot crater. The whole ground was honey-combed with holes, each filled with gurgling boiling water. One geyser, affectionately and gratefully known as "Old Faithful," went off with wonderful regularity every 63 minutes; the others were more capricious. The singular depositions round the orifices of eruption and round the margins of the pools on the cones were referred to, and among other interesting phenomena an account was given of the "Devil's Paint Pot," a mud geyser, throwing out white and brilliantly-coloured mud, boiling like a great vat of rather thick pasty porridge, and surrounded with small mud cones, each of which had formerly been a point of emission.

In quitting the Yellowstone region, it was impossible not to reflect with admiration upon the labours of the explorers who had first made known the wonders of this remote and inaccessible region. The Reports of Hayden and his associates were found to be most trustworthy and useful. Nor could one forget the sagacity with which Hayden proposed, and the enlightened liberality with which Congress enacted, that for all time the Yellowstone Region should be a tract set apart as a national park for the instruction and recreation of the people.

On the way out of the mountains by Henry's Lake and the head of the Snake River branch of the Columbia River, the travellers came upon a party of armed Indians, who explained that they were out of their reservation on their way to a council of Indians in Montana. As the great outbreak of the White River Utes, who killed Major Thornburgh and his men, took place only about ten days or so later, and as there was then some excitement among the tribes to the West, the geologists, though pleased at the time to have seen the noble red man in his war-paint among his native wilds, came to think that on the whole they might congratulate themselves on having seen no more of him. Only last year the Yellowstone country was dangerous from roving bands of Indians, several lives having been lost in it. Leaving the Indians, who pursued their northward course in a bee-line, the travellers held westward along the edge of the vast basalt plateau of the Snake River—one of the most extensive lava fields in the world. A great plain, thousands of square miles in extent, had there been deluged with dark basalt. No cones or eminences appeared from which the lava migh have been poured. Perhaps the eruptions took place from open fissures. Here and there later cones had risen upon the plain, belonging, doubtless, to some of the later stages of the volcanic activity. Some of these cones still retained well-shaped craters.

Reaching eventually the basin of the Great Salt Lake, one of the first geological features that struck the travellers was the evidence of the former vast expansion of the Salt Lake. Lines of terrace ran as prominent features along the sides of the mountains, the highest of them standing at a height of nearly 1000 feet above the present level of the lake. Striking into some of the cañons descending from the Wahsatch Mountains into the Salt Lake Basin, Prof. Geikie found the rocks smoothed, polished, and striated by the glaciers that had come down from the heights and had brought with them great quantities of moraine matter. Mounds of rubbish blocked up the valleys here and there, and some of them he observed to descend to the level of the highest terrace. Hence when the Salt Lake extended far beyond its present area, and was about 1000 feet deeper than now, the glaciers from the Wahsatch Mountains reached its edge and shed their bergs over its waters. Bones of the musk-ox had been found in one of the terraces, showing that an arctic fauna lived in this region during these cold ages.

On his return journey the Professor resumed the examination of the surface deposits of these prairies. Coming out of the Colorado Mountains, he noted, in connection with the gravel formerly observed, great quantities of a peculiar grey clay or *loess* inter-stratified with the gravel, and here and there containing a small terrestrial shell (*Succinia vermeta*). It was a freshwater deposit, one that had been swept by the waters coming down from the mountains over the prairie. It might be regarded as marking one of the phases in the period during which the gravel and sand were being thrown down. Tracing the gravel mounds over an extensive tract, he found that they had been deposited irregularly, as might have been the case from the action of water escaping tumultuously and interruptedly from the melting ends of the ice. The water currents would traverse the plain now in one direction, now in another. The whole prairie, for many leagues east from the mountains, must have been flooded with water derived from the melting ends of the great glaciers.

By these successive floods the gravel and sand were spread out irregularly over the plain, and during the same prolonged period of ablation of the ice there were here and there greater streams or periods of more muddy water, when the fine grey loess was diffused over the flats, as has taken place in the valleys of the Danube and Rhine. No doubt some of the fine detritus may be travelling eastward still, for though the rainfall over much of the prairie country is exceedingly slight, it may suffice to give the fine particles of sand and gravel an intermittent movement to lower levels.

NOTES

WE take the following from the *Times*:—The medals awarded and recommended by the Council of the Royal Society for the present year are: The Copley medal to Prof. Rudolph J. E. Clausius, of Bonn, for his well-known researches upon heat; the Davy medal to Mr. P. E. Lecoq de Boisbaudran for his discovery of gallium; a Royal medal to Mr. William Henry Perkin, F.R.S., for his synthetical and other researches in organic chemistry; and a Royal medal to Prof. Andrew Crombie Ramsay, F.R.S., for his long-continued and successful labours in geology and physical geography. These medals will be presented at the anniversary meeting of the Society, on December 1, when Mr. W. Spottiswoode will deliver his first annual addres as president.

THE following is the list of office-bearers to be proposed at the annual meeting of the Royal Society of Edinburgh, on November 24:—President, the Right Hon. Lord Moncreiff; Vice-presidents, the Right Rev. Bishop Cotterill, Principal Sir Alexander Grant, Bart., David Milne Home, LL.D., Sir C. Wyville Thomson, LL.D., Prof. Douglas Maclagan, M.D., Prof. H. C. Fleeming Jenkin, F.R.S.; General Secretary, Prof. Tait; Secretaries to Ordinary Meetings, Prof. Turner, Prof. Crum Brown; Treasurer, David Smith; Curator of Library and Museum, Alexander Buchan, M.A.; other Members of Council, Prof. Rutherford, Dr. R. M. Ferguson, Rev. W. Lindsay Alexander, D.D., Dr. Thomas A. G. Balfour, J. Y. Buchanan, Rev. Thomas Brown, Robert Gray, Dr. William Robertson, Prof. Campbell Fraser, Prof. Geikie, Rev. Dr. Casenove, David Stevenson, M. Inst. C.E.

A GRAND diploma of honour has been granted by the Jurymen of the Champs Elysées Exhibition to the Signal Corps of the United States for its magnificent set of maps. No other public institution has sent anything to compete with so formidable an opponent.

ABOUT thirty members of the Academy of Sciences have memorialised M. Jules Ferry, the Minister for Public Instruction, in order to obtain a promotion in the Legion d'Honneur on behalf of M. Henry Giffard, the inventor of the injector and the originator of many interesting experiments in aëronautics. M. Giffard was created a Chevalier about eighteen years ago.

PROFESSORS A. WINNECKE (Strassburg) and G. B. Schiaparelli (Milan) have been nominated correspondents of the physico-mathematical class of the Royal Academy of Sciences of Berlin.

THE magnificent series of scientific collections at Dresden have recently been further enlarged by the addition of an ethnographical and anthropological museum. Many of the objects now exhibited in the lecture-hall of the "Zwinger" had accumulated since the year 1857, and the director, in due recognition of the important position now occupied by ethnography and anthropology in the list of natural sciences, has recently made considerable purchases for the opening of the new museum. The director in question is the well-known New Guinea traveller, Dr. A. B. Meyer, under whose able superintendence the Dresden Zoological Museum is also placed.

WE are glad to receive from Mr. E. W. Lewis his "Lectures on the Geology of Leighton Buzzard and its Neighbourhood," which were given to the Working Men's Club of that town. We should like to see lectures of this kind become more and more common; it is a good method of exciting an interest in science and of encouraging the study of local natural history; it is certainly much better than giving a *rechauffé* of scientific text-books.

AT the meeting of the India Council, last week, a final decision was come to regarding the disposal of the India Museum. The Museum will be taken over, as is proper, by the Lord President, and will be administered by the South Kensington authorities; important collections in illustration of the Indian building art of antiquity, and of the economic, mineral, vegetable, and animal productions of India will, therefore, now be from time to time sent to the great centres of the United Kingdom. The botanical part has been intrusted to the authorities at Kew. A grant of 2,000*l*. has been made for the enlargement of the Kew Museum on that account, and a small annual sum will be allowed for contingent expenses and to secure the services of an expert cryptogamist in connection with the collection. In its economic section the India Museum was little more than a very costly duplicate of Kew, which it could never approach in encyclopædic completeness, and it will necessarily be of incalculable benefit to the India Office to keep its economic collections for the future at Kew, where they will be in charge of the first English botanists. In fact, the Indian Secretary will now always have the assurance that the reports on Indian products forwarded by him to the local Governments in India have not only been carefully prepared by his own officers, but are supported by the best scientific advice in this country. The Kew authorities, in continuation of a scheme set on foot by Dr. Forbes Watson, the late Reporter on Products, have undertaken to supply out of their surplus stores samples of Indian articles to any museums in our larger manufacturing and commercial towns which will undertake the cost of suitably exhibiting them to the public. As to the zoological collection, it has always been understood that it would be transferred to the British Museum on the completion by the trustees of their new Natural History Museum at South Kensington. The Buddhistic sculptures will also be taken by the British Museum.

THE *Times* Naples correspondent, writing under date November 8 and 10, states that Vesuvius, which for some time had been capricious in its action, had for a week previously hoisted its red flag. This arises from a small eruptive cone which has sprung up in the centre of the large crater of 1872, and which now rises a few metres above its border. To compare great things with small, the appearance of the summit is that of a small cup in the centre of an immense saucer. The saucer is almost full of lava, which, says the *Osservatorio Vesuviano*, or Prof. Palmieri, has run over the side since October 30, and continues its downward progress on the side of the cone. It is fortunate, says the *Osservatorio*, that on the side on which they are constructing the funicular railway there is a considerable cavity which is not yet filled, so that hopes are entertained that some time will elapse before the lava presents itself in that direction. It may happen, too, adds Palmieri, that an eccentric eruption may occur which will prevent the accumulation of more material. It is thought that a crisis in the history of the mountain is approaching; either there will be a great discharge, such as will terrify the neighbourhood, or, as is more likely, there will be an overflowing of lava, covering the cone with a mantle of fire, and silently inflicting more destruction on property than a grand eruption. Vesuvius has been in an active state now for several years, and Prof. Palmieri has from the first prophesied that the eruption would consist in the overflowing of lava. On the 10th Vesuvius was covered with snow down to its middle, a rare thing so early in the year.

THE juvenile lectures of the Society of Arts will be given this year by Mr. W. H. Preece, on "Wonders of Sound" and "Wonders of Light." The dates for his lectures are December 30 and January 6.

THE French Minister for Commerce has sent to the Academy of Sciences a request to know whether a *diagometer* can be relied upon for ascertaining whether olive oil has been adulterated by common seed oil, and in what proportion. Prof. Palmieri, the director of the Vesuvian Observatory, sent M. Dumas a pamphlet published at the expense of the Chamber of Commerce of Naples nine years ago, showing that the problem had been solved by this apparatus. The principle is the same as the bifilar magnetometer, also invented and designed by Palmieri.

WE have received programmes of the new session of the numerous societies united together under the name of the Cumberland Association for the Advancement of Literature and Science. The programmes of lectures and ordinary meetings are fairly divided between the two fields. The continued prosperity of this provincial association for culture is exceedingly gratifying.

THE Pacific Steam Navigation Company have begun to use the electric light in the illumination of the saloons on board their steamers.

WE are glad to be able to acknowledge the receipt of the Report of the Sheffield meeting of the British Association. This early publication is decidedly a mark of progress.

FOR the first time in its history the Paris Academy of Sciences has regular archives. More than seven hundred cases are filled up with scientific memoirs and documents from the end of the seventeenth century to the present time. Scientific papers left by Réaumur and Ampère are a part of this unexampled collection.

THE bequest of the late Mr. John Miers, F.R.S., to the British Museum, consists of his herbarium of South American plants which he made during his long stay in that country; original drawings and the manuscripts of his published works; and some unpublished manuscripts. Among the more important of his unpublished manuscripts is a list of the native names of the plants. The extent of the herbarium is about 20,000 sheets, on which the specimens are carefully mounted, and as it includes the type specimens figured in Mr. Miers's publications, the acquisition to the Museum is of great value. The cases in which the collection was kept form part of the bequest. It was only last year, when nearly ninety, that Mr. Miers published his "Apocynaceæ of South America," with general remarks on the whole family. The work, which was of 277 quarto pages, was illustrated by 35 plates. The "Contributions to Botany," published in three volumes in 1861, 1869, and 1871, were illustrated by 153 plates, and contained 940 quarto pages of letterpress. All the originals of these are included in the collection sent to the British Museum. There are also a large number of other drawings and sketches of dissections.

ON October 10 a large balloon fell on a farm in the town of Milwaukee, U.S. The air-ship was picked up and temporarily stored in a warehouse. On the 11th an inspection of the canvas was made, to ascertain whether it was the *Pathfinder*, a balloon in which Prof. Wyse had ascended some days previously in company of a gentleman, and had not been heard of since. It was proved that this balloon had been liberated on Thursday, October 7, at six in the evening, at Waukosha in Wisconsin, and had been wandering in the atmosphere. Before being discovered in Milwaukee, it had been seen coming from Lake Michigan in an opposite direction to where Waukosha lies. The body of Prof. Wyse has not been recovered, but the gentleman who had ascended with him was found drowned and naked. It was supposed he had prepared to escape by swimming, and precipitated himself into the water.

THE Manchester Field Naturalists and Archæologists send us an interesting and varied Report for 1877. It contains an account of the numerous excursions made and the papers read at the Society's meetings.

THE several stations of meteorology which have been established in several parts of Paris, according to a vote of the Municipal Council, have been in complete operation for a few months. Startling differences have been occasionally discovered between the readings taken by the several observers at a distance of a very few miles.

THE *éloge* on M. Thiers was pronounced by M. Henry Martin before the French Institute on November 13. M. Marmier returned thanks in the name of the Académie Française. The lecturer made allusion to the studies of M. Thiers in astronomy under the guidance of M. Leverrier, and in chemistry, of M. St. Claire Deville. It was stated that many experiments were made by the late President of the French Republic in the last years of Napoleon III.'s rule. These experiments were conducted in the laboratory of the École Normal Supérieure, rue d'Ulm.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. L. H. Ruegg; a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, presented by Mr. H. L. Cocksedge; a Mace's Sea Eagle (*Haliaëtus leucoryphus*) from India, presented by Capt. Butler; a Pomatorhine Skua (*Stercorius pomatorhinus*), British, presented by Mr. F. L. Smith; a Woodcock (*Scolopax rusticola*), British, presented by Mr. J. Pollard; a King Penguin (*Aptenodytes pennanti*) from the Staten Islands, Cape Horn, a Cinereous Vulture (*Vultur monachus*), Europe, a Downy Owl (*Pulsatrix torquata*) from South America, deposited; a Water Rail (*Rallus aquaticus*), British, an Anaconda (*Eunectes murinus*) from South America, purchased.

OUR ASTRONOMICAL COLUMN

THE BIELA COMET METEORS.—Assuming, as some astronomers will probably be inclined to do, that Biela's comet has now lost the cometary form in which it presented itself to us from 1772 to 1852, and that its constitutuent particles, or whatever we may term them, are drawn out into a stream or band, beyond the circumstance of a great aggregation having been encountered by the earth on the evening of November 27, 1872, we are ignorant of the position of any other centre or centres of condensation that may exist, and even of the real extent of that which has been observed, along the comet's track; and hence it is desirable that a watch for the Biela meteors should be maintained during the whole of the last week in the present month. We are not assuming as a consequence of the disruption of Biela's comet before it was generally observed in 1846, that such is the actual condition of its constituent parts; Mr. Pogson's observations of a cometary body at Madras in December, 1872, require that such an assumption should be taken at present *cum grano*, but under any circumstances observations about the time when the earth approaches nearest to the orbit of the comet this year, will possess great interest, and we hope there may be an effective organisation of observers. In 1852, when the comet was last observed, its period of revolution, in the instantaneous ellipse at perihelion, was 2,417½ days; the effect of planetary perturbation thence tended to increase the period, so that in January, 1866, the latest time to which the calculations have been carried, the revolution extended to 2,445 days, according to Michez and Clausen. If this were about the period of the meteoric mass which the earth encountered on November 27, 1872, it is very doubtful if we shall be in proximity to it again during the present century; nevertheless, as above remarked, we do not know its extent along the orbit, and other aggregations may exist. A body moving in the orbit of Biela, and approaching the earth at this date, would be at a distance of about 1·4 from the planet Jupiter in September, 1878, and there might be very sensible effect upon the period of revolution.

A NEW NEBULA.—Dr. Tempel states that on September 19 he found a new nebula which, from his description, appears to be nearly as bright as an average second-class of Sir W. Herschel, and is therefore deserving of attention on the score of possible variability, since in these days we hardly expect to meet with many unknown second-class nebulæ visible in European latitudes. Dr. Tempel mentions that there is a central glimmer as from very minute stars: it is about one minute in diameter, and its position for the beginning of the present year is in R.A. 22h. 41m. 25s., N.P.D. 102° 27'·1: it is very little fainter than the nebula II. 744. He adds that he has often sought for the nebula No. 49 of Auwers, which should be near the new one, but has only found in its assigned position a star of 12m., which has a very faint companion. Auwers 49 is the object observed as a star 11·5m. on October 8, 1855, in one of the Markree zones, and called "nebulous;" position for 1850 in R.A. 22h. 52m. 35s., N.P.D. 101° 19'·9. The late Mr. Edward Cooper had so unfavourable an opinion of the climate in his locality for astronomical purposes (perhaps from long experience of the skies of Italy), that probably he would not have been surprised at the discovery of any number of "nebulous" objects at Markree; but the four volumes of positions of small stars for which astronomers are indebted to him, sufficiently illustrate the good work that may be effected by well-directed energy and skilful arrangement, even in such a climate as we remember to have heard him describe that of Sligo. Pons expressed his fear that the second comet of 1826 would be "drowned in Eridanus," as the sky had been overcast ever since it entered this constellation; on which Mr. Cooper ("Cometic Orbits," p. 152) is tempted to remark that, had Pons "written from the interior of Ireland, there would have been little to fear, for he might have made quite sure of it!"

THE SATELLITES OF MARS.—Both satellites of Mars have been observed with the Washington refractor; the measures of *Deimos* commenced on October 13, clouds interfering on the 10th, when it was first seen, and those of *Phobos* on the 12th. The correction required to the periodic time of *Deimos*, as determined by Prof. Asaph Hall from the observations of 1877, is so small that it will only be certainly ascertained from an exact discussion of the measures at this opposition; the periodic time of *Phobos* requires to be diminished 1·074s., or the corrected period is 7h. 39m. 13·996s.

Phobos and *Deimos* are also under observation with the Ealing reflector.

PHYSICAL NOTES

THE *Scientific American* describes a self-resonant tuning-fork, the invention of the indefatigable Edison. It consists of a tube of thick bell-metal closed at one end, and sawed down longitudinally nearly to the closed end, thus making two "prongs" united to a common base. To tune the prongs into unison with the column of air between them, the tube is put into a lathe and turned thinner and thinner until unison is reached. But how such forks are made of any precise pitch, or how the inclosed air-column contrives to vibrate in spite of the long lateral cuts, our contemporary does not vouchsafe to inform us. There are not many organ-pipes that would resound to their proper note with a saw-cut incised down them front and back.

FOR observation of atmospheric electricity M. Mascart (*Journ. de Phys.*, October) uses a Thomson electrometer connected with a vessel having continuous outflow of water. The deflections of the needle are transmitted every two and a half minutes to a pencil which records them on a sheet of paper. The series of traces forms a curve, not continuous, indeed, but nearly so. This apparatus was put in action at the College of France in the end of February this year, and the curves obtained during the following five months present several interesting features. The potential of the air is shown to be generally positive, with more or less rapid variations. In bad weather the curves become more irregular; rain nearly always produces very great negative deflections. The change of sign appears before the rain comes, and sometimes rain is followed by very high positive indications. There are also some very rare cases of positive rains, and of great negative deflections without apparent rain in the neighbourhood. (This predominance of negative electricity in rain clouds M. Mascart regards as an important point in the question of the origin of atmospheric electricity.) Neglecting accidental variations, one is struck by the fact that the electricity is much more uniform at night and more variable by day. The potential is also considerably higher at night than in the day. The maximum seems to occur about 9 or 10 P.M.; the curve descends slowly towards 6 A.M., then more rapidly; reaches a minimum about 3 P.M., and then rises again in a nearly uniform manner. The indications by the curves are confirmed by numerical tables of monthly averages of eight daily observations at three hours' interval. The results thus obtained are in contradiction with ideas commonly adopted. M. Mascart remarks that the continuous maximum of positive electricity observed at night may be of an exceptional character, owing to the anomalous season; He also suggests the possibility of previous observations having been vitiated through defective insulation.

THE influence of changes of temperature and pressure on double refraction has been recently investigated by Herr Pfaff, of the Erlangen Society of Physics and Medicine, and with (briefly) the following results:—In crystals of the rhombohedric system, when the temperature is raised, double refraction diminishes in quartz, but increases in vesuvianite, beryl, and apatite; it is not changed in Iceland spar (perpendicular to the principal axis), carbonates of iron and of magnesia, tourmaline, mellite, ferrocyanide of potassium, zircon, and cassiterite. In the orthorhombic system it increases in the case of arragonite (perpendicular to the median line), celestine (parallel to P); it diminishes in topaz, celestine, and heavy spar (perpendicular to the median line). In the clinorhombic system it diminishes in adularia (parallel to the median line) and mica; it increases in gypsum (parallel to the primary cleavage), remains constant in anhydrite, topaz, arragonite (inclined to the median line), witherite, carbonate of lead, adularia parallel to M), and the anorthic crystals, albite, oligoclase, labrador, anorthite, axinite, cyanite, and sulphate of copper. Pressure on the whole surface produces the same effect as a lowering of temperature in carbonate of magnesia, Iceland spar, celestine, gypsum, and heavy spar; the others do not present any modification, even those which, like topaz and vesuvianite, are very sensitive to variations of temperature.

PROF. REITLINGER and Dr. Urbanitzky have recently presented to the Vienna Academy the first portion of a memoir "On the Phenomena of Geissler Tubes under External Action," giving in more developed form, an investigation, of which they had already published some results. Various interesting experiments are described, *e.g.*, with reference to the attractions and repulsions of the light columns in Geissler tubes, and a possible joint action of the electrostatic and dynamic states in these, the authors hung a strip of tinfoil (15 ctm. long) from a platinum electrode at the top of a tube, 20 ctm. long, connected with a mercury pump (the second electrode being a straight platinum wire). Before rarefaction commenced the strip flew to the side, immediately the Ruhmkorff was set in action. But on rarefying, this phenomenon became less pronounced, till at 7 mm. the strip hung freely down in the middle. When in this state, it was attracted by a shellac rod rubbed with cloth, and repelled by a glass rod rubbed with amalgam (if the strip was connected with the positive pole, conversely in the other case); but these actions diminished as the rarefaction proceeded, becoming hardly perceptible at 4 mm. with the strip positive, and even at 6 mm. in the other case. A good conductor brought near caused attraction at all degrees of rarefaction in one case; but this, too, disappeared in the other. An experiment showing how the action of static electricity on a conductor is arrested when the latter is made a carrier of dynamic electricity, was made by bringing a rubbed glass or vulcanite rod near the strip, which thereupon went from the vertical to an inclined position. On sending through it the induction current (in either direction) the strip recurred at once to the vertical and remained there.

M. NIAUDET has lately constructed for Prof. Stefan, of Vienna, a Gramme magneto-electric machine, in which the permanent steel magnets are of circular form, instead of the usual elongated horse-shoe shape. The soft iron cheeks which embrace the rotating armature are also of a peculiar form. The new machine is much more compact than those hitherto constructed, and gives very satisfactory results.

A VERY singular theory of electricity and magnetism has recently been put forward by M. Bjerknes, who endeavours to explain the various phenomena upon mechanical principles. If a number of spherical bodies are plunged in an incompressible liquid, in the midst of which they execute isochronous vibrations, they are found to exercise certain forces upon one another. These forces may be either attractive or repulsive, according to the nature of the motions executed. Thus the actions exercised by an electrified particle may be illustrated by a pulsating sphere, that is to say, one which periodically increases in volume. A sphere vibrating to and fro similarly represents a magnetic particle. Unfortunately, however, the theory, to be applicable to electric and magnetic phenomena, would require the forces to act just in opposite directions to that which is found to be the case; for with M. Bjerknes' spheres the like poles attract, while the dissimilar poles repel. Experimentally, the attractions and repulsions thus theoretically deduced have been observed by means of an ingenious apparatus constructed for the inventor in Sweden. The pulsating bodies are a species of elastic capsule suspended from knife-edges by a hollow tube, by means of which the air is forced into and out of the capsule in rapid alternations. The vibrating bodies are little spheres set in motion by delicate levers. The mechanism is in each case driven by a pulley turned by hand. The liquid in which they are immersed is water, and the resultant attractions and repulsions are very clearly demonstrated.

M. GERNEZ has been studying the little-known phenomena of evaporation and distillation under the influence of electrification, discovered by the Abbé Nollet in 1746. The results of M. Gernez's observations have been communicated by him to the Physical Society of Paris, and are of considerable interest. Two concentric tubes communicating with one another above only are filled with a liquid to a common level. Sparks from a Holtz machine are then passed across the intervening air, when it is found that the level rises at the negative and falls at the positive pole. There is, therefore, apparently an actual transport in the direction conventionally agreed upon as the direction of the current. M. Gernez is inclined to attribute this phenomenon to an electrical transport of the liquids along the moistened surfaces of the tubes. Pure alcohol distils over thus at a rate three times as great as that of water, but a mixture of alcohol and water in equal parts at a less rate than pure water. The rapidity of the distillation is increased by the addition of any soluble salt or of a few drops of sulphuric acid or of ammonia solution. No appreciable amount of distillation takes place with bisulphide of carbon, tetrachloride of carbon, or with turpentine. M. Gernez, however, does not think that there is any assignable relation between the conductivity of a liquid and its rate of electro-convective evaporation; nor does he think that there is any necessary connection between this phenomenon and that discovered by Porret of the electric endosmose of liquids across diaphragms of various kinds.

GEOGRAPHICAL NOTES

AT the last meeting of the Russian Geographical Society, in the section of Physical Geography, M. Rylcke communicated the results of his precise measurements on the levels of the Baltic and of the Black Sea. These measurements were begun in 1877, by order of the General Staff, according to the resolutions of the Brussels Congress. Accurate measurements in the ports of the Baltic have proved undoubtedly that the level of the sea at Cronstadt is, by nearly two feet, higher than at Reval, and that its height decreases regularly from north to south, this conclusion being fully supported by Prussian measurements at Memel and at Kiel. For a comparison of the level of the Baltic with that of the Black Sea the necessary computations are not yet advanced enough to yield trustworthy results.

IN his last paper on the Agomes Islands (*Isvestia*, 1879, p. 37) M. Miclucho-Maclay says that here he happened to determine the dimensions of the heads only of fourteen men, and that the so-called "index of the breadth" varied from 69·6 to 81·3; it was thus nearly the same as on the Taui Islands (70·5 to 84·5), where the traveller has done no less than 119 measurements, and does not much differ from what was seen of the Papuans of New Guinea, whose "index" varies from 62·0 to 86·4. According to this wide variation of the "indexes," M. Maclay affirms that we have no right to describe the heads of Melanesians as well as those of the Papuans as dolichocephalic, but rather as mezocephalic; and that the form of the head must not be considered as a proof of a race-distinction between Negritoes and Papuans, as both Melanesians and Papuans display an obvious tendency to brachycephalism, whilst this last was formerly considered as a distinctive feature of the Papuans from the natives of the Philippine Islands. He considers also that within the same races we shall always find both forms of heads, and that a true classification of human races cannot be established on this sole feature; it must be based on a thorough study of the whole of the comparative anatomy. A few measurements on living subjects, however accurate, cannot give the necessary solid bases for a scientific classification.

ACCORDING to a telegram received in Paris from Sierra Leone, two Frenchmen, MM. Zweifel and Moustier, have at length discovered the sources of the River Niger, a feat which has hitherto baffled all explorers. The party appear to have been recently instructed by their employer, M. Verminck, of Marseilles, to explore the Niger for both scientific and commercial purposes; and accordingly, starting from Sierra Leone and following the course of the Kobelle, they reached the foot of the Kong Mountains. By adroit treatment of the hostile tribes at this point, where foreigners had always been refused passage, they were allowed to pass the mountains and explore the three streams which, uniting after a short distance, form the River Niger.

BEFORE concluding his recent explorations in South America, Dr. Crevaux made two attempts to ascend the Içą or Putumayo tributary of the Amazon. Having failed the first time, he ascended the main stream to Tabatinga, on the frontier of Peru and Brazil, and then returned to Para. He there obtained means to enable him to carry out his original intention, and at the second attempt succeeded in ascending the Içą to Cnembe, to the north of Cotopaxi, on the frontier of Bolivia and Ecuador. Starting from this place on May 16, Dr. Crevaux reached the foot of the Andes in eight days. Thence continuing his route towards the north, he arrived at the sources of the Japura after sixteen hours' march. After experiencing great hardships, and hostility on the part of the natives, he reached the Amazon again on July 9, arriving at Para on July 24. He has brought back with him much information interesting alike from a geographical and ethnographical point of view, as well as a collection of plants, which are expected to prove useful as medicines.

IN publishing an interesting letter from its special correspondent with the Russian expedition against the Tekke Turkomans, the *Daily News* states that the "nature of the ground along the course of the Attrek from the Caspian Sea has never been accurately described from personal observation." Without wishing to undervalue this and other letters from the same source, we may be permitted to point out that the ground had been previously examined by a party under General Llomakin, and that Sir Henry Rawlinson, in his paper on the "Road to Merv," read before the Geographical Society on January 27, quoted at length from Russian newspapers a description of this very route by a member of the expedition. A summary of the letters, giving an account of this expedition, which had been addressed to the *Moscow Gazette*, also appeared in NATURE, vol. xix. p. 271.

A LETTER from Herr Hildebrandt, dated Nossibé (Madagascar), states that he has visited Beravi, where the unfortunate traveller, Dr. Chr. Rutenburg, was murdered some time ago. Hildebrandt erected a stone monument on the spot; the body, however, could not be found, in spite of the most assiduous inquiries, the murderers having thrown it into a mountain torrent. Hildebrandt has photographed the spot, and sends a copy to Bremen, accompanied by the last diary and stenographical notes of Rutenburg.

THE Geographical Society of Algiers has nominated for its president M. MacCarthy, an explorer of the Algerian Sahara, who is settled in Algiers, and has been appointed librarian of the National Library of Algiers. This Society has been divided into three sections: Political Geography, Economical Geography, and Physical Geography.

THE Belgian African Society has received letters from Zanzibar, according to which MM. Popelin and Van der Heuvel had arrived at Mpwapwa on August 15 and at Chunyu on September 2. They were to leave the latter place on September 3, and to penetrate into the Ugogo district. At Mpwapwa they met the elephant caravan led by Carter. Each elephant carried about 10 cwt. The march was performed most satisfactorily. In the districts where the tsetse flies abound, the animals were often covered by them without feeling any the worse for it. Only one elephant died through change of nourishment, the whole caravan being fed with what the country offered. M. Dutalis, who suffered from a severe attack of fever, has returned to Europe.

THE Geographical Society of Munich has conferred the title of Honorary Members upon Prof. Nordenskjöld, Dr. Joseph Chavanne (Vienna), and Dr. Emil Holub (Prague). The reception of the latter upon his return to Prague was most enthusiastic. He had been absent for over seven years. The Vienna Geographical Society has elected the following gentlemen as Honorary Members:—Prof. Ujfalvy (Paris), General Kauffmann (Tashkend), Dr. E. Holub (Prague), and Prof. Arendts (Munich). The last-named gentleman has also been nominated Corresponding Member of the Paris Society for commercial geography.

A GENERAL "Geographentag" will be called at Berlin during the summer of 1880. Its special object will be the consideration of plans for the formation of a great German "Gesellschaft für Erdkunde." The idea is not a new one, but projects for the new General Society have already been mooted upon several occasions. At the recent Karl Ritter celebration at Berlin, a "commission" was appointed and charged with the working out of certain preliminaries referring to the subject. The commission is formed of Dr. Nachtigal (Berlin), Prof. Neumayer (Hamburg), Prof. Bruhns (Leipzig), Prof. Rein (Marburg), and Dr. Roth (Dresden)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—In a congregation held on Tuesday, November 18, the amendments to the proposed statute to confer degrees in natural science were taken into consideration. The proposed statute made Greek an optional subject in the natural science curriculum. It appeared from counsel's opinion that the proposed degree would not carry with it the rights and privileges of the master of arts degree. On the latter ground opposition was made to the statute by a considerable portion of those engaged in teaching natural science at Oxford. Prof. Odling had issued a memorandum, extensively signed by residents interested in science, in which he had explained his reasons for opposing the statute. The statute, by completely separating the faculties of arts and natural science, would allow no honour student in one faculty to become an honour student in the other without beginning in the new faculty *ab initio*; and no honour student in the faculty of natural science could fall back, as at present, on the ordinary pass degree. The broader question of lowering the value of natural science degrees by putting them on a different footing from degrees in arts, was not discussed in congregation on Tuesday; but Dr. Magrath's amendment to reject the whole statute except the preamble, was passed by a vote of fifty-four against forty-eight. The whole subject will thus have to be rediscussed on a future occasion.

The examination in the Honour School of Natural Science will commence next Monday, November 24.

CAMBRIDGE.—The Cambridge women students add no unimportant quota to the numbers in residence, numbering something lik 160 or 170 this term. At Girton College there are over fifty students, including about six of the first year who purpose studying natural science. They have a good chemical laboratory, under Miss Herschel's superintendence, also a library which includes many valuable presents of books and apparatus. There are now eleven lecture- and class-rooms, and a good hospital and nurse's room have been built, capable of being entirely detached from the rest of the College. Miss Tomlinson's success in winning an entrance scholarship at the London School of Medicine for Women, and entering for the London Medical Examinations, will doubtless tend to show that a Cambridge course in science is no bad preparation for women as well as men before proceeding to medical degrees.

The Newnham College Association will shortly have two houses of residence facing one another, together with a complete set of lecture-rooms and a chemical laboratory. There are eighty-two students in residence at Cambridge who have come for the lectures to women, besides about twenty who attend the lectures each term, being residents, school-mistresses, &c. Miss Lawrence, who gained marks equivalent to a second-class when informally examined in the last Natural Sciences Tripos, remains in residence, and demonstrates for the lady-students who attend Dr. Michael Foster's and Mr. Balfour's lectures. Mr. Vines's lectures on Vegetable Physiology are open to ladies who obtain special permission.

Mr. Freeman, of St. John's College, has given to the Women's Association a quantity of valuable electrical apparatus which will be used in giving instruction in experimental physics. Mr. R. T. Wright, on leaving Cambridge, resigns his active work for the Association as secretary, and pending the formation of the Newnham College Company, Miss M. G. Kennedy is appointed secretary to the Association for the remaining period of its existence. Nine scholarships have been awarded by the Association on the last higher local and other examinations, and over 700*l*. thus given or lent to students in one year. About 1,000*l*. has been paid to the Association during the year by students attending its lectures. As soon as the memorandum and articles of association of Newnham College are complete, a copy will be kept by Mrs. Bateson at St. John's Lodge, for inspection by any member of the existing Association.

A noteworthy entertainment of the British Medical Association by Cambridge University, town, and county, may be expected next August, when Prof. Humphry will preside. The president's position will be very conspicuous, for he is now, by Mr. Lestourgeon's retirement, senior surgeon and clinical lecturer on surgery to the Cambridge (Addenbrooke's) Hospital and Medical School, as well as professor of anatomy. A public meeting was held on Friday, the 14th, in the Cambridge Guildhall, at 2.30, under the presidency of the Vice-Chancellor (Dr. E. H. Perowne, Master of Corpus Christi College), when Dr. Humphry made a statement of the objects of the Association and the proposed arrangements for the meeting. His son, Mr. A. P. Humphry, one of the Esquire Bedells, is honorary secretary of the Local Executive Committee. Most probably at least a thousand members will attend the meeting. Dr. Michael Foster will deliver the address in Physiology, and Mr. Timothy Holmes that on Surgery. Dr. Paget, Regius Professor of Medicine, will preside over the section of Medicine, he having been president of the Association itself when it last met in Cambridge; and Sir James Paget will be president of the newly constituted section of Pathology. Dr. J. B. Bradbury is to deliver the address in medicine at the meeting; he holds the Linacre Lectureship, delivering lectures on pathology, is medical lecturer of Gonville and Caius College, and one of the physicians to Addenbrooke's Hospital, and took a distinguished position in the Cambridge Natural Sciences Tripos.

Mr. G. B. Atkinson, Trinity Hall, Cambridge, has been appointed secretary of honour examinations.

We are glad to learn that mathematics and geology are now studied by more students who enter the Cambridge Higher Local Examinations. In the examination in mathematics in June, the candidates showed better style and appreciation of mathematical ideas. All the subjects gain favourable reports, and in astronomy one candidate did remarkably well. The work in the differential and integral calculus was good, the introduction of this paper having been successful. In botany there was much guesswork and little evidence of histological work by candidates. One of the candidates, placed first in zoology, sent up admirable work in botany. Some candidates did very well in practical chemistry. The examiner's report on physiology, now first introduced as a separate subject, is on the whole favourable; only one set of papers on physics was sent up. In 1879, Group C (Mathematics) had 60 candidates, of whom 19 failed and 8 obtained a first class; in Group E, 73, of whom 35 failed and 4 obtained a first class.

The Report of the Board of Natural Sciences Studies, which we referred to last week, was rejected by 46 to 26 votes. Prof. Paget and Mr. Bettany issued a fly-sheet complaining that the subjects of examination were now too numerous and extensive; encouraging candidates to an injurious amount of memory-work in attaining "general knowledge and proficiency;" and that there should now be a Biological and a Physical Tripos. Mr. Sedley Taylor and Mr. Vines, as well as Prof. Dewar and Mr. Balfour, object to the advance of human anatomy to so conspicuous a place in the Tripos Dr. Humphry considers the recognition of human anatomy in the Tripos not greater than it deserves. However, he would now prefer a "Medical Tripos."

SCIENTIFIC SERIALS

Journal of Anatomy and Physiology, Normal and Pathological, vol. xiv. part i., October.—Drs. Gibson and Malet, on a pre-sternal fissure, uncovering the base of the heart, pl. 1.—Dr. W. Ostler, case of congenital and progressive hypertrophy of the right upper extremity.—Prof. Flower and Dr. Garson, the scapular index as a race character in man.—Dr. W. Allen, the varieties of the atlas in the human subject and the homologues of its transverse processes, pl. 2.—Prof. Cleland, note on the foregoing.—Dr. Creighton, the infection of the connective tissue in scirrhous cancers of the breast.—Dr. Watson, the homology of the sexual organs, illustrated by comparative anatomy and pathology.—Prof. Bridge, on the pori abdominales of vertebrata.—Prof. Turner, on the pori abdominales in some sharks.—Prof. Turner, a description of a cleft sternum.—Dr. J. Barlow, the physiological action of ozonised air.—Prof. Charles, on the mode of propagation of nervous impulses.—Dr. Cook, on a logwood staining solution.—Dr. Dobson, case of the development of hair on the eyeball of a dog.—Dr. Osler, on Giacomini's method of preserving the brain.—Anatomical notes.

THE recent numbers of the *Scottish Naturalist*, which has now been in existence for nine years, show no falling off from the interest of the earlier ones. In addition to the descriptive papers and lists of localities in the various departments of natural history, we find in the last number a paper on the Gaelic names of plants, one on the effects of the past winter and present summer on hard-wooded plants, and one on the auriferous quartz of Wanlockhead. The list of Scottish insects by experts in the various sections of entomology is still continued in each number. The number for October contains an appreciative notice of the late excellent naturalist, Sir Thomas Moncreiff, Bart., president of the Perthshire Society of Natural Science.

Royal Society of Tasmania, Papers and Proceedings of, for 1877.—Hobart Town, 1878.—Among the more important papers are the following:—F. W. Hutton, on some South Australian Polyzoa (describes several new species from the shores of St. Vincent's Gulf).—Rev. J. E. T. Wood, census, with brief descriptions of the marine shells of Tasmania and the adjacent islands.—Rev. W. W. Spicer, on alien plants.—Rev. J. E. T. Woods, on Australian Siphonaria (describes a new species, *S. zonata*).—M. Allport, on the present stage of the salmon experiment (November 12, 1877).—Baron Ferd. von Mueller, contributions to the phytography of Tasmania, in which he adds a few more plants to his previous enumeration and effects a few changes in nomenclature; there is added a note on *Phyllota* (*Pultenaca*) *diffusa*.—Rev. J. E. T. Woods, on some new Tasmanian marine shells (describes several new species).—The meteorology of Hobart Town, January to December, 1877. In January apricots and Jargonelle pears were ripe, the general apple and pear crop in February. Leaves commenced to fall in March; the chrysanthemums were in flower in April; Lachenalia and Photinia in May; crocuses and *Pyrus japonica* in June; almonds in full bloom in July; trees breaking into leaf in August; horse chestnut in flower in September; mulberry and lime trees in leaf in October; cherries and strawberries ripe in November; currants and gooseberries in December.

Morphologisches Jahrbuch, Band 5, Heft 3.—Dr. G. Born, on the nasal cavity and tear passages in the amniotic vertebrates, pls. 23-24.—L. Graff, on *Geonemertes chalicophora*, a new land Nemertine, pl. 25-27. This new species was found in the earth of a flower-pot in the palm-house at Frankfurt. The larger specimens were 12 mm. in length and $\frac{2}{3}$ mm. in breadth; they are of a milk-white colour. A list of the land nemertines now known is appended, these being the original species of the genus described by Semper, *G. palaensis*, and *Tetrastemma agricola*, of Willemoes-Suhm.—M. v. Davidoff, on the comparative anatomy of the posterior limbs in fishes, pl. 28-31, to which is appended a note by the editor, Prof. Gegenbaur, on the limb question.—Notice of Schneider's "Comparative Anatomy."

Journal of the Russian Chemical and Physical Society.—The last number of this journal contains a paper by Prof. Butleroff, on the present meaning of the chemical theory.—The conclusion of the researches, by M. Lebavin, on the nucleine of milk.—On derivates of the fumaric and maleic acids, by M. Ossipoff.—On cholécamphoric acid, by M. Latchinoff.—On a new alkali derived from quinine, by MM. Wischnegradsky and Prof. Butleroff.—On the theory of dispersion of light, by M. Cheboueff.

SOCIETIES AND ACADEMIES

London

Mathematical Society, November 13.—Mr. C. W. Merrifield, F.R.S., president, in the chair.—The treasurer's and secretaries' reports were read.—The new council was elected, the only changes in which were the substitution of Messrs. Leudesdorf and Lloyd Tanner, in the place of Dr. Spottiswoode, P.R.S., and Prof. H. J. S. Smith, F.R.S., the retiring Members.—The Chairman briefly, but in feeling terms, alluded to the losses the Society had recently sustained by the deaths of such accomplished mathematicians as Prof. Clifford, Sir J. G. Shaw Lefevre, and Prof. J. Clerk Maxwell.—The following communications were made to the Society:—(1) On the binomial equation $x^p - 1 = 0$, trisection and quartisection, Prof. Cayley, F.R.S.—(2) On cubic determinants and other determinants of higher class, and on determinants of alternate numbers, Mr. R. F. Scott.—(3) On a problem of Fibonacci's, Mr. S. Roberts, F.R.S.—(4) Notes on a class of definite integrals, Mr. T. R. Terry. (1) was principally concerned with the presentation in a simplified form of results given in Reuschle's "Tafeln complexer Primzahlen welche aus Wurzeln der Einheit gebildet sind" (4to, Berlin, 1875), and in Jacobi's "Canon Arithmeticus" (4to, Berlin, 1839). (2) was on a branch of determinants which has received but little attention in this country. Mr. Lloyd Tanner communicated a paper on the subject to the Society at its June meeting in the present year. Amongst Continental papers are memoirs by Armenante, Padova, and Garbieri (in the *Giornale di Matematiche*), Dahlander and A. de Gasparis. (3) was an account and extension of work done in the Diophantine Analysis by Fibonacci, and recently by Genocchi. (4) The integrals considered were

$$\int_0^\pi \frac{\cos p x \, d x}{(1 - 2a \cos x + x^2)^n} \text{ and } \int_0^\pi \frac{\sin^2 p x \, d x}{(1 - 2a \cos x + a^2)^{n+p}},$$

where p is a positive integer and n any real quantity, positive or negative, integral or fractional.

Geological Society, November 5.—Henry Clifton Sorby, F.R.S., president, in the chair.—Henry Bruce Armstrong was elected a Fellow of the Society.—The following communications were read:—On the probable temperature of the primordial ocean of our globe, by Robert Mallet, F.R.S. According to the latest hypotheses as to the quantity of water on the globe, its pressure, if evenly distributed, would be equal to a barometric pressure of 204·74 atmospheres. Accordingly water, when first it began to condense on the surface of the globe, would condense at a much higher temperature than the present boiling-point, under ordinary circumstances. The first drops of water formed on the cooling surface of the globe may not impossibly have been at the temperature of molten iron. As the water was precipitated, condensation of the remaining vapour took place at a lower temperature. The primordial atmosphere would be more oblate and less penetrable by solar heat than the present, and the difference of temperature between polar and equatorial regions would be greater; so that, in the later geologic times, ice may have formed in the one, while the other was too hot for animal or vegetable life. Thus, formerly the ocean would be a more powerful disintegrant and solvent of rocks, mineral changes would be more rapid, and meteoric agencies would produce greater effects in a given time.—On the fish-remains found in the cannel coal in the middle coal-measures of the West Riding of Yorkshire, with the description of some new species, by James W. Davis, F.G.S.—On the skull of *Argillornis longipennis*, Owen, by Prof. R. Owen, C.B., F.R.S. In this paper the author described a fragmentary cranium from the London clay of Sheppey, from which it was procured by Mr. W. H. Shrubsole, who also furnished him with the humerus described in a former paper under the name of *Argillornis longipennis*.[1] In the present specimen the lower jaw and the fore-part of the upper jaw are deficient. The author described the characters presented by the specimen in detail, and stated that, like those of the humerus previously described, they seemed to approximate the fossil most nearly to the albatross among existing birds, although, like *Odontopteryx*, it differed from *Diomedea* and also from the cormorant and the totipalmates generally, in the absence of the basirostral external nares and of the supraorbital gland-pits. The present fossil differs from *Odontopteryx* in having the fore-part of the frontal broader and the upper tract of the bill less defined, as also in some other characters; but no comparison of the palatal structure can be made upon the existing specimens. In point of size, taking the albatross as a term of comparison, this skull may well have belonged to a bird with wings of the extent indicated by the humerus already described: and the resemblance of the skull to that of the albatross would also seem to be confirmatory of the specific collocation of the two specimens. The presence of four small pits or perforations on the only part of the alveolar border which appears to be uninjured, leads the author to conjecture that the bird may have been dentigerous.

Physical Society, November 8.—Prof. W. G. Adams in the chair.—The first paper read was on an analogy between the conductivity for heat and the induction balance effect of copper-tin alloys, by W. Chandler Roberts, F.R.S. Mr. Roberts traced a remarkable resemblance between a curve representing the induction balance effect of the copper-tin alloys published by him in June last, and the curve of Calvert and Johnson for the conductivity of heat, and on the other hand he showed that the induction curve does not agree with Matthiessen's curve for the electric conductivity of the same alloys. The author showed that the two alloys which occupy critical points of the curve ($SnCu_3$ and $SnCu_4$) are of much interest. Possibly both are chemical combinations, and the wide difference in the position they occupy probably marks a difference of allotropic state. For the solution of such questions, however, Mr. Roberts considered that we might look with confidence to Prof. Hughes' beautiful instrument, which, he hopes, will also help us to determine whether the relation between conductivity for heat and electricity is really as exact as it has hitherto been supposed to be. As supplementary to this subject Dr. O. J. Lodge stated that he had compared the conductivity of six bars of the tin-copper alloys, as measured by the balance and by the Wheatstone-bridge, and found them to agree very closely. The bridge results confirmed the resemblance traced by Mr. Roberts. Prof. Hughes expressed his opinion that existing tables of conductivity were erroneous. They disagreed among themselves

[1] *Quart. Journ. Geol. Soc.*, vol. xxxiv. p. 124.

and the induction-balance showed that it was difficult to get two pieces of the same metal exactly alike; hence the variation of specific conductivity results.—Prof. Ayrton stated that at a former meeting he had suggested that the electric inertia of the different specimens of metal tested might cause the difference between the results obtained by the Wheatstone Bridge and the induction-balance. Calculation had since led him to the conclusion that the inductive effect is not proportional to the resistance of the metal tested, but to an expression in which the resistance is an exponential. Prof. Hughes replied that as the inductive effect of the metal was destroyed by cutting it so as to interrupt the circuit in it, it was reasonable to suppose that the said effect was due to induced currents circulating in the metal, and therefore was proportional to the conductivity of the metal.—Capt. Armstrong exhibited a standard Daniell cell formed of a porcelain vessel with a porous partition dividing it into two compartments. In one the zinc plate was immersed in a solution of sulphate of zinc, in the other the copper-plate in a solution of sulphate of copper. To use the cell as a standard, it was only necessary to connect the two liquids by a cotton string moistened with water. This arrangement prevented mixing of the liquids, as the string could be withdrawn after use. The resistance was high, but it was a constant standard of electromotive force.—Prof. Guthrie mentioned that Prof. Pirani, of Melbourne, in a letter to him had pointed to the fact that when a dilute acid was being electrolysed, the positive electrode, if made of iron, became incandescent below the surface of the liquid. Prof. Guthrie had found this to be true not only for iron but for other metals, and that it could hardly be due to oxidation, because it took place not only at the cathode or positive electrode, where oxygen was evolved, but also at the anode where hydrogen was evolved. The incandescence appeared to him to be due to resistance. The author exhibited certain experimental results. The positive electrode when immersed in the electrolyte was seen to get red hot and to vibrate rapidly. As the liquid heated the red glow became fainter. The negative electrode, on the other hand, emitted a bright light, accompanied by a noise. The light was tinged with the characteristic colour of the flame of the metal of which it was composed; in the case of a copper electrode, for example, it was greenish. These effects were shown by Prof. Guthrie with iron, copper, and platinum electrodes, in dilute sulphuric and dilute nitric acid. In reply to Prof. Adams, Prof. Guthrie said he had not yet examined the flame by the spectroscope; and in reply to Prof. Foster he stated that the battery power used was fifty Grove's cells. He asked for suggestions as to the cause of the phenomenon.

PARIS

Academy of Sciences, November 10.—M. Daubrée in the chair.—M. de Lesseps stated that a corps for boring operations had been sent out to Panama, and he was going out in a month with a commission of selected engineers of various countries. He applied for a committee to formulate a programme of observations that might be useful to science.—Climatological conditions of the years 1869 to 1879 in Normandy, and their influence on ripening of the crops (first note), by M. Mangon. The observations were made at Saint-Marie-du-Mont (Manche), a few kilometres from the sea. The exceptional character of 1879 in temperature and rainfall is shown by numerical data (the relation to the crops being reserved for another paper).—On a new species of the genus *Anomalurus*, by M. Milne Edwards. The animal was in a collection formed at the Gaboon, by M. Leglaize. It is remarkable for its beauty of colours, and the author calls it *A. erythronotus*. It is like *A. fraseri* in general proportions, but is easily distinguished. The discovery raises to six the number of representatives of *Anomalurus;* all belong to the west of tropical Africa.—On the presence, in surface layers of the ground, of fecundated winter-eggs of phylloxera, by M. Boiteau.—On the results of treatment of phylloxerised vines with sulpho-carbonate of potash, and on the mode of use of this agent, by M. Mouillefert.—The satellites of Mars in 1879, by Mr. Hall.—Determination of the figure of apparent repose of an inextensible cord in motion in space; conditions necessary for its production, by M. Léauté.—On the thermal absorbent and emissive power of flames, and on the temperature of the voltaic arc, by M. Rossetti. For 0·01 m. of any flame traversed by radiation from a flame of the same nature, the coefficients of transparence and of absorption are represented, respectively, by 0·865 and 0·135 m. A thickness of 1 m. renders a flame almost completely athermanous for rays from another like flame. The absolute thermal emissive power of white gas flames (or the intensity of radiation of such flames of indefinite thickness, compared with that of soot at a temperature equal to the mean temperature of the flame), is equal to unity; that of a Bunsen flame 0·3219. A large number of experiments gives about 3900° C. as the maximum temperature of the positive polar carbon extremity, and 3150° for the negative; for the voltaic arc, between these, a temperature of about 4800° (with any intensity of current or thickness of arc).—Researches on the passivity of iron, by M. Varenne. Fuming nitric acid does not act on iron and render it *passive*, so that it is not attacked by dilute nitric acid. The author describes various experiments throwing light on the case. It appears that any agitation in the neighbourhood of the passive metal, whether by a shock or a vibration, or by a current of gas (very weak it may be) as from spongy platinum placed at the bottom of the vessel of dilute acid, in which the passive iron is hung, abolishes the passivity. The gaseous sheath formed on the iron seems to be the obstacle to attack. It is more adherent on a smooth surface, and on a specimen of great molecular condensation than on one rugous and less compact. *In vacuo* the sheath, and with it the passivity, disappear.—On alcoholic fermentation, by M. Cochin. He concludes from experiment that yeast does not produce a soluble alcoholic ferment.—Complementary note on calcination of the *vinasses* (or spent-wash) of beetroot, by M. C. Vincent. A reply to MM. Duvillier and Buisine.—On the organisation and the cellular form in certain kinds of mosses (*Dicranum* and *Dicranella*), by M. Heckel.—On the resistance of sheep of Barbarine race to inoculation with *charbon*, by M. Ollive. He affirms the generality of this character. During the eight years he has lived in Mogador he has never met with any case of the disease.—On the rhythmic excitability of the muscles and their comparison with the heart, by M. Richet. For the heart, as for the muscle of a claw of the cray-fish, contraction (systole) exhausts the muscular element, which then ceases to contract; but it is restored very quickly, and it is during the period of exhaustion (diastole) that the reparation takes place. The cause of rhythm is the same in both heart and muscle—rapid exhaustion and rapid reparation.—Comparison of the action of various curares on the smooth and striated muscles, by M. De Lacerda. They differ in intensity of action on these muscles, not in the nature of the action.—On medullary osseous abscesses, by Dr. Chassargnac.—M. Larrey presented Dr. Bateman's work on Darwinism demonstrated by language, and gave an *aperçu* of it.—M. Chasles presented (from Prince Boncompagni) a photolithographed copy of a long letter from Gauss to Mdlle. Sophie Germain, a student of the École Polytechnique.

CONTENTS

THURSDAY, NOVEMBER 27, 1879

THE SACRED BOOKS OF THE EAST

The Sacred Books of the East. Translated by various Oriental Scholars, and Edited by F. Max Müller. Vol. I. *The Upanishads,* Translated by F. Max Müller. Vol. II. *The Sacred Laws of the Aryas,* Translated by Georg Bühler. Vol. III. *The Sacred Books of China,* Translated by James Legge. (Oxford: The Clarendon Press, 1879.)

THE series of volumes, of which the first three have just been issued simultaneously, under the able editorship of Prof. Max Müller, are a very significant sign of our age. Their object is none other than to give to the public the sacred books of the historical religions of the world, translated into English by the best living scholars, without praise or disparagement, and with no reference to theological controversies or the needs of missionary zeal. The translations aim at being exact and faithful representations of the originals, so far as this is possible, and they are published in the interests of science, not of religious dogma. It is intended that the scientific student of religion should possess in them trustworthy materials on which to found his generalisations and build his conclusions. The fact that such a work should appeal to a large public is not so remarkable as the further fact that it has been published at the expense of a university once supposed to be the stronghold of a narrow orthodoxy.

It is difficult to realise that the days are not long past when the very conception of a scientific treatment of religion would have been regarded either with horror or with indifference. The religious world would have none of it; the fashionable world associated science with bones and machinery. The task of translating or of reading the sacred books of other peoples was left to a few zealots bent on destroying the Christianity of modern Europe, or a small band of scholars whose labours were almost unknown beyond the privacy of the study. In many cases, indeed, translation in the true sense of the word was impossible; scientific philology had not yet explained the meaning of half-forgotten Eastern tongues, literary and historical criticism was still seeking its canons, and the wildest notions passed muster as to the antiquity of Oriental books. The mutilated and misunderstood fragments of Hindu or Chinese texts paraded before the reading public were travestied on behalf, now of a traditional orthodoxy, now of an irrational denial of the popular faith. The filthy and absurd rites of later Hinduism were made to subserve the cause of the apologist, while his antagonist retorted with moral excerpts to which a fabulous age was assigned or painted an ideal portrait of Confucius and his doctrines.

Thanks to the application of the scientific method to the study of language, of history, and of society, we can now examine the historical religions of mankind calmly and dispassionately, can estimate their relative influence and importance, can trace their origin and subsequent development. We have learned the great doctrine of historical evolution. The mind of man does not move by fits and starts any more than external nature; it is conditioned by the circumstances surrounding it, and slowly grows to a ripe maturity. The various forms in which the religious emotions of man have clothed themselves, the various dogmas into which they have been crystallised, result from causes which can be discovered by careful research. The words in which they have been expressed lie like fossils in the strata of society revealing to the comparative philologist the ideas that prevailed at the time they were first coined or at the successive periods when their meaning was modified. Doctrine must necessarily develop because the mind of man develops, continually gaining new ideas and new points of view and recasting those of a past generation.

The history of doctrine may be read in the sacred books of a religion and the mode in which they have been interpreted. We see the words of the text gradually becoming fixed and sacred, and then taking upon them strange senses coloured by the beliefs and ideas of a later day. The simple utterances of an Aryan poet came to be regarded as the awful commands of the Almighty, and to constitute an infallible and irresponsible text-book of life and morals, of law and learning.

The relation of a religion, however, to its Bible may be twofold. It may have had an individual founder like the Buddha or Zoroaster, or Mohammed, and then the authority of the founder overrides that of the sacred book which derives its force and sanctity from him; or it may be the slow growth of time and circumstances, moulded, as in the case of Brahmanism, by a powerful priesthood, whose influence and dogmatic system rest entirely on the divine authority with which they have been able to invest their sacred scriptures. In the latter case a far stricter and more uncompromising theory of inspiration is necessary than in the former. To impugn a single jot or tittle of the canon is to overthrow the very foundations of the faith.

It will be a long while before the science of religion can do more than collect its facts and lay down a few broad and more or less provisional generalisations. Only when we know the way in which each of the historical religions of the world has been born and grown up, shall we be able to compare them with one another and with the unorganised religions of barbarous tribes. It has yet to be seen whether the different races of mankind have started with the same stock of religious ideas and followed similar courses of development, or whether, as has sometimes been asserted, each race has its own religion as peculiar and appropriate to itself as the colour of its skin or the character of its hair. If we may argue from the analogy of language the assertion is likely to turn out a false one.

The question of the origin of unrevealed religion cannot, of course, be answered by the study of sacred books. The early struggles of religion to clothe itself in articulate utterance lie too far behind the age of organised faith when a canon first becomes possible. An uncivilised people cannot have a Bible. It may be brought to them by others, but if so, civilisation is brought with it. To determine whether fetishism, or animism or any other "ism" was the primitive form of religion, we must look to other evidences than those presented by sacred books. Sacred books are the records of historical religions only. But it is with these records that the student of religion must begin, rather than with the fragmentary and uncertain relics of older phases of faith.

In his introduction to the first volume, Prof. Max Müller offers some useful words of warning to those who approach the study of these old texts with exaggerated ideas of Eastern wisdom and profundity. "By the side of so much that is fresh, natural, simple, beautiful, and true," there is "much that is not only unmeaning, artificial, and silly, but even hideous and repellent." The extracts culled from them by popular writers, in order to illustrate the exalted character of ancient thought, too frequently stand by the side of other passages which painfully recall the infirmities of human nature. Mankind has worked its way but slowly to its present level of knowledge and enlightenment, and the mixed character of these ancient books may serve to remind us that we, too, have our infirmities and imperfections which will seem as strange to a future generation as those of Eastern sages do to us. Man is the creature of his age, and the best and wisest among us cannot escape from the influences that surround us, and the limitations imposed by the knowledge and prejudices of our own day.

These translations will be useful in dispelling another illusion which the enthusiastic pioneers into the realm of Oriental religion have occasioned. They are as faithful and accurate as the present state of philological science allows, and the reader will, therefore, miss the modern ideas that have too often been read into passages quoted from the sacred books of the East. By changing a word here, and inserting a word there, by assimilating the expressions of the original to the familiar language of our own Scriptures, a false impression of the character of these old books has not unfrequently been produced.

The Upanishads, with which the series of translations opens may be described as the text-books of sacred Hindu philosophy. They preceded the era of the Sûtras, or grammatical treatises on the Veda, the beginning of which may be roughly placed about 600 B.C., and form part of that of the Brâhmanas or Vedic commentaries. They embody the traditional doctrines of the Brahmans regarding the highest objects of human interest and inquiry, and in many cases may be shown to have been incorporated into a Brâhmana. They aim at ascertaining the mystic sense of the Veda, and so lay the foundation of the later Hindu metaphysical systems. At the same time they are not exclusively Brahmanical; on the contrary, they seem composed rather in the interest of the Kshatriya Kings than of the priestly Brahmans. About 150 of them exist, partly in prose, partly in verse, out of which Prof. Max Müller has selected five of the most important to place before the English reader. It must be remembered that, like the Brâhmanas, the Upanishads form part of the inspired Hindu Canon.

The sacred laws of the Hindus, as taught in the schools of Apastamba and Gautama, occupy the second volume of the series. They belong to the Sûtra period of Indian literature, and we have not to read them long to discover the tyrannically Brahman spirit which they breathe. Dr. Bühler considers that the Gautama Dharmasastra is in the main the oldest of existing works on sacred Hindu law. He further places Apastamba at latest in the fourth or fifth century B.C. A translation of the laws taught in the schools of Vâsishtha and Baudhâyana will follow in another volume.

The third volume contains Dr. Legge's translations of the texts of Confucianism, the Shû King, the Shih King, and the Hsiâo King. The Shû King is a collection of historical records, beginning with the reign of Yâo in the twenty-fourth century B.C., and coming down to that of Hsiang B.C. 961. The Shih King or Book of Poetry consists of 305 ancient poems, five of which belong to the time of the Shang dynasty (B.C. 1766–1123), and the rest to that of the dynasty of Châu (B.C. 1123–586). Its philological and literary value is naturally very great. The short treatise known as the Hsiâo King, or classic of filial piety, is regarded by Dr. Legge as containing a Confucian element, but mostly composed in the first century before our era. Astronomical and other reasons on the other hand, dispose him to accept the antiquity claimed by the Shû and the Shih.

Prof. Max Müller may be congratulated on the successful commencement of his great undertaking. The publication of other sacred texts, including the Korân, the works of Lao-tse, and selected portions of the Buddhist and Zoroastrian Scriptures, are expected soon to follow. For obvious reasons, however, the sacred books of ancient Egypt and Babylonia, of which we now possess considerable fragments, have been excluded from the series. The Book of the Dead, the most important part of the Egyptian Canon, will be independently issued before long in a revised text and revised translation, while we must wait for future excavations to complete the mutilated hymns of early Chaldea, a portion only of which is at present in our hands. For many years yet we shall have to be content with collecting and preparing the materials that others will use, with sowing the seed which another generation will harvest. We have, indeed, come to realise that there is a science of religion, but it will necessarily be long before the science has passed out of its firs classificatory stage. A. H. SAYCE

MODERN CHROMATICS

Modern Chromatics, with Applications to Art and Industry. By Ogden N. Rood. International Science Series. (London: C. Kegan Paul and Co., 1879.)

IN Sir Charles Eastlake's preface to his translation of Goethe's "Theory of Colours," he took occasion to pronounce against the accepted theory of Newton (that white light consists of coloured lights compounded together), in the following sentences:—

"It must be admitted that the statements of Goethe contain more useful principles in all that relates to the harmony of colour than any that have been derived from the established doctrine. It is no derogation of the more important truths of the Newtonian theory to say that the views it contains seldom appear in a form calculated for direct application to the arts."

Since the time of Sir Charles Eastlake, however, great strides have been made in the theory of colour. The work of Prof. Rood now before us is the latest contribution to this branch of science; and in dealing with "Modern Chromatics," the author has brought to bear not merely a profound acquaintance with the work of all recent scientific writers on colour-theory, but also an intimate knowledge of the artistic and decorative functions of colour. The reproach laid against the true colour-theory of Newton that it was less fruitful for artistic ends than the false theory of Goethe, is impossible in the face of such modern works as those of Chevreul, Field, Helmholtz, Brücke, and von Bezold. And now Prof. Rood's new work will be welcomed as an addition to the literature of the subject.

The first two chapters are devoted to the general laws of light, and of its dispersion by refraction and by diffraction. Then comes a chapter on the three "constants" of colour, *purity*, *luminosity*, and *hue*, the term luminosity being employed, not as artists sometimes employ it to describe a particular "effect" of light and shade in a picture, but as the equivalent of the measurable intensity or brightness of the light. The author avoids the term "intensity" in this sense, that it may not be confounded with the term "saturation," a quality of colour which depends upon both purity and luminosity, and which is also sometimes erroneously spoken of as the "intensity" of a colour. The four following sections deal with the production of colour by interference and polarisation, by turbid media, by fluorescence and phosphorescence, and by absorption. The last of these chapters is very carefully written, and contains spectroscopic diagrams of a number of absorbing media. Their bearing upon the all-important question of the tint transmitted by two coloured media jointly is clearly explained. The remaining chapters are devoted to Young's Theory, Mixture of Colours, Complementary Colours, Colour Systems, &c. A concluding chapter deals with Painting and Decoration.

Following von Bezold, Prof. Rood rejects the term "indigo" introduced by Newton into the classification of the spectrum colours, and describes the colours between green and violet as *blue-green*, *cyan-blue*, *blue*, and *violet-blue*. The spectrum line F stands between "cyan-blue" and "blue," while "violet-blue" begins about half-way between F and G, and ends a little beyond the latter line. This classification differs slightly from that of Listing.

A detailed account is given of Maxwell's Theory of Colours, of the experiments by which he arrived at his results, and of the colour-chart devised by him. It is unfortunate, however, that the author has divided his excellent remarks on this head, giving part in an appendix to Chapter VIII., part in another appendix to Chapter XIV., and the elementary explanation of the method of balancing the colours upon p. 219 of the text. Apart from this awkward arrangement the matter is admirably put; and is the best exposition of Maxwell's theory in the language. Indeed it is singular that most English text-books ignore Maxwell's work in this department. In the English edition of Deschanel's "Natural Philosophy," which is almost the only one which touches the matter at all, the brief paragraph in which the theory is dealt with lacks the perspicacity that mostly distinguishes that well-known work.

There are one or two sentences in the work which cannot command our assent; and should be revised when another edition is called for. Thus, on p. 86, we are told that Becquerel and other earlier experimenters succeeded in obtaining fleeting photographs of the colours of the spectrum, but that "the colours thus obtained are produced merely by the *interference* of light." And again, "In blue eyes there is no real blue colouring matter *at all*" (p. 58). On p. 94 the author claims as his own an experiment described originally in this country by T. Rose, the inventor of the kalotrope. A reference is given on p. 82 to the darkening of tint of water when heated, due to increased absorption: but the author makes no reference whatever to the important observations of Gladstone, Hartley, and Ackroyd on the similar changes which take place in almost all coloured bodies when heated; nor to the significant observation of the last-named experimenter, that with increasing temperature the absorption appears to increase most in the blue end of the spectrum in the case of those solid bodies of fixed composition which expand with a rise of temperature, while it increases most at the red end for those few bodies such as iodide of silver which contract with a rise of temperature. Hering's theory of colours deserves a more extended notice than the very short note given in the final appendix. A brief account is given on p. 83 of a simple means devised by Simmler for observing the red rays which are abundantly reflected by green leaves: a thick plate of blue cobalt glass in conjunction with a plate of yellow glass serving to cut off all rays except the red and the blue-green. The writer of this notice independently described some few years ago a similar device, in which by taking a solution of permanganate of potash in a glass tank of a convenient size, the blue, green, and yellow rays were similarly absorbed, allowing only red and violet bands to pass, thus constituting, like Simmler's double plate, an erythroscope.

The portions of Prof. Rood's book which bear upon artists' work are numerous, and his observations are of importance. There is, for example, a careful discussion of the change of visible tint suffered by coloured surfaces under diminished illumination; and a parallel discussion of the results obtained by mixing pigments with a proportion of black. A list is given of those pigments which are liable to change or fade by exposure. The reason why oil colours do not materially change their tint on drying is carefully argued; and the *rationale* of Pettenkofer's "regeneration" process for picture-restoring is given. Chapter IX. sums up the indisputable evidence for regarding red, blue (or violet), and *green*, and not red, blue, and *yellow*, as the three fundamental colours, and later on is discussed the reason why a greater luminosity is obtained in mixing two colours optically, or by laying them side by side in minute touches, than is obtained by laying them over one another or by mixing them on the palette; and the author adds no less truly than concisely: "every mixture of pigments on the painter's palette is *a stride toward blackness*."

We can commend the volume to the notice of all who study colour, whether from an æsthetic or a scientific point of view. SILVANUS P. THOMPSON

OUR BOOK SHELF

Zeitschrift für das chemische Grossgewerbe. Kurzer Bericht über die Fortschritte der chemischen Grossindustrie. In Vierteljahres-heften, iii. Jahrgang. Unter Mitwirkung angesehener Technologen und Techniker. Herausgegeben von Jul. Post. (Berlin: Verlag von Robert Oppenheim, 1879.)

THIS volume is the third issue of an Annual Report of Chemical Technology in Europe and America, published in quarterly parts, the contents of each part being arranged under the following heads :—

1. Generalities and Statistics, Description of Apparatus and Machinery, Heat-production.
2. Dry Distillation of Heating and Lighting Materials, Sulphide of Carbon, Petroleum, Coal-gas, Wood-tar, Asphalte, &c.
3. Sulphur, Acids, Alkalis, Aluminium Salts, Borates, Chromates.
4. Oils and Fats, Resins, Glycerin, Volatile Oils, Lubricating Materials.
5. Sugar, Starch, Fermentation, Wine, Beer, Spirits, Vinegar.
6. Food, Meat and its Preparations, Milk and Dairy Produce, Flour and Baking.
7. Dye-stuffs, Dyeing and Calico-printing.
8. Tanning.
9. Matches and Explosives.
10. Glass, Earthenware, Cement, Plaster.
11. Metallurgy—Iron, Copper, Tin, Lead, Bismuth, Antimony, Nickel, Mercury, Silver, Gold, &c.
12. Smaller Industries—Oxalic Acid, Cellulose, Salicylic Acid, Tartaric Acid, Chloral Hydrate, Mineral Waters, Chloride of Zinc.

Detailed criticism of the immense amount of matter contained in the 900 pages of the volume is, of course, impossible. Suffice it to say that the whole has been compiled with great care; every available source of information appears to have been thoroughly ransacked; and the necessarily condensed descriptions of the several processes and products are supplemented by copious references to original papers. Lists of chemical patents taken out in Great Britain, America, France, Belgium, and Austro-Hungary, are also given at the end of each quarterly part, the whole extending to forty closely-printed pages.

In the possession of such a report of chemical industry as the one now under consideration, and of the admirable *Jahresbericht* of Dr. Wagner, the manufacturers of Germany are certainly fortunate; and when we consider the vast extent and importance of chemical manufactures in England and America, it is matter of surprise and regret that no similar work exists in the English language. Projects for such a work have, indeed, been started in this country, but their execution appears to be a problem for the future.

Southern Stellar Objects for Small Telescopes, between the Equator and 55° South Declination, with Observations made in the Punjab. By J. E. Gore, M.R.I.A., A.I.C.E., &c. (Lodiana, 1877.)

THIS small work is divided into two sections. The first contains objects arranged according to the constellations, and chiefly selected from Sir John Herschel's Cape volume, which are within the scope of telescopes of very ordinary capacity, including double stars, clusters and nebulæ, with special reference to stars which may prove to be variable. The second section contains the more original work of the author, who was provided with telescopes 3 and 3·9 inches aperture, in the Punjab, and wholly relates to southern stars possibly variable, some new and noteworthy cases being adduced.

Mr. Gore appears to have made a useful comparison of Harding's "Atlas" with the sky, so far as relates to stars found in it, which do not occur in the great catalogue from the "Histoire Céleste" of Lalande, or are underlined in the "Atlas," and it is in such cases that he has met with the most decided evidence of variability. Amongst them we may note L. 1028, a star twenty minutes due north of L. 8951, one in R.A. about 4h. 58m. for 1880, N.P.D. 111° 14′, apparently variable from 6m. to 9m.; L. 19,662 from 4·5m. to 7m.; L. 23,228; Oeltzen 17,670 (No. 31 in Mr. Gore's list), observed three times by Argelander, and estimated 5, 7, and 5·6, which is 6m. in Harding, but not in Lalande or Heis; No. 37, or Oeltzen 20363, called "a fine ruby star" by Sir John Herschel, and 6½, and found to be only 8½ or 9m., and fiery red with a 3-inch refractor in July, 1875, and L. 43,239. Generally, the objects mentioned in the author's second section will deserve further examination.

There is frequent reference to the magnitudes assigned in Proctor's "Atlas," by the side of those given by such original authorities as Lacaille, Heis, or even Harding; this is a mistake, and is more calculated to mislead than to assist a judgment on the question of variability. The author of this Atlas distinctly states in his preface that he has followed the magnitudes of the British Association Catalogue except for stars in Sir John Herschel's list, which is a comparatively small one; the work is more of a popular description, and so far as we know may be useful to amateurs, but it is idle to quote the indications of this Atlas with those of Argelander or Heis, whose magnitudes are the results of actual comparison with the heavens. Probably after his clear reference to the source whence his magnitudes have been derived, no one will have been more surprised to find his work quoted as an authority in a question of change of brightness of a star than Mr. Proctor himself. We should hardly have referred to this point, were it not that others have made the same mistake as Mr. Gore.

There are many misprints in this small volume, which should be avoided in another edition.

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.*]

A New Nebula

ON November 14, the Rev. T. W. Webb discovered a small nebula, or nebulous star, in Cygnus. It is apparently identical with D.M. + 41, No. 4004, 8·5m.

1880 = 21h. 2m. 31s. + 41° 45′·3.

At Dunecht Observatory the object was seen, on November 22 and 23, to be approximately monochromatic, seen through passing clouds; about 5″ diameter. LINDSAY

Dunecht Observatory, November 24

Does Sargassum Vegetate in the Open Sea?

THE reply of Dr. Wild in NATURE, vol. xx. p. 578 to my query, does not satisfy me, for he partly cites old reports, that are, as I showed, mostly suspicious of being a mixture of the prevalent opinion since Columbus and observed facts.

If it has been stated formerly that pelagic varieties (?) multiply only by simple growth and subdivision, and a wide area covered with sea-weeds corresponding to the Sargasso Sea occurring in the North Pacific, I believe that is only a compilation. I crossed the Pacific Sargasso Sea (as it is printed on the charts) in December, 1874, from 140° W. long., 35° N. lat., to 174° W. long., 29° N. lat., and observed no Sargassum at all! But it is possible that the quantity differs in different years. I ask, therefore—and beg forpersonal observations only—has any one seen a difference in the quantity or density of floating Sargassum in different years, and in what degree or quantity has (1) brownish or olive-coloured, and (2) yellowish pale Sargassum been seen in several years?

A flowering branch with buds of any garden plant, if cut and put into water, does not wither suddenly, but sometimes opens continuous to the buds, and may even sprout, but never for a long time; but we never call such cut flowering branches put into a water-glass water plants. I take Sargassum to be analogical, and it should not be allowed to consider the dying broken Sargassum or Fucus, that swing in the open sea, as pelagic in habit, or as a living variety of the open sea.

If it has been stated that the last branches of floating Sargassum are paler, more delicate, and more active in their vitality; I believe that to be no real observation, but only a supposition, for the more delicate and more branched ends become certainly pale at first, and with the diminution of chlorophyll can never increase their vitality. Does any one know in what time the olive-coloured broken Sargassum gets pale, and if pale Sargassum does really sprout to some extent, which I doubt, how long it continues to sprout? and further, after what time do the dead round air-vesicles of Sargassum break off? I should wish these questions cleared up by personal observations.

Leipzig-Eutritzsch, Germany OTTO KUNTZE

Remarkable Prediction of Cold

IN NATURE, vol. xxi. p. 48, in the Meteorological Notes, it is stated, on the authority of Mr. Glaisher, that the present unusually cold weather set in on October 27, 1878. You perhaps are not aware that this was predicted almost to the day by Prof. Piazzi Smyth in NATURE, vol. v. p. 317. In an article on Heat Waves he gives the dates of these phenomena as follows:—Years 1834·8, 1846·4, 1857·8, 1868·8, and 1880·0; the heat wave of 1880 to be preceded by a cold wave commencing 1878·8, which is, I need scarcely say, the end of October, 1878.

Dulwich, November 17 B. G. JENKINS

The Lizard

LAST August, while superintending the burning of some dry bush in my pasture, I was surprised to see a ground lizard (*Lacerta agilis*) run up to the flames and stop on a bed of hot ashes. My little son who was with me endeavoured to turn it aside with a stick, but on his trying to do so, it darted into the fire and was soon consumed. This I thought at the time accidental, but later in the day we returned to the same spot, and in a few minutes a larger lizard of the same species deliberately ran up to the burning bush; it paused on the warm ashes wagging its tail to and fro, apparently enjoying the heat, when all of a sudden it darted into the flames, and like the first one was instantly a willing holocaust. I turned to the Negro, who was burning the bush, for explanation, but like most of his race he accepted the fact as a matter of course, remarking "lizard seem to love fire." My ideas went back to the legends of the salamander. The story of the French consul at Rhodes (M. Pothonier), who one day found his cook in a terrible fright thinking the "devil was in the fire," and when he looked into the bright flames, saw there a little animal with open mouth and palpitating throat, and on trying to secure it with the tongs, it ran into a heap of hot ashes. He secured it and gave it to Buffon, who found it to be a small lizard, whose feet and a portion of the body were half roasted. M. Pothonier first thought it was incombustible, having remained in the fire three minutes, but imagined that it might have been brought in with the fuel. Nicander, Dioscorides and Pliny, all allude to the fire-proof qualities of the "salamandra." Aristotle speaks of the salamandra's power of extinguishing fire with the copious secretion of saliva which it has the power of ejecting into the flames. As far as my own observation goes all lizards have the power of ejecting saliva. The Negroes have a dread of the croaking lizard's (*Gecko*) "spitting" at them. I do not believe that any Jamaica lizard has *poisonous* saliva, but that the saliva is deleterious, I am quite sure. That cats get "fits" from eating lizards is a well accepted fact, their *hair* falls out, and they become sick and droop, confirming the belief in the depilatory properties of the salamander's saliva. As Martial puts it (Lib. ii. Ep. lxi.):—

> "Desine jam, Lalage, tristes ornare capillos,
> Tangat et insanum nulla puella caput.
> Hoc salamandra notet, vel sæva novacula nudet,
> Ut digna speculo fiat imago tuo."

Before closing these jottings, I should like to correct an error in a recent work on Natural History, in which it is stated that "the *Iguana is extinct in Jamaica.*" This is *not* the case. They are still to be found in numbers on the Cashew trees in the lowlands, especially St. Catherine's. I once had a long fight in trying to pull a large one out of a hole in a tree, by the tail. He won the battle "by the skin of his tail."

Monattrie, St. Andrew, Jamaica, W.I., October 14 JASPER CARGILL

The "Hexameter," Πᾶσα δόσις ἀγαθή . . . κ.τ.λ.

IT is surely no argument against Prof. Clerk Maxwell's notion, that in the epistle (James i. 17) the enclitic particle τε is omitted. Read, of course,

Πᾶσα δόσις τ' ἀγαθὴ καὶ πᾶν δώρημα τέλειον,

and the verse is perfect. The practice of omitting a word (or part of a word) necessary to the scansion of a verse is all too common with prosists quoting poetry. I give one example from an English writer. Robert Greene, the earliest to allude to Shakespeare, in his "Groatsworth of Wit bought with a Million of Repentance" (1692), quotes, just as if they were prose, six lines from a contemporary poet; and in so doing omits two whole words, and part of another! He writes, as prose, omitting all that I here give in italics—

> "*Then* onely Tyrants should possesse the earth,
> *Who* striving to exceede in Tyranny,
> Sh*ould* each to other be a slaughter-man;
> *Un*till the mightiest outliving all,
> One stroke were left for Death, that in one age
> Man's life should end."

I am pleased to learn from the obituary notice in NATURE of that great man, that Clerk Maxwell's thoughts during his illness reverted to Shakespeare; but had he less profitably thought of Greene's assault on Shakespeare, and had it struck him that the foregoing must be in heroic verse, what would be thought of the critic who should object to this, that the first, second, and fourth of these so-called verses are, by one syllable each, too short?

Athenæum Club, November 22 C. M. INGLEBY

IT cannot be supposed that our translators meant to compose a verse when they wrote the line which Longfellow transfers bodily into his "Evangeline":—

"Husbands, love your wives, and be not bitter against them."

So the metrical cadence here may be quite accidental. Still I cannot think that the defect of quantity in the final syllable of δόσις is fatal to the idea that it may be a line from an early Christian doxology: especially when we suppose it written in Alexandrian or Hellenistic Greek. The arsis, or natural stress of the voice, would cover up the defect, especially in chanting; and it would scarcely be a defect at all to non-classical ears. The process which rapidly from the Christian era substituted stress or accent, as we now understand it, for quantity, seems to have been greatly accelerated by the hymns of the Church. In any case every trace of such quotations is of great interest to every student of the New Testament. HENRY CECIL

Bregner, Bournemouth, November 22

Unconscious Cerebration

I HAVE delayed noticing a communication, headed Unconscious Impressions, by Mr. C. J. Monro, in NATURE, vol. xx. p. 426. This refers to what Dr. Carpenter calls Unconscious Cerebration, but which when I discovered it likewise, I called Unconscious Thought.

With Mr. Monro's conclusion that an unconscious impression is stronger than a conscious one, his statement does not impress me, nor is it supported by my own experience.

My attention had been recalled to the subject by observing children, and in their actions it appears to me we may find the beginning of the process of unconscious cerebration. So far it appears that conscious cerebration precedes and lays the foundation for the unconscious process. When a baby is practising, as for instance in handling an object, its attention is closely given in the early stages and in its various experiments, and it is only after a time that the performance becomes purely mechanical.

The same is to be noted of young animals.

Hence I conclude that as various practices become habitual, and, as some style them, instinctive, conscious cerebration ceases to be employed. Thus is formed the habit of only regarding some objects consciously, and necessarily that of regarding others without cerebration. Thus I treat unconscious cerebrations as becoming habitual. HYDE CLARKE

32, St. George's Square, S.W., November 20

Mr. Thomas Bolton's Natural History Discoveries

I ONLY became aware on Saturday evening last, the 15th inst., of the paragraph kindly inserted by Prof. E. Ray Lankester, F.R.S., as editor, in the *Quarterly Journal of Microscopical Science* for October, in reference to my studio and agency for the supply of microscopic organisms. Of course I have to thank him most sincerely for calling the attention of naturalists to my efforts, and so strongly calling on them to support me, but he has given me credit in some directions which is due to other naturalists to whom I am under considerable obligations. I wish to correct this view at once by writing to your periodical in preference to waiting till the next number of the *Quarterly* can appear. Prof. Lankester's language may lead those who have not seen other reports to put down the actual first finding of several organisms new to the British fauna to me, whereas several of them were first picked up by others.

The *Leptodora* was found at Olton during a visit made by a party of the Birmingham Natural History and Microscopical Society on July 26. Whilst the president, Mr. Graham, the curators, Messrs. Levick and Lloyd, some other members, and myself, were searching the pool from a boat, Mr. Levick's unusually sharp eyes first called the attention of the others to some lively organism in his bottle, which he at first thought to be a larva, and Mr. Graham was, I believe, the first to suggest that it was probably a larval form of an Entomostracan. After this they were collected in large numbers with the net. As soon as possible I asked my friend Mr. Forrest to make a drawing, which I had printed, and drew up a short account of it for my subscribers, describing it as a larval form of one of the Entomostraca; but before I had finished writing this I found one carrying four large eggs in the second segment of the body, which fact I added to my description, and which I pointed out would lead to the supposition that it was no larva, but a mature animal. I sent the specimens out on August 1, and the earliest notice I had from my subscribers was from Sir John Lubbock, F.R.S., who wrote by return to say he was much interested in the curious crustacean which he believed to be new to this country, and on August 6 Prof. Lankester wrote to say the crustacean I had sent was the *Leptodora hyalina*. In looking over the water in which we had taken the Leptodora, I found another Entomostracan which was new to me, and I called Mr. Forrest's attention to it, and gave him some specimens which he took home and studied, and finding no trace of them in Baird's "Entomostraca," he made a drawing of it and drew up a description of it for the *Midland Naturalist* of September, under the name of *Daphnia bairdii*. With permission of the editor I distributed copies of this plate and description, with living specimens, to my subscribers on August 8, and on the 13th Prof. Lankester wrote me to say "the beautiful *Daphnia bairdii* of Mr. Forrest is the already described *Hyalodaphnia kahlbergensis* of Schödler" (see Mr. Forrest's further remarks, *Mid. Nat.*, November, page 281). In looking over Prof. Lankester's remarks, I was surprised to see his account of the new Protozoa, which reminded me that on April 30 he had written to me saying that the Amœbæ gathering was only interesting, and asking me to send him a good lot more, as he thought he had found something new, but I could only send him a small tube more, as this, together with the large Amœbæ to which he refers, came from a small beaker aquarium in the study of my friend Mr. Levick.

I must apologise for having taken up so much of your space, but in fairness to Mr. Levick and Mr. Forrest, I could not well let the report pass without comment, giving them full credit of first finding the objects; but at the same time I cannot help thinking that the discoveries (if ever published) would have been much longer before they had been brought before the scientific world, had it not been for the distribution of the specimens through my agency. As it is, however, my wish not to take more credit than is due, I shall always be glad to point out the first finders of organisms which may be entrusted to me for distribution, and which may *afterwards* turn out to be of any special interest.

In furtherance of Prof. Lankester's kind appeal to naturalists for the pecuniary support of my agency, I must really ask them to act upon it, as, so far, my studio is not sufficiently remunerative to induce me to persevere with it much longer, as my receipts for the last year have barely covered my office rent, collecting, and individual expenses. THOMAS BOLTON

17, Ann Street, Birmingham, November 19

Intellect in Brutes

THE following is a curious instance of discrimination, which I have observed in my bullfinch. He is in the habit of coming out of his cage in my room in the morning. In this room there is a mirror with a marble slab before it, and also a very cleverly-executed water-colour drawing of a hen-bullfinch, life-size. The first thing which my bullfinch does on leaving his cage is to fly to the picture (perching on a vase just below it), and pipe his tune in the most insinuating manner, accompanied with much bowing to the portrait of the hen-bullfinch. After having duly paid his addresses to it, he generally spends some time on the marble slab in front of the looking-glass, but without showing the slightest emotion at the sight of his own reflection, or worthying it with a song. Whether this perfect coolness is due to the fact of the reflection being that of a cock-bird, or whether (since he shows no desire to fight the reflected image) he is perfectly well aware that he only sees himself, it is difficult to say.

SOPHIE FRANKLAND

"Asia Minor" in the "Encyclopædia Britannica"

IN the article on "Asia Minor" in the new edition of the "Encyclopædia Britannica," in speaking of Tchihatcheff's "Asie Mineure," the writer says: "But those [vols.] which should have contained the geology and the archæology have never been published." As this may mislead some of your readers it may be worth recording the fact that the part on geology was published in 1867-69; and the palæontological division in 1866-69. J. B. B.

Oxford

ON THE SOLUBILITY OF SOLIDS IN GASES[1]

THIS investigation was undertaken in the hope that, by an examination of the conditions of liquid matter up to the "critical" point, sufficient knowledge might be gained to enable us to determine under what particular conditions liquids are dynamically comparable, in order that the microrheometrical method[2] (which the Royal Society has done one of us the honour of publishing in the *Philosophical Transactions*) might be applied to determine their molecular mass and energy relations. It seemed that as the laws relating to gases and liquids merge at what was called by Baron Cagniard de la Tour[3] "l'état particulier," and by Dr. Andrews[4] the "critical point," an examination of matter up to the limit of the liquid state would be likely to yield us much information. The time we have to devote to scientific work being very limited, we found that it was quite impossible to make much advance by using the apparatus devised by Dr. Andrews, as the time required to change from one liquid to another was more than we had at our disposal. We therefore devised a new apparatus, which will be described in a more lengthy communication, but which, we may state, can be opened, the liquid changed, and again closed for a new experiment, in about one minute.

The question as to the state of matter immediately beyond the critical point being considered by Dr. Andrews to be at that time incapable of receiving an answer, we imagined that some insight might be gained into its condition by dissolving in the liquid some solid substance whose fusing point was much above the critical point of the liquid, and noticing whether, on the latter passing its critical point and assuming the gaseous condition, the solid was precipitated or remained in solution. We found that the solid was not deposited but remained in solution, or rather in diffusion, in the atmosphere of vapour, even when the temperature was raised 130° above the critical point, and the gas was considerably expanded. When the side of a tube containing a strong gaseous solution of a solid is approached by a red hot iron, the part next the source of heat becomes coated with a crystalline deposit which slowly redissolves on allowing the local disturbance of temperature to disappear. Rarefaction seems to be the cause of this deposition, because if

[1] By J. B. Hannay, F.R.S.E., F.C.S., and James Hogarth. Read at the Royal Society, November 20.
[2] "On the Michrorheometer," *Phil. Trans* Roy. Soc., 1879.
[3] *Ann. Chim.*, series 2me, xxi. p. 127; xvii. p. 410.
[4] "Bakerian Lecture," *Phil. Trans. Roy. Soc.*, 1869, p. 588.

the temperature be raised equally and the volume retained at its original value, no deposition takes place. Those experiments have been done with such solvents as alcohol (ethyl and methyl), ether, carbon disulphide and tetrachloride, paraffins, and olefines, and such solids as sulphur, chlorides, bromides, and iodides of the metals, and organic substances such as chlorophyll and the aniline dyes. Some solutions show curious reactions at the critical point. Thus ethyl alcohol, or ether, deposits ferric chloride from solution just below the critical point, but re-dissolves it in the gas, when it has been raised 8° or 10° above that temperature.

It appeared to us to be of some importance to examine the spectroscopic appearances of solutions of solids when their liquid menstrua were passing to the gaseous state, but as all the substances we have yet been able to obtain in the two states give banded spectra with nebulous edges, we are only able to state that the substance does not show any appreciable change at the critical point of its solvent. Such was the case with anhydrous chloride of cobalt in absolute alcohol. It was suggested to us by Prof. Stokes that the substance obtained by the decomposition of the green colouring matter of leaves by acids, and which yields a very fine absorption spectrum, might be useful for our purpose. We have prepared the substance according to the careful directions so kindly furnished us by Prof. Stokes, and find that it shows the phenomenon in a marked manner, whether dissolved in alcohol or ether. The compound is easily decomposed by heat under ordinary circumstances, and yet can be dissolved in gaseous menstrua, and raised to a temperature of 350° without suffering any decomposition, showing the same absorption spectrum at that elevated temperature as at 15°.

We considered that it would be most interesting to examine by this method a body such as sodium, which, besides being an element, yields in the gaseous state sharp absorption lines. An opportunity seemed to be afforded by the blue solution of sodium in liquefied ammonia, described by Gore,[1] but we found that, on raising the ammonia above its critical point, the sodium combined with some constituent of the gas, forming a white solid, and yielding a permanent gas, probably hydrogen.

There seems, in some cases, to be a slight shifting of the absorption bands towards the red, as the temperature rises, but we have as yet been able to make no accurate measurements.

When the solid is precipitated by suddenly reducing the pressure, it is crystalline, and may be brought down as a "snow" in the gas, or on the glass as a "frost," but it is always easily redissolved by the gas on increasing the pressure. These phenomena are seen to the best advantage by a solution of potassic iodide in absolute alcohol.

We have, then, the phenomenon of a solid with no measurable gaseous pressure, dissolving in a gas, and not being affected by the passage of its menstruum through the critical point to the liquid state, showing it to be a true case of gaseous solution of a solid.

Private Laboratory, Sword Street, Glasgow

ON PHOTOGRAPHING THE SPECTRA OF THE STARS AND PLANETS [2]

FOR many years it has seemed probable that great interest would be attached to photographs of the spectra of the heavenly bodies, because they offer to us conditions of temperature and pressure that cannot be attained by any means known at present on the earth. The especial point of interest is connected with considerations regarding the probable non-elementary nature of the so-called elementary bodies. There has long been a suspicion in the minds of scientific men that one or more truly elementary bodies would be found from which those substances which have not as yet been decomposed are formed. The recent publications of Lockyer have attracted particular attention to this topic.

The most promising laboratory processes for accomplishing the dissociation of our present elements depend upon the action of heat, especially when accompanied by electrical influences, and upon relief of pressure. But the temperature we can employ is far below that found in the stars, which is comparable only with the heat of our sun, and when in addition the application of heat is restricted by the narrow range of circumstances under which we can also reduce the pressure, complete success seems to be impracticable in the laboratory.

But in the stars, nebulæ, and comets, there is a multitude of experiments all ready performed for us with a variety of conditions of just the kind we need. It remains for us to observe and interpret these results, and this is the direction I have sought to pursue.

There is but one mode of investigation that can add materially to the knowledge astronomy has given us of the heavenly bodies—that is the spectroscopic. This in its turn is capable of a subdivision into two methods, one by the eye, the other by photography. Each of these has its special advantages and each its defects. The eye sees most easily the middle regions of the spectrum, and can appreciate exceedingly faint spectra; by the aid of micrometers it can map with precision the position of the Fraunhofer lines, and by estimation it can with tolerable accuracy approximate to the relative strength, breadth, and character of these lines. The character of the spectrum lines is, however, of great value for the purposes we are now speaking of, and the greatest precision is needed. Photography, on the other hand, as applied to faint spectra, deals mainly with the more refrangible region, and cannot at present be employed in stellar work below the line F. Fortunately there is no break in the spectrum between the place where the eye leaves off and photography begins, and hence the two methods lend one another mutual assistance. The photograph, when suitably accommodated with a standard reference spectrum from some known source, gives valuable indications as to the positions and all the peculiarities of the lines.

But the application of photography to the taking of stellar spectra is surrounded by obstacles. These are partly due to the small quantity of light to be dealt with, and partly to the fact that it is necessary to overcome the motion of the earth and other causes, such as atmospheric refraction, which seem to make a star change its place continually. The exposures of the sensitive plate require to be sometimes for two hours, even with a large telescope; and if during that time the image of the star at the focus of the telescope has changed place $\frac{1}{350}$ of an inch, the light no longer falls on the slit of the spectroscope. The changes of the earth's atmosphere in regard to photographic transparency, as well as by fog, also offer impediments and promote the chances of failure. There is often a yellow condition of the air, which may increase the length of exposure required forty times or more.

It will from what has been said above, be readily perceived that a research such as this consumes a great deal of time; in fact, these experiments and the preparations for them have extended over more than twelve years. A large telescope is required, and for many reasons the reflector at first seems most suitable. Recently, however, I have found that the refractor has also some special advantages.

In 1866 I had already constructed a silvered glass reflector of $15\frac{1}{2}$ inches aperture, which was commenced in 1858, and had taken with it many hundreds of photographs of the moon. But as the mounting had been

[1] *Proc. Roy. Soc.*, vol. xxi. p. 145.
[2] Read before the National Academy of Sciences, October 28, by Henry Draper, M.D.

contrived for lunar photography and to avoid the moon's motion in declination, the instrument was not suitable for the spectroscopic work contemplated. A reflector of 28 inches aperture was therefore commenced in 1866, and in 1871 it was ready for use.

On May 29, 1872, my first photograph of the spectrum of a star was taken, the spectrum of Vega being photographed by the aid of a quartz prism. At this time I did not happen to know that Dr. Huggins, who is so distinguished for his thorough and accurate researches on the visible portion of the spectra of the heavenly bodies, had already made some attempts in this direction, as is shown by the following paragraph from the *Transactions* of the Royal Society for 1864:—"On the 27th of February, 1863, and on the 3rd of March of the same year, when the spectrum of Sirius was caused to fall upon a sensitive collodion surface, an intense spectrum of the more refrangible part was obtained. From want of accurate adjustment of the focus, or from the motion of the star not being exactly compensated by the clock movement, or from atmospheric tremors, the spectrum, though tolerably defined at the edges, presented no indications of lines. Our other investigations have hitherto prevented us from continuing these experiments farther, but we have not abandoned our intention of pursuing them."

During August, 1872, I took several photographs of the spectrum of Vega, and these showed four strong lines at the more refrangible end of the spectrum, the least refrangible being near G. On pursuing the subject and seeking to ascertain what substances gave rise to these lines, it became obvious that a photographic study of this part of the spectrum for the metals and non-metals was necessary to interpret the results. This, of course, opened out a large field for experiment, requiring many years for its study, and hence, as several physicists were engaging in the study of the spectra of the metals, I concluded to discontinue the experiments commenced in 1870 on the spectra of the metals and to confine the investigation mainly to the non-metals. The initial step was, however, to obtain a fine photograph of the normal solar spectrum, so that the wave-lengths of the lines up to O [wave-length 3440] might be determined with precision.

In the spring of 1873 I published a paper on the diffraction spectrum of the sun, illustrated by a photograph embracing the region from wave-length 4350, near G, to 3440, near O, and in the fall of the same year took photographs of the spectra of several non-metals, notably nitrogen, carbon, and oxygen. The experiments were interrupted, in the spring of 1874, by going to Washington to superintend the photographic preparations for the United States observations on the transit of Venus.

Since that time my experiments have been divided into two parts, an astronomical portion occupying principally the summer season, and a laboratory portion during the rest of the year. The former consisted of photographs and observations on the spectra of the stars, planets, and sun; the latter of photographic work on the spectra of the elements, and particularly the non-metals, and has led to the discovery of oxygen in the sun.

In 1876 Dr. Huggins published a note in the *Proceedings* of the Royal Society, accompanied by a woodcut of the spectrum of Vega, with a comparison solar spectrum. Seven lines were observed in the spectrum of Vega. In the summer and autumn of 1876 I made several photographs of the spectra of Vega, α Aquilæ, and Venus, and sent a note concerning them to the *American Journal*.

Since that time Dr. Huggins has pursued the subject actively in spite of the London atmosphere, and has attained very fine results, which I had the pleasure of seeing at his observatory last spring. These he is preparing to publish shortly. In my observatory photographs have been taken of the spectrum of Vega, Arcturus, Capella, α Aquilæ, Jupiter, Mars, Venus, the moon, &c. Recently the plan has been to have a comparison solar spectrum on every plate, derived either from the diffused light of our atmosphere or from the moon or from Jupiter. In this way no difficulty in determining the wave-lengths of the lines is encountered, and the changes produced by our atmosphere are eliminated. The telescope and spectroscope are now in good working order, but to secure the requisite degree of precision of movement it has been necessary to make seven different driving-clocks before a satisfactory one was attained.

It has been remarked that on account of the faintness of the light of stellar spectra, prolonged exposures of the sensitive plate are required. In former times, when the dry processes of photography were much less sensitive than the best wet plates, the exposure was limited by the length of time the plate could be left in the camera without being stained by drying. But now, since the gelatino-bromide process has been introduced, this obstacle has been removed and a sensitive plate is sometimes exposed two hours to the spectrum of a star and then almost an hour to Jupiter for the comparison spectrum. The best, and most sensitive, gelatine plates I have used are those made by Wratten and Wainwright, of London; Dr. Huggins was good enough to call my attention to them.

It is not worth while to describe the various forms of spectroscope that have been employed in the last ten years; quartz, Iceland spar, hollow prisms and flint glass have been the materials, and they have been sometimes direct vision and sometimes on the usual angular plan. Gratings on glass and speculum metal given to me by Mr. Rutherford have been tried. The length of spectroscope has been sometimes 28 feet and sometimes not as many inches.

The especial spectroscope for stellar work that is now on the telescope is intended to satisfy the following conditions: (1) to get the greatest practicable dispersion with the least width of spectrum that will permit the lines to be seen; (2) to use the entire beam of light collected by the 28-inch reflector or 12-inch achromatic without loss by diaphragms; (3) to permit the slit to be easily seen so that the star may be adjusted on it; (4) to avoid flexure or other causes that might change the position of the spectrum on the sensitive plate in pointing the telescope first on one and then on another object; (5) to admit of observing the spectrum on the sensitive plate at any time during an exposure without risk of shifting or disarrangement. The dispersion is produced by two heavy flint prisms which are devoid of yellow colour; the telescopes are about 6 inches in focal length, and the slit has a movable plate in front of it, enabling the operator to uncover either the upper or the lower portion at will.

During the past summer this spectroscope has been used with the Clark refractor of 12 inches aperture, partly because the 28-inch reflector has been kept unsilvered since it was used in taking photographs of the transit of Mercury, on account of its employment in certain experiments on the sun. Moreover, there is an advantage possessed by the refractor for this work which does not appear at first sight. Naturally one supposes that a reflector which brings all the rays from the star, no matter what their refrangibility, to a focus in one plane, would be best, because when the slit is put in that plane it is equally illuminated by rays of all refrangibilities, and the spectrum will be parallel-sided in its whole length. On the other hand a refractor is not achromatic, for the violet end of the spectrum comes to a focus either inside or outside of the plane of the rays in the middle of the spectrum, and in observing the spectrum it is not parallel-sided. This peculiarity was used by Mr. Rutherford to enable him to correct a telescope lens for the ultra-violet rays. It is easy, therefore, with a refractor, so to adjust the position of the slit that you may have a spectrum tolerably wide at F and G, and which gradually diminishes in width towards H, and finally becomes linear at M. Now as the effect of atmospheric absorption on the spectrum increases as you pass from G toward H and above H, by diminishing the width of the spectrum you can in some measure neutralise the effect, and at one exposure obtain a photograph of nearly uniform intensity from end to end, though it is of variable width. If it were not for this it would be necessary to have the spectrum over-exposed at G in order to be visible above H, or else to resort to an elaborate diaphraghming which is difficult.

It is my intention next season to return to the use of the 28-inch reflector, because it collects nearly five times as much light as the 12-inch does, after making allowance for the secondary mirror. Of course in a large reflector the difficulties of flexure and instability of the optical axis are much increased, and keeping a star on the slit will be troublesome, especially as the magnifying power on the image is about 50.

As to the results obtained, it has already been mentioned that the spectra of several stars and planets have been photographed. The subject of planetary spectra will be reserved for a future communication. A preliminary examination at once shows that these stellar spectra are divisible into two groups: (1) those closely resembling the solar spectrum, and (2) those in which there are relatively but few lines, and those of great breadth and intensity. The photographs of the spectra of Arcturus and Capella are so similar to the solar spectrum, that I have not up to the present detected any material differences. But, on the other hand, the spectra of Vega and α Aquilæ are totally different, and it is not easy without prolonged study and the assistance of laboratory experiments to interpret the results, and even then it will be necessary to speak with diffidence. I have not as yet obtained any stellar spectrum photographs belonging to the third and fourth groups of stellar spectra as described by Secchi. These, if obtainable, will aid materially in discussing the whole subject, but unless a star passes near the zenith it is hard to make a fair study of its spectrum by photography, because atmospheric absorption in the ultra-violet region increases rapidly as the altitude decreases. In the case of the sun I have found that at sunset the exposure necessary to photograph the spectrum above H, is often 200 times as long as at mid-day.

In the case of the spectrum of Vega, when examined by the eye, the lines C, F, near G and *h*, are readily visible, but lines such as D and *b* are relatively faint. It is clear, then, that hydrogen exists to a large extent in the atmosphere of that star. But on examining the photograph of its spectrum it is evident that other lines just as conspicuous as the hydrogen lines, are present. One of these corresponds in position and character to H_1, and seems to coincide with a calcium line. It appears to me, however, that the evidence of this coincidence is not complete.

In attempting to reason from these photographs as the matter now stands, it is necessary to try at every step farther experiments in order to find out whether the facts agree with the hypothesis, and it is this very condition of affairs that gives hopes of results valuable in their bearing on terrestrial chemistry and physics. In the photographs of the spectrum of Vega there are eleven lines, only two of which are certainly accounted for, two more may be calcium, the remaining seven, though bearing a most suspicious resemblance to the hydrogen lines in their general characters, are as yet not identified. It would be worth while to subject hydrogen to a more intense incandescence than any yet attained, to see whether in photographs of its spectrum under those circumstances any trace of these lines, which extend to wave-length 3700, could be found.

It is to be hoped that before long we may be able to investigate photographically the spectra of the gaseous nebulæ, for in them the most elementary condition of matter and the simplest spectra are doubtless found.

THE FUNCTION OF CHLOROPHYLL

THE Report of the Berlin Academy for July last contains a remarkable paper by Prof. Pringsheim on this subject. In pursuing his researches upon chlorophyll, he had found that positive results could only be obtained by employing *intense* light, and in this paper he gives some account of the conclusions at which he has been enabled to arrive by the use of this method.

By means of a heliostat and a strong lens, the object to be observed under the microscope is brightly and constantly illuminated; the effects of this illumination, which are striking, are produced in a few (3-6) minutes. Assuming that the object contains chlorophyll-corpuscles, the first visible effect is the rapid disappearance of the green colour, so that the object appears as if it had been lying for some days in alcohol, the corpuscles retaining however their form and consistence. Changes now gradually become apparent in the protoplasmic cell-contents; the circulation of the protoplasm, where it exists, is arrested; the bridles of protoplasm rupture, and the nucleus is displaced; the ectoplasm contracts, becomes permeable to colouring-matters, and the turgidity of the cell disappears; the cell presents, in fact, all the symptoms of death.

It seems natural to suggest that these effects may be due, to some extent at least, to the action of the high temperature to which the cell is exposed under these conditions. Prof. Pringsheim, anticipating this criticism, is careful to point out that they are produced by all the different parts of the visible spectrum. They are quite evident when the light has previously passed through a solution of iodine in carbon disulphide, but they are more distinct when the light has passed through an ammoniacal solution of cupric oxide; the light to which the object is exposed consisting, in the former case, of red rays, in the latter, of blue and violet. Moreover, if the solution of iodine be so concentrated that only the rays of a greater wave-length than 0·00061 m.m. can pass, these effects are not produced although about eighty per cent. of the heat is transmitted; on the other hand, if the ammoniacal solution of cupric oxide be so concentrated that the whole of the rays of low refrangibility to a wave-length of 0·00051 m.m. are absorbed, the effects are rapidly and vividly produced, although the amount of heat which passes is comparatively small. From these facts he concludes that the phenomena in question are the results not of the action of heat, but of that of light.

This important point being settled, he proceeds to determine in what manner this action of the intense light is affected by the atmosphere in which the object exists. As the result of a variety of experiments he finds that these effects are only produced when the atmosphere contains oxygen.

These are very briefly the facts which Prof. Pringsheim has ascertained by this method; we will at once pass to the consideration of the conclusions which he draws from them. He concludes, in the first place, that the decomposition (oxidation) of chlorophyll in the living plant is a process of combustion which is influenced and promoted by the action of light, and which stands in no relation to the decomposition of carbonic acid by the plant. Since the green colour of the chlorophyll-corpuscles which have become blanched is not subsequently restored, even though the cell continue to live, it appears that this oxidation of the chlorophyll is not a normal physiological occurrence, but that it is purely pathological. Prof. Pringsheim was unable to find any substance in the cells which might be regarded as the product of the oxidation of the chlorophyll, neither could he detect any increase of the fat or starch in the blanched cell, nor the formation of grape-sugar or dextrin: he therefore concludes that the products of the oxidation of the chlorophyll are given off in the gaseous form. In the second place he concludes that the changes produced in the protoplasmic cell-contents are the direct effects of the photochemical action of light. That they are not due to the presence of the products of the decomposed chlorophyll is shown by the fact that they may be observed equally well in cells which do not contain chlorophyll, such as the stinging-hairs of the nettle, &c. This being the case, he infers that they too are produced by a process of combustion. The final conclusion to which he comes is that chlorophyll exercises a protective influence over the protoplasmic cell-contents by absorbing the actinic rays of the spectrum, thus diminishing the combustion (respiration) going on in the cell; that it is in fact the regulator of the respiration.

In another series of experiments Prof. Pringsheim endeavours to determine what are the substances which become oxidised in the process of respiration. He finds in all chlorophyll-containing cells, a substance which can be best extracted by immersing the parts—leaves for instance—in dilute hydrochloric acid for several hours. This substance, to which he gives the name of hypochlorin or hypochromyl, is of an oily nature; it is probably a hydrocarbon which consists only of carbon and of hydrogen, or one which contains oxygen also in its molecule, but in smaller proportion than the carbohydrates; it is soluble in alcohol, ether, turpentine, and benzol, but insoluble in water and in solutions of neutral salts; it occurs in long, red-brown, crystalline needles which soon harden after extraction, into an imperfectly crystalline mass of resinous or waxy consistence. It is readily oxidisable, as is shown by the fact that it disappears from the cell on exposure to intense light in an atmosphere containing oxygen, even sooner than the chlorophyll. Prof. Pringsheim is of opinion that this substance is the first product of the assimilation of the chlorophyll-corpuscle, and that starch and oil are subsequently formed from it by oxidation.

Applying these views to the life of the cell under ordinary conditions, the changes going on in the cell when exposed in the air to sunlight would be somewhat as follows: the general protoplasm would undergo some amount of oxidation, but not so much as to materially diminish its quantity or affect its properties; in the chlorophyll-corpuscles, oxidation would be either entirely arrested in consequence of the absorption of the actinic rays by the green colouring-matter, or at least so much diminished that the synthesis of the elements of water and carbonic acid to form hypochlorin could take place.

Since this paper is stated to be a merely provisional account of these very interesting experiments, it is hardly fair to submit it to a detailed criticism: it will be better to wait until the publication of the more complete account which Prof. Pringsheim promises in an early number of his *Jahrbücher*. All that will be attempted at present is to indicate some of the principal difficulties which beset the acceptance of these new views. For instance, exception may be taken to the view that chlorophyll, when exposed to intense light is oxidised into gaseous bodies. It is well known that an alcoholic solution of chlorophyll, when exposed to sunlight in the presence of air, becomes oxidised and assumes a pale yellow colour; it may be that this also takes place in the chlorophyll-corpuscles, the yellow colour being hardly distinguishable on account of the smallness of the quantity which is present. Again, it will doubtless have occurred to every reader of this paper that hypochlorin may be nothing more than the wax which has long been known to exist in considerable quantity in chlorophyll-corpuscles. But the main difficulty has reference to the protective functions which Prof. Pringsheim ascribes to chlorophyll. Admitting that the changes described above as occurring in the protoplasmic cell-contents are really the results of excessive oxidation consequent upon exposure to the intense light, it is evident that they are effected less quickly than the oxidation of the chlorophyll itself; that is to say that, *ceteris paribus*, the chlorophyll is more readily oxidised than the protoplasm. This being the case, it is not easy to understand how the former can efficiently protect the latter from the oxidising influence of light and regulate its respiration. This difficulty might perhaps be met by the suggestion that fresh supplies of chlorophyll are continually being formed, but we have no knowledge yet at present of any such continual formation of chlorophyll; on the contrary, it is a well-established fact that when once the chlorophyll of a corpuscle is oxidised, it does not regain its green colour.

It might perhaps be possible to obtain some further knowledge on this subject by observing the effects produced in cells by the action of strong light falling upon them, in some cases, directly, in others, after having passed through a solution of chlorophyll which would be renewed from time to time if necessary. If it were found, that, in the latter case, the cells remained uninjured whereas in the former they soon died, some important evidence in favour of Prof. Pringsheim's views would be obtained. It might then be possible to extend these experiments and to bring about the formation of starch from carbonic acid and water in the cells of fungi, and even of animals, for Mr. Geddes' interesting observations on planarians show that animal as well as vegetable protoplasm is capable of effecting this synthesis.

SYDNEY H. VINES

THE CAMBRIDGE NATURAL SCIENCES TRIPOS

WOULD science suffer by the division of the second part of the tripos into a non-biological and a biological division which might be taken in successive weeks with separate examiners?

Let us make sure that in future geologists know well their chemistry and physics, and insist on all biologists knowing how to work their microscope well. Perhaps some geologists will shrink from a division of subjects; and consider that every geologist should know palæontology well. But the study of fossil plants and animals is surely a part of systematic botany and zoology; in fact, geology and palæontology would gain by being separated, so far as the one is physical, stratigraphical, petrological, and mineralogical, or the other truly biological. The knowledge of fossils as characterising a "formation" is not a biological subject; a man may recognise fossils well enough for geological purposes who knows little of zoology properly so called. Biology suffers greatly from the want of palæontologists as distinct from physical geologists and petrologists. How many men are there who would agree that biology ("the study of things living or that have lived") is very difficult to separate from physical and non-biological subjects for examinational purposes? Let us acknowledge that it is more necessary that, at the commencement of his scientific career, a man should be known and recognised as a well-educated biologist than as a vegetable anatomist, or a palæontologist, or an embryologist. Every man seeking biological honours may find sufficiently little chemistry and physics in the first part of the natural sciences tripos not to daunt him, if he is capable of research. Surely it is better to secure a man's general physico-chemical knowledge if he is to be a geological surveyor of the first rank, and also train him in elementary biology, than to encourage too early specialisation.

My proposal is that in the second part of the natural sciences tripos four or more examiners should be specially chosen to set and approve the biological questions, and four or more, the physico-chemical and geological questions; that the latter should have a separate class-list and days of examination, with four written papers of three rows each, and a practical examination; and that the biological examination should have four papers and be in other respects similarly conducted, letting no special marks of distinction be given. Few first-rate candidates would desire to take both these examinations, and if they desire further distinction in particular subjects, original work in research or authorship, is surely the best test; and the University might subsequently give to competent men degrees in science which now it unfairly cannot give; the degree of Doctor of Science should be given to men qualified to be University Readers or Professors in Science.

Mr. Hillhouse, of Trinity, the Assistant Curator of the Cambridge Herbarium, and one of the editors of the *Cambridge Review*, in an article last week, admits that which many promoters of learning might think a sign of unrest and indecision, rather than of real growth, namely, that the regulations issued by the Board of Natural Sciences Studies must be very mutable, and continually need revision. As to the argument for human anatomy as such receiving a prominent place in a tripos, Mr. Hillhouse says it rests on the fallacy that men are likely to study a subject with more interest if it is made a subject of a tripos, than if it is included in the M.B. But, his experience is, the man who will not work for his M.B. will surely not work for his tripos; if anything, he will work better for M.B. than tripos.

The University of London, having for a long time required all candidates for the degree of B.Sc. to pass in elementary mathematics, physics, geology, palæontology, and the other biological sciences, as well as logic, has now reverted to the wiser plan of examining at its 1st B.Sc. in elementary mathematics, physics, inorganic chemistry, and elementary biology, and at the degree examination (for B.Sc.), giving the degree for passing in three out of nine divisions of sciences, so that a biological student may, if he chooses, enter for a very clearly-defined examination in botany, zoology, and physiology. The Cambridge man will then soon prefer the B.Sc. Lond., with the subsequent possibility of a doctorship in science, given for thorough attainment in the special subject of his life-study and teaching, unless biology receives fair play at Cambridge. Why is it that Martin, Hartog, Marshall, and Vines have taken their D.Sc. (Lond.), to mention biologists only? It is surely not that they are devoted to examinations, but that Cambridge was not yet able to give them the distinction in their chosen subjects which they were entitled to demand. Biology, worthy of the name, is still to a very considerable extent proscribed or suspected in Cambridge. In a future age how strange a survival of prejudice this will seem. G. T. Bettany

THE PLANETS OF THE SEASON

Saturn

We recently called the attention of our astronomical readers to that noble planet, the captain of our celestial guard, those three that keep the mid-watch of the night in an imposing order that may not return for ages; at distances nearly equal, and in a line not widely deviating from a great circle of the sphere. Saturn, the next in position, may now be the subject of a cursory notice.

The aspect of this most interesting of the planets is at the present time singularly elegant and attractive. The relief, however, is delicate, and the details not conspicuous; but though the presentation may be less adapted for a close scrutiny than that of either the full opening or the evanescent phasis of the ring, its examination will not fail to reward the careful observer.

Schröter had a true insight into the pervading character of the universe when he described it as uniform in plan, with an endless variety in detail. Such is evidently the case with the planetary system. We find everywhere arrangements in part closely parallel or even identical with those most familiar to us, in part so rapidly divergent that the connecting analogies are strained, and thin away, as it were, till the bond of union can be traced no longer. Saturn is a complete instance of this. The dependence on the great central ruler, the spherical form, the polar flattening, the rotation on an inclined axis, the accompaniment of an atmosphere—all correspond with our own; while the differences, not only in magnitude, but in density and the force of gravity, are so great that we cannot even guess at the component materials. We endeavoured lately to point out how limited is our knowledge of Jupiter, though in various ways favourably circumstanced for observation; but on Saturn, with the exception of his change of seasons, we should find ourselves still greater strangers; and the terrestrial analogies that aided us so little there would here be of still less service. Every difficulty is magnified by the vast increase of distance and defalcation of light; we can only record what we see, and much of that is neither familiar nor intelligible.

It is easy, however, to perceive a strong general resemblance between these two great globes, not only in gigantic dimensions, want of density, and velocity of rotation, but in various atmospheric characteristics, such as parallelism of direction (sometimes, according to Herschel I., not quite equatorial on Saturn), contrasted colouring, and the occasional formation of bright and obscure patches. And yet in one main feature there is a very marked dissimilarity—the position of their axes. In this one point Saturn, after a decided interruption in the series, reverts to the type of the earth and Mars. And it is scarcely conceivable that the presence or absence of a change of seasons should not be strongly felt in its effects. One result, however, which might on a superficial view have been expected, is absent from Saturn. There is no luminous deposit around the poles, which, on the contrary, are often more dusky than the equatorial regions, and this alone would infer a different atmospheric constitution from our own, even if we left out of sight the consideration that such might well be expected when the subjacent materials are as light as cork, and the whole globe would float high out of water. But for this curious deviation from regular sequence—a kind of deviation so remarkable and so significant in the planetary system—we should have remarked as complete an analogy between Jupiter and Saturn as that which is believed to obtain between the Earth and Mars.

The changes, however, in the atmosphere of Saturn are not usually so conspicuous as those on Jupiter; nor is this to be wondered at, when we consider its inferior brilliancy at a distance measured by hundreds of millions of miles. The equatorial zone is usually represented as of prominent and unvaried brightness, and the dusky belts differ much in depth and arrangement at different times. Luminous and dark patches, though not common, are far from being unknown. The white equatorial spot, resolving itself ultimately into a streak, which was observed by Hall in 1876, though not, as has been asserted, an unprecedented, was a very remarkable instance of the former class, as one perceived by Herschel I., ninety-six years before, had been of the latter. This dusky spot was situated near the limb, where on Jupiter it would presumably have been invisible; yet much could not be inferred from this solitary observation, nor from that of Chacornac on the transit of the largest satellite, which showed a limb more luminous than the centre of the disk. Everything of this kind should be noted, but nothing pressed into the service of a foregone theory.

The flattening of the sphere at the equator, as well as the poles, announced by Herschel I. as the result of many observations in 1805, has never been very satisfactorily explained. It might have been discarded as an illusion resulting from the crossing of the outlines of the globe and rings, had it not been confirmed by repeated measurement at the time. It is considered to have been subsequently disproved by a repetition of that process in other hands; but it does not appear that the latter measures were taken at a time when the alleged deception existed. An experiment might be tried of placing at a distance from the eye (or better, the telescope, to insure perfectly similar conditions) a transparency copied from Herschel's figure, but with an elliptical, instead of "square-shouldered," outline; but even if, under any varied illumination, the deception should recur, his measures would still have to be accounted for, which do not seem to have been affected by any imperfection in his micrometer.

Part of Saturn's ring as observed by Trouvelot with the 26-inch Washington refractor.

But however this apparent anomaly may be disposed of, we are brought face to face, in the ring-system, with phenomena unexampled, as far as our sight can reach, though there may be thousands of them, and of still stranger things in the depths of infinity. The minor peculiarities of this complex arrangement are at present not readily traceable in so foreshortened a projection, and some of them would require instruments of great light and power; but the gauzy portion of the slowly-opening ring is already within the reach of moderate apertures. On many accounts these marvellous features deserve an increasing degree of scrutiny as the opportunities for it are becoming more and more favourable; and we may yet gain a further insight into their structure. Still we must not expect too much. Even should the bright rings be, according to the prevalent opinion, a closely-packed mass of satellites, we can hardly suppose it to be "resolvable" with any future increase of optical power. Theory, indeed, pronounces against a solid or even fluid composition; but the confident application of theory may possibly prove hazardous where materials wholly unknown may be dominated by polar forces of unexplored intensity. It may, indeed, be still an open question whether the aspect of the dusky ring, especially as projected across the ball, can be reconciled with the idea of a thin and scattered stream of satellites, an idea that perhaps would never have occurred to any actual observer, and that seems only a theoretical consequence of the supposed constitution of the other rings. Many questions, in fact, remain open, in this system of wonders; whether its general dimensions, or the proportions of its several parts, are unchangeable; whether minor divisions can always, or ever, be established; whether the gauze ring is distinctly separated from its neighbour; whether its colour is invariable; whether a similar material glazes over, so to speak, the great division of the two bright rings; whether any plausible explanation can ever be attempted of the extraordinary outlines of the shadow of the globe upon the outer ring, consistent with a thinness edgeways almost invisible. There may well be "more things" here "than are dreamt of in our philosophy." And in respect of the general idea of possible changes, it is but fair to bear in mind that our knowledge of this planet is confined to a relatively short period, as compared with his annual revolution. Only some seven Saturnian summers and as many winters have been exercising their influence on that peculiarly delicate and complicated system since the first employment of telescopic investigation—far less time since the commencement of minute scrutiny. And in addition to this the excentricity of the orbit is sufficient to vary the amount of solar radiation at different periods of his year, much more than is the case with our own globe.

It should not be forgotten, too, that the rotation of the ring has hitherto been deduced from theory alone, and ought, if possible, to be determined by observation; though where Herschel I. has failed, and Bond has not succeeded, there may not be a very bright prospect for subsequent observers.

The satellites are interesting in many respects; among others they afford a curious instance of the diversity of detail with unity of idea already alluded to. In our own case the attendant bears so large a proportion to its primary that Earth and Moon have been compared to a double planet. Next, in Mars, we find a ratio of the most opposite description. In Jupiter an intermediate proportion exists between the primary and secondaries, while the latter do not differ in magnitude very widely among themselves. In Saturn we have an extension and combination of the previous systems, not only in number but in character; extreme minuteness in several being found in juxtaposition with considerable bulk in one of the attendants. The striking irregularity of their sequence in point of magnitude is a fresh exemplification of the deviation from uniformity already referred to as so generally, and indeed almost universally, observable in the solar system. It may be noted among the retinue of Jupiter, where the largest is not the outermost of the satellites; but it is still more observable in the more complicated arrangement of the satellites of Saturn. The smallest in a general sense range nearest to the primary, yet the largest is not the most distant; and next in position to him comes the most minute of all. On the same principle it is highly unlikely that the regular progression 1, 2, 4, 8 should express the real number of the satellites attending respectively on the Earth, Mars, Jupiter, and Saturn. More, probably, own the control of the latter, and may be reserved as a triumph for Mr. Common's magnificent 37-inch mirror which the spirited possessor fully deserves.

The well-known fact that the difficulty in detecting objects of this nature diminishes as they become more familiar, is well exemplified in these minute points. Enceladus, once considered as suitable only for great apertures, has been several times seen by Franks with a 5-inch object-glass; my less acute vision with 9½ inches of a silvered mirror distinguished it in 1878, not readily, indeed, but quite certainly, in the absence of the primary from the field.

The variable light of the outermost, Japetus, in different parts of his orbit, has long been known, and might have been readily explained by a synchronism of rotation and revolution, but for superinduced irregularities similar to those of the satellites of Jupiter, and probably depending upon a similar cause. Schröter detected differences of brightness in some of the others, on opposite sides of the planet; but the subject deserves a fuller investigation.

T. W. WEBB

NOTES

WE record with deep regret the death of John Allan Broun, F.R.S., on Saturday last, at the age of sixty-two years. Mr. Broun was many years in India, as Director of the Observatory of the Maharajah of Travancore, and has been resident in London for the last six years. We hope next week to give details of Mr. Broun's life and the valuable services he has rendered to meteorology.

WE regret to learn that Prof. A. H. Sayce is compelled to spend the winter in Egypt on account of his health. We trust his sojourn on so congenial a soil will quite re-establish him.

A MARBLE medallion of Father Secchi has been placed in front of the Stilvio Observatory, 2,543 metres above the level of the sea. The observatory owes its establishment to him.

THE Swedish Academy of Sciences has appointed Dr. B. V. Wittrock, the celebrated algologist, to be keeper of the botanical department of the Swedish State Museum, in succession to Prof. N. J. Andersson, who has retired in consequence of the bad state of his health.

THE works for creating an astronomical observatory on the top of Etna were progressing favourably, but have been arrested for some months owing to the state of the weather. The central iron cupola and the telescope would have been placed this year if the operation had not been prevented by the large quantity of snow which fell prematurely on the mountain. This establishment is unrivalled for its position under an admirable sky, and will be placed on an immense natural platform situated at an altitude of 3,000 metres above the sea. The central crater has an elevation of 350 metres, and the observatory has been built at its very foot. An hotel is also being built, where twenty persons can find board during fine weather.

THE Municipal Council of Lyons, after a protracted discussion, has voted a credit for raising a statue to Ampère, who was, with Arago, the inventor of the electro-magnet. Ampère was a Catholic, and the son of a magistrate who had been beheaded at Lyons after the great revolution of 1793. The elder Ampère had written the charge against Challier the *Montagnard*, whose death caused the breaking out of civil war and the shedding of the blood which deluged Lyons during so many months.

THE death is announced of the eminent physicist, Friedrich von Ewald. He died at St. Petersburg on October 16 last, at the age of sixty-six years. He was for many years instructor to the Czarewitch.

FRIENDS and admirers of the late Herr Theodor Heuglin, the well-known African traveller, have erected a monument to his memory in the Prager Cemetery, at Stuttgart; it consists of a large erratic block from Upper Suabia, adorned with the medallion portrait of the deceased. Prof. Kopff, of Baden Baden, was the sculptor of the medallion. The monument was unveiled a few days ago.

THE death is announced of Mr. Serjeant Cox, on Monday, in his seventieth year. Mr. Cox was known as the author of several works in physiological psychology, written mainly from a spiritualistic point of view.

AT Hamburg, the resolution has been passed to erect a new Natural History Museum, for which the sum of 1,000,000 marks (50,000*l.*) will be expended. It appears that through the great marine trade of the city, its rich natural history collections are rapidly increasing year by year. Up to the present not one half of these collections could be properly exhibited to the public for want of space. All this will be changed when the new building is completed.

A CATALOGUE of scientific serials, from 1633 to 1876, has been recently prepared by Mr. Samuel H. Scudder, assistant-librarian at Harvard College Library, and under the auspices of that library, which has met the expense of publication, with the expectation that the demand for the volume will refund the outlay, and with the promise that, if so far remunerated, this shall be the beginning of a series of "works such as may be properly undertaken by a public library, and do not offer inducement for commercial speculation." The catalogue embraces the transactions and bulletins or proceedings of learned societies in the natural, physical, and mathematical sciences of all countries, as well as independent journals. It is the result of a large amount of painstaking labour and should prove an invaluable companion to those engaged in research, or otherwise interested in the progress of science.

FEW local natural history societies can show a better record of work done than the Torrey Botanical Club, the *Bulletin* of which is published monthly or bi-monthly. In addition to records of localities and descriptive articles of local and geographical interest, the pages of this publication not unfrequently contain contributions of sterling value on important points of morphology and physiology. Articles of this character in the numbers which have recently reached us are "Notes on the Relative Age and Dimensions of a Number of Different Trees," by N. L. Britton, and "A Few Notes on the Abnormal Absence of Colour in Plants," by A. Hollick.

IT is intended to erect a statue at Hanover in memory of the late eminent technologist, Karmarsch.

THE recent Hungarian earthquakes were coupled with phenomena of a most remarkable nature. The large island in the Danube near Old Moldowa was completely cleft in two by one of the shocks. From the chasm thus formed a gigantic column of water shot forth partly flooding the island. On October 18 the giant fountain suddenly ceased to flow, but numerous funnel-shaped craters had formed from which black sand and clay were ejected. Near Weisskirchen the old ruins of the Castle of Golubacz have fallen in completely, and in the vicinity several caves were rendered inaccessible. These caves were the breeding places of the dreaded Kolumbacs mosquitos, and if this insect is thus exterminated the earthquake may, with all the damage it did, have yet been of some use. Another smart shock was felt at Temesvar on Friday morning last. A violent earthquake is reported from Iceland. It occurred on September 24 last and is ascribed to volcanic eruptions in the Krisuvik mountains, a locality where eruptions have not been known within the memory of the present generation.

RUDOLF FALB has written from San Francisco to German friends to inform them that a monument in Bolivia much more ancient than the times of the Incas has given him a clue to the origin and development of speech and writing. He is apparently inclined to recur to the Semitic hypothesis.

AT the opening meeting, last week, of the Society of Arts the following prizes were awarded:—The Gold Medal, offered for the best means of saving life at sea, to Messrs. J. and A. W.

Birt, "for the collection of buoyant articles sent in by them;" the Society's Silver Medal, to Mr. Herbert Singer, for his "Essay on the Art of the Silversmith;" to Mr. F. Toplis and to Mr. Joseph Lucas, for their papers containing "Suggestions as to the best Means of dividing England and Wales into Districts for the Supply of Pure Water;" to Mr. Alfred Haviland, M.R.C.S., for his paper on "The Distribution of Disease popularly considered;" to Mr. John Hollway, for his paper on "A New Application of a Process of Rapid Oxidation, by which Sulphides are utilised as Fuel;" to Mr. Conrad W. Cooke, for his paper on "Edison's Loud-Speaking Telephone;" to Mr. Thomas Wardle, for his paper on "The Wild Silks of India, principally Tusser;" to Dr. William Wallace, F.R.S.E., for his paper on "Gas Illumination."

THE second part of vol. xxiv. of the "Mémoires de la Soc. de Physique et l'Histoire Naturelle de la Genève" has just appeared. It contains:—Report of the President to December 31, 1878, by Prof. E. Wartmann; Researches on the Fecundation and the Commencement of Henogeny among Various Animals, by M. Hermann Fol; On the Genus Hemimerus, Wolk., apparently furnishing a new order in the class of Hexapods, by M. H. de Saussure; Description of a New Species of Trygonid belonging to the genus Pteroplatea, by M. Godefroi Lunel; Comparative Anatomy of the Leaves in some families of Dicotyledons, by M. Casimir de Candolle.

IN reference to an article in the *Globe* on Sapphires in Siam, Mr. Bryce-Weight writes to that paper that through one of the Siamese princes in England he has learned that there are several sapphire mines in Siam, on the sea coast, with thousands of people at work, valuable gems having been found and sold at a good profit.

IN the beginning of October there was discovered, at about a kilometre from Guisseny, under a mass of rocks, a cavern fifteen metres long by four broad. This cave has two openings, one towards and about four metres above the sea, the other towards the land. The cavern was found throughout its length covered with a bed of ashes and charcoal about two centimetres thick. Underneath this was found a sort of dry stone masonry, then human bones, remains of cinerary urns, evidently of "Celtic" origin, and a considerable quantity of bones of mammals. Among the latter are some which do not appear to belong to contemporary fauna. Finally, a stone hammer and a sharp, polished axe of porphyry appear to show that this cavern is a sepulchral grotto of prehistoric times.

A SECOND enlarged edition is announced by Mayer, of Cologne and Leipzig, of Sonnenschmidt's "Kosmologie," the history and development of the universe on the basis of the most recent scientific researches.

THE *Journal of Applied Science* draws attention to the substitution of paper for wood in Germany in the manufacture of lead-pencils. It is steeped in an adhesive liquid and rolled round the core of lead to the required thickness. After drying, it is coloured to resemble an ordinary cedar pencil. The pencils sell in London to retailers at about 3*s*. a gross.

AT the first meeting of the Statistical Society, on the 18th inst., the President, Mr. Brassey, presented the Howard Medal and 20*l*. to Miss Beatrice A. Jourdan, as the writer of the best essay "On the Improvements that have taken place in the Education of Children and Young Persons during the Eighteenth and Nineteenth Centuries." The President announced as the subject of the essay of next year, "The Oriental Plague, in its Social, Economical, Political, and International Relations."

THE long pending telephone litigation in the United States has at last been settled by a compromise which leaves Prof. Bell master of the field. The National Bell Telephone Company have bought up the conflicting rights, and acquired all the telephonic inventions of Elisha Gray, of Mr. Edison, and of Mr. G. M. Phelps. The Western Union Telegraph Company, however, is to be licensed to convey telephonic messages, while the right to establish telephone exchange systems is to remain exclusively with the Bell Company. The shares of the National Bell Telephone Company are now quoted at 700 per cent.

THE multiplication of the correct time by electricity, as inaugurated by Leverrier, is now organised at Paris, on an immense scale, by the Municipal Council. A length of 15,000 metres of tubes is placed alongside the Boulevards and the principal streets, where a large number of dials will mark the time during day and night. Private clocks will be kept to time on payment of a small fee.

A COMPETITIVE experiment took place on September 19 in the green-room of the Grand Opera of Paris, on the respective illuminating power of Jablochkoff candles and Werdermann lights. The Werdermann light was found most steady, and the Jablochkoff most powerful. The experiments will be continued next week before the public, and a final resolution will be taken afterwards. The President of the Republic and the Minister of Fine Arts are represented.

ON November 11 a stream of falling stars was observed, at nine o'clock, at Chatelherault, when the sky was exceptionally clear.

A COURSE of six evening lectures on Photography will be given at the Sorbonne every Thursday evening by M. Davanne, President of the Photographic Society of Paris, with experiments. These lectures are organised by the Scientific Association of France, presided over by M. Milne Edwards. The ordinary evening lectures will begin only in January.

THE second French Atlantic cable has been successfully laid down from Brest to the American shores, through the Scilly Islands and Newfoundland. Congratulatory messages have been exchanged between the Presidents of both Republics.

PHOTOGRAPHERS, professional and amateur, will, we believe, derive much assistance from the "Photographic Printer's Assistant," by Mr. W. Heighway, just published by Richardson and Best. The directions given are such as have been found successful in actual practice.

M. CHARCOT, the chief physician of Salpetrière, opened, three years ago, a course of lectures on nervous affections, annexed to his clinic. The number of persons asking for admission has been so considerable that the administration of Public Assistance has built an amphitheatre with 500 seats in the hospital. The lectures, which are delivered every Sunday, were begun on November 16, before a full house. The amphitheatre was fitted up with an Alliance Magneto-electric machine, worked by the steam-engine of the washing-house. In each lecture a number of patients are introduced on the platform illustrating the theories of the lecturer, and many photographs are projected on the screen by electricity. In the lecture of November 23 the lecturer projected two engravings reproduced from Montgeron, an author of the beginning of the eighteenth century, who advocated the genuineness of miracles executed on the grave-stone of Diacre Paris. One of these represented a young lady who had been declared by the doctors of the age to be incurable of club-foot, and the other engraving the same person after having been cured in a trance. These two figures were engraved and published by Montgeron as exhibiting a case of supernatural agency. M. Charcot proved they were analogous to several of the cases which had been presented to his audience and could be cured by the same process.

Dr. Richardson asks us to say that in his article on Fleuss's New System of Diving in last number, p. 63, col. 2, 25th line from bottom, "fully seven minutes" should be "forty-seven minutes."

The additions to the Zoological Society's Gardens during the past week include a Yellow Baboon (*Cynocephalus babouin*) from West Africa, presented by Mr. Cecil B. Hankey; a Collared Peccary (*Dicotyles tajaçu*) from South America, two Domestic Sheep (*Ovis aries*), presented by Mr. H. Sandbach; a Little Grebe (*Podiceps minor*), British, presented by Mr. A. F. Buxton; a South American Rat Snake (*Spilotes variabilis*) from South America, presented by Mr. Thomas Harrod; two Geoffroy's Cats (*Felis geoffroii*) from Paraguay, two Barbary Falcons (*Falco barbarus*) from North Africa, a Red-throated Diver (*Colymbus septentrionalis*), British; a Common Curlew (*Numenius arquata*), European, deposited; two Common Tiskins (*Chrysomitris spinus*), a Reed Bunting (*Emberiza schœnichus*), a Pied Wagtail (*Motacilla yarrelli*), British, purchased; a Gaimard's Rat Kangaroo (*Hypsiprymnus gaimardi*), two Smooth Snakes (*Coronella lævis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

The "Uranometria Argentina."—The publication of this great and meritorious work is just announced, though, so far as we know, the complete volume has not yet reached Europe. The system of observations upon which it is based was designed and commenced by Dr. B. A. Gould, the distinguished director of the Argentine Observatory, immediately after his arrival at Cordoba in September, 1870, on accepting the superintendence of the new establishment, and while awaiting the completion of the observatory buildings and the arrival of telescopes which had been ordered in Europe, but delayed by the outbreak of the Franco-German war, and the work upon it has been continued with more or less attention to the present year. It was intended to represent in a series of charts and accompanying catalogue the sky from the south pole as far as 10° north of the equator, as it appears to the naked eye, showing all stars down to a round magnitude fixed at 7·0, with their characteristics of duplicity, variability, and colour, and the milky-way in all its ramifications and gradations of brightness. The actual observations were assigned to the four assistants, Messrs. Rock, Davis, Hathaway, and Thome, who had proceeded to Cordoba from the United States, the first three returning home at the expiration of three years, when the Uranometry was already finished as to its general details. Mr. Thome subsequently reviewed the entire work twice, and with the result that Dr. Gould considers it improbable that any star so bright as 7·0, on a scale which it has been desired to extend accurately from Argelander's, will have escaped insertion, while notwithstanding the great degree of nicety implied, he thinks the magnitudes are essentially correct to the nearest tenth. During the first two years the work was continued on all cloudless nights, both summer and winter, at an average of six hours' work each night. The total number of stars of which the magnitudes have been assigned is 10,649, and the total estimates of magnitudes 44,510, or more than four for each star.

With the view to having a uniform basis for estimates of magnitude throughout the whole heavens, Argelander's magnitudes for a region lying from 5° to 15° north of the equator, having the same meridian altitude at Bonn and Cordoba, were collected by classes, and "the stars of each class then assorted and shaded into the adjoining ones until a scale of tenths was formed." . . . "The scale as finally adopted resulted from the accordant estimates of all four assistants for each tenth up to 7·0." A "Type-belt Catalogue" of 722 stars was formed in this way, intended, as we have intimated, to serve as a standard for all future determinations of magnitude, in whatever part of the heavens. All the stars occurring in the "Uranometria" have been observed for accurate position at least four times with the meridian circle, and a general catalogue will appear in due course.

The charts are thirteen in number, and an index-chart is added showing at once the whole extent of the Uranometry. The printing was effected by the photolithographic process, as the most accurate and least expensive. Photographic negatives of the manuscript charts were taken, thus permitting their exact transfer to the stones. The chief trouble experienced in the printing was to give the star-dots the proper blackness, and yet to keep the milky-way within reasonable shade.

In a special chapter, Dr. Gould collects all variable and suspected variable stars, with particulars, thus providing interesting work for those amateurs who can command the southern heavens, and work from which much may be learned.

From a discussion of the general distribution of the stars throughout the sky, Dr. Gould is led to conclude that "there is in the sky a girdle of bright stars, the medial line of which differs but little from a circle inclined to the Galactic circle by a little less than 20°. The grouping of the fixed stars brighter than 4·1 is more symmetric relatively to that medial line than to the Galactic circle, and the abundance of bright stars in any region of the sky is greater as its distance therefrom is less. The known tendency to aggregation of faint stars towards the milky-way is according to a ratio which increases rapidly as their magnitudes decrease, and the law of which is such that the corresponding aggregation would be scarcely, if at all, perceptible for the bright stars." These facts, Dr. Gould continues, indicate the existence of a small cluster, within which our own system is excentrically situated, but which is itself not far removed from the mean plane of the Galaxy; this cluster he considers to be of a flattened shape, somewhat bifid, and consisting of rather more than 400 stars, of an average magnitude of 3·6 or 3·7, but comprising stars from the first to the seventh.

We have abridged these particulars from an interesting article on the "Uranometria Argentina," in the Buenos Ayres *Standard*.

It is impossible to avoid expressing admiration for the scientific spirit and enlightenment of the Government of the Argentine Republic in providing means for the execution of this important work, the first astronomical contribution from their National Observatory, but, we believe, to be followed by others, for which materials are completing, and which, it cannot be doubted, under the superintendence of Dr. Gould, will collectively secure for the Observatory of Cordoba a high position in the history of astronomical establishments, and, in connection with other enterprises of which we hear from time to time, for the comparatively small nation by which it is supported, the respect and good wishes of the scientific world.

The "Lick Observatory," California.—From San Francisco we receive details of recent progress towards carrying out the intentions of the will of the late James Lick, who died October 1, 1877, bequeathing the sum of 700,000 dollars to trustees for the purpose of purchasing land and erecting upon it "a powerful telescope, superior to and more powerful than any telescope ever yet made," with an observatory and other appurtenances, to be conveyed eventually to "the Regents of the University of California." The first site considered was at Lake Tahoe, but it was soon rejected; Mount St. Helena, at the intersection of Napa, Sanoma, and Lake counties, was then visited; it is upwards of 4,300 feet high, and was known to have atmospherical conditions favourable for astronomical purposes. Mr. Lick spent one night upon its summit. Among other points visited was Mount Hamilton, the elevation of which is still greater, and Mr. Lick finding that its advantages, so far as known, were equal to those of the former mountain, finally determined upon Mount Hamilton as the site of his proposed observatory; it is something less than fourteen miles east by south, from San José in Santa Clara county. A road to the summit twenty miles long was commenced in 1875, and finished in December, 1876, at the expense of Mr. Lick, and surroundings to the extent of more than 1,500 acres were secured to form the observatory property. The site was thus, contrary to what has been generally stated, decided upon before Mr. Lick's decease, and Prof. Newcomb had been asked to test the capabilities of the station, to obtain a guide as to the size and character of the instrument or instruments to be provided; Prof. Newcomb was too much engaged upon his official duties to undertake this work in 1877, and recommended application to be made to Mr. S. W. Burnham, of Chicago, who arranged last April to visit Mount Hamilton, with his own 6-inch Alvan Clark refractor; he arrived in the middle of August, and after spending thirty-two nights upon the mountain, up to September 27, all of which except five were extremely favourable, he appears to have agreed in opinion with Prof. Newcomb, who was able to visit Mount Hamilton early in October, that it is "the finest observing location in the United States." With regard to the size of the great telescope to be mounted there, much will probably depend upon the success attending the construction of the 30-inch refractor, which Alvan Clark and Sons have engaged to furnish for the Imperial Observatory at Pulkowa, but the trustees purpose to secure a 12-inch to be used in the observation of the next transit of Venus, and to remain one of the permanent fixtures of the Observatory.

San José is in about 121° 50′ west of Greenwich, and 37° 16′ N. Of Mount Hamilton it is stated that, "although practically out of the coast range fog-belt, an occasional gale blows the mist across the Santa Clara Valley from two points—Monterey Bay and the Sand-hill Gap just south of the city. On extraordinary occasions this fog reaches the crest of Mount Hamilton, but ordinarily the sky is cloudless all summer." The trustees have their work well in hand, though there remains much to be done before the whole design of the munificent founder of the observatory can be realised. It is intended that a meridian-circle, an instrument necessarily requiring considerable time in its construction, and other accessories, shall be provided in addition to the great telescope and the smaller equatorial. If we are not mistaken, Mr. Burnham has added a number of new double-stars to our lists, from his tentative work with the 6-inch refractor on Mount Hamilton.

GEOGRAPHICAL NOTES

A RUSSIAN journal announces the early departure of a scientific expedition, under the direction of Lieut. Onatsevitch, to make hydrographic investigations in the Sea of Japan and the Sea of Okkotsk. One of M. Onatsevitch's assistants, Ensign Heller, has already gone to Vladivostock in the cruiser *Asie*, taking with him numerous instruments with which the hydrographic department has equipped the expedition. M. Lanevsky Volk and four other naval officers will accompany M. Onatsevitch by way of Siberia. The object of this expedition is to fill lacunæ in the works of Babkine, Bolchew, Staritsky, Yelagnine, and others. It will have to explore, especially from the hydrographic point of view, the mouths of rivers which fall into the Sea of Japan, from the southern frontier of Russia to the Bay of Castries. It will make geodetic observations in the southwest part of Peter the Great Bay and at the mouth of the Amour. Lastly, it will study the water-courses, and the east and south parts of the Isle of Sakhaline, the district of La Perouse, &c.

AT the meeting of the Geographical Society on Monday evening the secretary read a paper by Capt. A. H. Markham on the Arctic campaign of 1879 in the Barents Sea. The title of the paper, however, is somewhat of a misnomer, as the narrative was chiefly confined to the proceedings of the *Isbjörn*, to which we have already referred. Some few details were also furnished as to the trip of the second Dutch expedition in the *Willem Barents*. Among the various matters of interest dealt with, perhaps one of the most interesting was the description of a large glacier on one part of the coast of Novaya Zemlya. This glacier Capt. Markham ascended, and walked along it for some two or three miles into the interior; he found numerous fissures in it, at the bottom of which ran rivulets, and some of which were so deep and wide that they could not be crossed except by making a long *détour*. During the trip a considerable amount of information was gained in regard to the movements of the ice in the Barents Sea, and the best season for future attempts at exploration, especially in the direction of Franz Joseph Land; it was made quite clear, however, that a larger vessel and the aid of steam are absolutely necessary to secure really useful results.

WITH reference to the discovery of the sources of the Niger, it is stated that MM. Zweifel and Moustier traversed the Hokko and Limbah countries, which, covered with forests on Winwood Reade's visit ten years ago, was now found very little wooded, the demand for the oily almonds of the palm tree having induced the natives to plant oil palms in the place of forests. A Koranks mission told the explorers that the Niger passed between Mount Lomat and another mountain, and that its three sources, the junction of which formed a small lake, were two days' march from the latter. After many dangers and privations, the travellers found the main source near the village of Koulaks, on the frontier of Koranks, Kissi, and Kono, its native name being the Tembi. The travellers could not enter the Sangara country on the right bank of the river; but they are confident that the Tembi is the longest of the three streams mentioned by the Koranks, and consequently the origin of the Joliba or Upper Niger.

M. DE LESSEPS is to leave in a few days for Central America, in order to survey the concession granted by the Columbian Government for a sum of 750,000 francs, which was paid a few months since. The surveying within a certain time is an obligation which, not being complied with, would render the concession void. The promoter of the new canal took leave of the Geographical Society of Paris on November 21.

A DISCUSSION has been raised before the Geographical Society of Paris by the alleged discovery of the source of the Niger by two Frenchmen, commercial travellers, as referred to last week.

THE Freie Deutsche Hochstift at Frankfurt has received further news from Dr. Gerhard Rohlfs and his travelling companion Dr. Stecker, according to which the two travellers were already on a steamer sailing for Malta. Herr Rohlfs is said to be so exhausted that he intends to abstain from any further African exploring expeditions. Amongst the objects which the travellers were robbed of are all their diaries, notes, and scientific instruments, besides the rich collection of presents sent by the Emperor of Germany to the Sultan of Wadai.

NO. 10 of Band xxii. of the *Mittheilungen* of the Vienna Geographical Society, contains papers on the Ethnological Conditions of South Russia at their chief epochs, from the earliest times to the first appearance of the Sclavs, by Dr. Jar. Vlach; the Mississippi and its Basin, by Dr. Hesse-Wartegg; the district of Shushu, in Transcaucasia, by Carla Serena. Among the notes is a valuable statistical and geographical account of the Vilayet of Trebizond, from an Austrian Consular Report. As a supplement to the *Mittheilungen* is announced a *Zeitschrift für wissenschaftliche Geographie*, edited by Julius Iwan Kettler, assisted by a staff of eminent German geographers. This journal will embrace all departments of mathematical, physical, commercial, ethnological, descriptive, and historical geography; and promises to prove one of the most valuable geographical journals published. It will be issued every two months.

CAPT. HOWGATE has published a neat little volume on the cruise of the *Florence* in the preliminary Arctic Expedition of 1877-8. He gives many interesting notes made during the wintering in Cumberland Gulf, both of the country and people. The scientific results have been published separately, and these we shall notice in detail.

THE *Cape Argus* announces the starting in October of an African Expedition from the Cape, under, and at the expense of, two young Englishmen, Messrs. Beaver and Bagot. They have only two bullock waggons and a few blacks, but their ambitious programme is to make a "General and Astronomical" survey of the whole region between the Zambesi and the Albert and Victoria Nyanzas. This region is ignorantly described in the *Argus* as being almost totally unexplored. The two light-hearted young Englishmen allow themselves four years to accomplish their gigantic undertaking. We shall watch their progress with curiosity. They are stated to have had an interview with the Geographical Society before leaving; the officials of the Society, we believe, are not able to recall the incident.

IN a letter to M. Sibiriakoff, Prof. Nordenskjöld expresses his intention of undertaking another voyage to the northern coast of Asia as soon as circumstances permit. "After my return," he says, "I think of spending a year on preparing an account of the voyage of the *Vega*, and it is my desire then to continue the exploration of the Icy Ocean along the coast of Siberia, making the River Lena the point of departure, and the New Siberian Isles the basis of operations. For the object I have proposed to myself—namely, the rendering of the northern part of Asia completely accessible to commercial shipping—the prosecution of these researches is of paramount importance."

A TELEGRAM to the *Moscow News*, dated Katt Koorgan, November 14, gives the latest intelligence received from the Russian scientific expedition appointed to explore the Oxus or Amu Darya, and report on the best route for a great Central Asian railway. On October 19 the members met the Khan of Khiva, who said he would give orders in due time for the demolition of the dams at Bant and Shamurat. The eldest men among the Yomouds and Tschenderen pledged themselves to procure labourers for the purpose of cleaning out the bed of the Usboi between Sary Kamysch and the Caspian Sea.

THE death is announced of the Dutch lieutenant, Koolemans Beynen, who accompanied Sir Allen Young in his two *Pandora* voyages, and last year was second in command of the Dutch

Arctic expedition in the *Willem Barents*. He edited for the Hakluyt Society an account of the three voyages of William Barents. A daily contemporary confounded Lieut. Beynen with the well-known Arctic explorer, Lieut. Payer, who, we are glad to say, is alive and as well as ever.

RECENT advices from Japan state that the port of Gensan in Corea has been opened to Japanese traders. The Japanese, however, appear to have been more anxious to obtain the opening of Nikawa, a more important place, and about nineteen miles from the capital, Hányang (Seoul). The Coreans refused to concede this point, probably on account of a sacred character attaching to the road which separates the two.

BIOLOGICAL NOTES

OOSPORES OF "VOLVOX MINOR."—Dr. Kirchner, in the recent part of Cohn's "Beiträge zur Biologie der Pflanzen," describes the germination of the oospores, and in this supplements the important contribution made by Cohn himself to our knowledge of this interesting plant in the first volume of the same work. The first appearance of germination was in February. The contents of the oospores during a rapid swelling out of the endospore, made their appearance through the ruptured exospore, and soon presented a sphere-shaped body, which then divided into two portions, these being perpendicular to one another. The newly-formed cells so separate from one another that they hang together by their ends. These ends form the one pole of the later-to-be-developed ball-like colony; the other pole is afterwards closed in, when the maximum of the cells is attained. Each oospore thus gives rise through cell division, followed by the characteristic cell displacement, to a new volvox colony. The fact of *V. minor* being diœcious was given as a character to distinguish it from *V. globator*, but this, according to the author, does not hold true; both colonies seem to pass through a purely female stage and afterwards through a male stage, each colony being bi-sexual.

CEDAR OF LEBANON IN CYPRUS.—Sir Samuel Baker, in his late residence in this island, has been fortunate in bringing to light the existence of this tree, or a variety of it, according to Sir J. D. Hooker. It seems the monks of Trooditissa Monastery assured the former that the "chittim-wood" of Scripture, a kind of pine, grew in the mountains near Krysokus. Trusty messengers having been despatched in search thereof, they brought back specimens of a cedar, with dense foliage and a superior quality of wood. Sir J. Hooker, to whom the specimens were forwarded, after a careful examination, finds that this tree differs from the true cedar of Lebanon in having shorter leaves and smaller female cones, with other slight differentiations. He names it, therefore, *Cedrus libani*, var. *brevifolia*, a short botanical account of which, along with Sir Samuel's letter, be laid before the Linnean Society at their last meeting. In his letter Sir S. Baker further hints that a variety of cypress some thirty feet high and seven feet girth, with a cedar-coloured wood, and powerfully aromatic scent of sandal-wood, in his opinion, is the celebrated "chittim-wood." He asks: "Why should Solomon have sent for cedar, which is so common in Asia Minor?" Another hard-wooded cypress, of twenty feet high, yields an intensely hard wood resembling *Lignum vitæ*.

NEW GENUS OF MYRIAPOD.—In the October number of the *American Naturalist* Mr. J. A. Ryder describes and figures a new genus allied to the little myriapod described some years since by Sir John Lubbock as Pauropus. This new American form is found in moist situations under sticks and decaying vegetable matter. It is called *Eurypauropus spinosus*, receiving its generic name in reference to its great relative width. The body is composed of six segments, possibly of seven. The head is partly free, the surface of the head and other segments is covered with small tubercles or spines. Two pairs of legs are attached to each of the second, third, fourth, and fifth segments, which, with a single pair on the first segment, makes nine pair in all. The legs are completely concealed in life by the lateral expansions of the body segments. The oral region seems to be very similar to that in Pauropus. There is no evidence of tracheal openings. Eyes seem to be absent. The antennæ are five-jointed, inserted close together at the front of the head, and are branched. The outer branch bears two of the many-jointed filaments, between the bases of which arises a pedicel surmounted by an ovoid semi-transparent body with linear sepal-like processes clasping it much as in *Pauropus pedunculatus*. The length is one-twentieth of an inch, and the habitat Fairmount Park, Eastern Penna.

ZOSTERA MARINA.—A. Engler, in a recent number of the *Botanische Zeitung* (October 10), has published some interesting observations on the fertilisation and growth of the sea grass growing at Kiel. He pronounces Hofmeister's observations on the fertilisation of Zostera as incorrect, but corroborates those of Clavaud (published in the *Botanische Zeitung* for August). At first it is true that the thread-like stigma lies on the neighbouring anther lobes, mostly those of two different anthers; next the style elevates itself, and so the stigma comes out of the narrow slit in the sheath, and receives the pollen given out by some of the older spadices. After fertilisation, the thread-like stigmas disappear, and at the same moment will be found clusters of as yet unopened anthers around the stigmaless gynœcia, these now having fertilised ovules. This was probably the stage observed by Hofmeister when he described the fertilisation as taking place inside the unopened inflorescence. Certainly the anther-lobes are not at this stage always emptied of their contents, and certainly when this emptying takes place the gynœcia are often beyond the power of being fertilised. The conditions of the buds in Zostera also specially engaged Engler's attention, because the sympodial bud system appeared similar to that in many of Araceæ. The main shoot which roots in the mud develops out of the angle of the nodal scale like lower leaves, which, however, soon die off, sterile buds, and then after the formation of four to six internodes in the ground, grows upwards, now developing leaves often a metre long, but never in the same year is the inflorescence observed. The sterile sprouts are found to the right and to the left of the main shoot; the upper internodes of this latter elongate and erect themselves, but now in the angles of the lower leaves are only fertile buds developed, which lie alternately right and left of the main axis. The first fertile bud is generally quite free, and carries three to four club-shaped bodies sympodially arranged as described by Eichler. The following fertile buds grow for a great while along with the main axis, the axis of growth thus presenting a flattened cone-shaped form with two furrows superimposed on a cylindrical axis. As to the inflorescence, Engler suggests that it is not impossible, but that the Gynœcia and Andrœcia may each represent separate flowers so arranged that male and female flowers of the s mplest type should stand opposite to one another. This, though opposed to the views of Ascherson and Eichler, seems to have some support from the fact that in the case of Spathicarpa ("Flora Brasiliensis," pl. 51), one of the Araceæ, this position of the male and female flowers occurs; only in this case, there can be no doubt of the fact, as there seems of necessity to be in Zostera, for the Andrœcia and Gynœcia are in Spathicarpa formed of several sexual leaves.

THE ONTOGENY AND PHYLOGENY OF THE CTENOPHORA.—Prof. Haeckel, in a recent number of *Cosmos* (vol. iii. Part 5, August, 1879), describes a new form which he calls *Ctenaria ctenophora*, as a connecting-link between the Ctenophora and the Medusæ. This species is figured, but fuller details are promised in the author's "System of the Medusæ," which, illustrated with forty plates, is nearly ready for publication. The new form is placed as a craspedote in the order of the Anthomedusæ, and in the family of the Cladonemidæ. Accompanying a brief description, there is an interesting paragraph on the "Ontogeny and Phylogeny of the Ctenophores." It would seem highly probable that the Ctenophores are descended from the Cladonemidæ, and that their still earlier ancestors were Hydrozoa allied to Tubularia. Among the newer adaptations, by means of which the Medusæ form of the younger Ctenophore originated, the most important is undoubtedly the change in the method of locomotion. The Medusæ swim in a spasmodic manner by irregularly contracting their umbrellæ, and then driving the water out of the cavity. The easy gliding, swimming movement of the Ctenophoræ is brought about by the vibrations of the little oar-blades which cross over the surface of the eight radial ciliated combs. While this newer form of motion took the place of the former, a number of other changes were immediately brought about according to the laws regulating the correlation of organs. The more important morphological relations were nevertheless, through the conservative power of inheritance, preserved. This interesting form possesses the eight ad-radial thread-cell channels as in Ectopleura, the trichter as in Eleutheria, the oral formation as in Cytæis, the canal-formation as in Cladonema, and the tentacles and tentacular pockets as in Gemmaria; transitory between two classes, it furnishes a new convincing proof of the verity of the doctrines of development.

ARSENIC IN ANIMALS.—Prof. Ludwig has recently (*Wiener Akad. Anz.*) inquired into the distribution of arsenic in the animal organism after ingestion of arsenious acid. The objects he examined were the organs of suicides who had poisoned themselves with arsenic, and of dogs which were poisoned, some acutely, some chronically, witb arsenic. In all experiments it was found that the arsenic accumulated most in the liver, and that in acute poisoning the kidneys also contained abundant arsenic, whereas in the bones and in the brain there was little of the poison. In case of chronic poisoning with arsenic, where death did not ensue, the poison was found to remain (after ingestion was stopped) longest in the liver, being much sooner excreted from the other organs. The results of this investigation are in direct opposition to those obtained by Scolosuboff, who always found most arsenic in the brain.

DIOPTRICS OF THE EYE.—In the investigation of the dioptric properties of the crystalline lens of the eye, physiologists have hitherto accepted an index of refraction of the lens determined for only one condition of accommodation. It seemed desirable to Herr Matthiessen to attain greater accuracy by ascertaining the dioptric properties of the lens in different states of accommodation, the structure of the lens as now known being fully considered. The subject is discussed at length by him in *Pflüger's Archiv* (xix. p. 480). In tabular form he presents a comparison of the positions of the dioptric cardinal points for the human eye and for the eyes of several lower animals, corresponding to different states of accommodation, infinite distance 160 mm. and 100 mm. A comprehensive list of works on the dioptrics of the lens and the eye generally is added to Herr Matthiessen's paper.

EXPERIMENTAL DETERMINATION OF THE VELOCITY OF LIGHT[1]

LET S, Fig 1, be a slit through which light passes, falling on R, a mirror free to rotate about an axis at right angles to the plane of the paper; L, a lens of great focal length, upon which the light falls, which is reflected from R. Let M be a plane mirror, whose surface is perpendicular to the line R M, passing through the centres of R, L, and M, respectively. If L be so placed that an image of S is formed on the surface of M, then, this image acting as the object, its image will be formed at S, and will coincide point for point with S.

If, now, R be turned about the axis, so long as the light falls on the lens, an image of the slit will still be formed on the surface of the mirror, though on a different part, and as long as the returning light falls on the lens, an image of this image will be formed at S, notwithstanding the change of position of the first image at M. This result, namely, the production of a stationary image of an image in motion, is absolutely necessary in this method of experiment. It was first accomplished by Foucault, and in a manner differing apparently but little from the foregoing.

In this case, L, Fig. 2, served simply to form the image of S, at M; and M, the returning mirror, was spherical, the centre coinciding with the axis of R. The lens, L, was placed as near as possible to R. The light forming the return image lasts, in this case, while the first image is sweeping over the face of the mirror, M. Hence the greater the distance, R M, the larger must be the mirror, in order that the same quantity of light may be preserved, and its dimensions would soon become inordinate. The difficulty was partly met by Foucault, by using five concave reflectors instead of one; but even then the greatest distance he found it practicable to use was only twenty meters.

Returning to Fig. 1, suppose that R is in the principal focus of the lens, L; then if the plane mirror, M, have the same diameter as the lens, the first or moving image will remain upon M as long as the axis of the pencil of light remains on the lens, and *this will be the case no matter what the distance may be.*

When the rotation of the mirror, R, becomes sufficiently rapid, then the flashes of light which produce the second or stationary image become blended, so that the image appears to be continuous. But now it no longer coincides with the slit, but is deflected in the direction of the rotation, and through twice the angular distance described by the mirror, during the time required for light to travel twice the distance between the mirrors. The displacement is measured by its arc, or, rather, by its tangent. To make this as large as possible, the distance between the mirrors, the radius, or distance from the revolving mirror to the slit, and the speed of rotation should be made as great as possible.

The second condition conflicts with the first, for the "radius" is the difference between the distances of principal focus and the conjugate focus for the distant mirror. The greater the "distance," therefore, the smaller will be the "radius." There

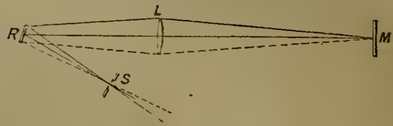


FIG. 1.

are two ways of solving the difficulty: first, by using a lens of great focal length, and, secondly, by placing the revolving mirror within the principal focus of the lens. Both means were employed. The focal length of the lens was 150 feet, and the mirror was placed about fifteen feet within the principal focus. A limit is soon reached, however, for the quantity of light received diminishes very rapidly as the revolving mirror approaches the lens.

The chief objection urged in reference to the experiments made by Foucault is that the deflection was too small to be measured with the required degree of accuracy. This de-

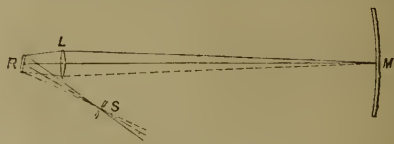


FIG. 2.

flection was but a fraction of a millimeter, and when it is added that the image is always more or less indistinct on account of atmospheric disturbances, as well as imperfections of lenses and mirrors, it may well be questioned whether the results could be relied upon within less than one per cent.

In the following experiments the distance between the mirrors was nearly 2,000 feet. The radius was about thirty feet, and the speed of the mirror was about 256 revolutions per second. The deflection exceeded 133 millimetres, being about 200 times that obtained by Foucault. If it were necessary it could be

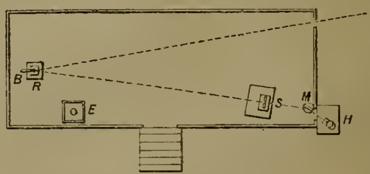


FIG. 3.

still further increased. This deflection was measured within three or four hundredths of a millimeter in each observation; and it is safe to say that the result, so far as it is affected by this measurement, is correct to within one ten-thousandth part.

The site selected for the experiments was a clear, almost level stretch along the north sea-wall of the Naval Academy. A frame building was erected at the western end of the line, a plan of which is represented in Fig. 3.

The building was forty-five feet long and fourteen feet wide, and raised so that the line of light was about eleven feet above

[1] By Albert A. Michelson, Master, U.S. Navy Read before the American Association.

the ground. A heliostat at H reflected the sun's rays through the slit at S to the revolving mirror, R, thence through a hole in the shutter, through the lens, and to the distant mirror. The interior of the building was painted black. In a room underneath the part, R, was the apparatus which supplied the air for turning the mirror.

The heliostat was kindly furnished by Dr. Woodward, of the Army Medical Museum, and was a modification of Foucault's

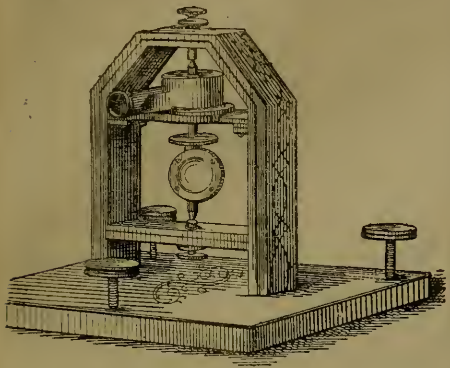


FIG. 4.

form, designed by Keith. It was found to be easy of adjustment and quite accurate.

The light was reflected from the heliostat to a plane mirror, M, Fig. 3, so that the former need not be disturbed after being once adjusted.

The revolving mirror was made by Fauth & Co., of Washington. It consists of a cast-iron frame, Fig. 4, resting on three levelling

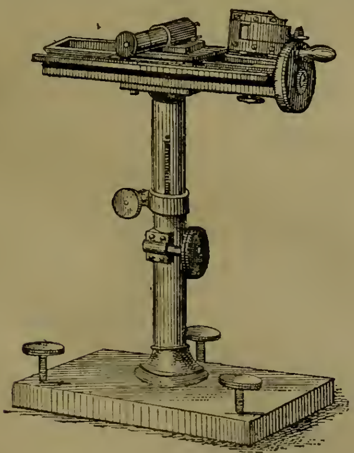


FIG 5.

screws, one of which was connected by cords to the table at S, Fig. 3, so that the mirror could be inclined forward or backward while making the observations. Two binding screws, terminating in hardened steel conical sockets, hold the revolving part. This consists of a steel axle, the pivots being hardened, expanding into a ring, which holds the mirror. The latter was a disc of plane glass, made by Alvan Clark, about one and a quarter inch in diameter and 0·2 inch thick. It was silvered on one side, the reflection taking place from the silvered side. A species of turbine wheel is held on the axle by friction. This wheel has six openings for the escape of air. The air entering on one side acquires a rotary motion in the box, carrying the wheel with it, and this motion is assisted by the reaction of the air in escaping. The disc above the mirror serves the purpose of bringing the centre of gravity in the axis of rotation. This was done, following Foucault's plan, by allowing the pivots to rest on two inclined planes of glass, allowing the arrangement to come to rest, and filing away the lowest part of the disc; then trying again, and so on, till it would rest in indifferent equilibrium. The part corresponding to the disc in Foucault's apparatus was furnished with three vertical screws, by moving which the axis of figure was brought into coincidence with the axis of rotation. This adjustment was very troublesome, and in this apparatus was found unnecessary. When the adjustment is perfect the apparatus revolves without giving any sound, and when this is attained the motion is regular and the speed great. A slight deviation causes a sound, due to the rattling of the pivots in the sockets, the speed is very much diminished, and the pivots commence to wear. In Foucault's apparatus oil was furnished to the pivots, through small holes running through the screws, by pressure of a column of mercury. In this apparatus it was found sufficient, at high speed, to touch the pivots occasionally with a drop of oil.

The quantity of air entering could be regulated by a valve,

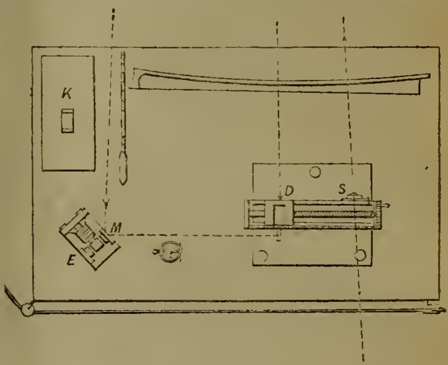


FIG. 6

to which was attached a cord leading to the table. The revolving mirror was mounted on a brick pier.

The apparatus for measuring the deflection was made by Grunow, of New York.

It consists of a screw, with divided circle, Fig. 5. To the frame is attached an adjustable slit. On the screw travels a carriage which supports the eyepiece, which consists of an achromatic lens, having in its focus at the end of the tube a single vertical silk fibre.

Next the eye is a piece of plane glass, inclined at an angle of 45°. In measuring the deflection, the eyepiece is moved till the cross hair bisects the slit (with which it is nearly in the same plane), and the reading of the scale and divided circle gives the position. This is made once for all, unless the slit be altered in width or position. Then the eyepiece is moved till the cross hair bisects the deflected image of the slit; the reading of scale and circle are again taken, and the difference in readings gives the deflection. The screw has no lost motion, so that readings may be taken with the screw turned in either direction. This apparatus is mounted on a standard with rack and pinion, and the base furnished with levelling screws.

To regulate and measure the speed of rotation, a tuning-fork, bearing on one prong a steel mirror, was employed. This was kept in vibration by a current of electricity from five gravity cells. The fork was so placed that the light from the revolving mirror was reflected to the piece of plane glass in the eyepiece, thence reflected into the eye. When fork and revolving mirror are both at rest, the eye sees an image of the revolving mirror.

When the fork vibrates, this image is drawn out into a band of light. When the mirror commences to revolve, this band breaks up into a number of moving images of the mirror; and when, finally, the mirror makes as many turns as the fork makes vibrations, these images are reduced to one which is stationary. This is also the case when the number of turns is a sub-multiple. When it is a multiple, or a simple ratio, the only difference is that there will be more than one image.

Hence, to make the mirror execute a given number of turns, all that is necessary is to pull the cord attached to the valve, to the right or left, till the images of the revolving mirror come to rest.

The electric fork made about 128 vibrations per second. No dependence was placed upon this rate, however, but at each set of observations it is compared with a standard Ut_3 fork, the temperature being noted at the same time. In making the comparison the beats were counted for 60 seconds.

It is interesting to note that the electric fork, as long as it remained untouched and at the same temperature, did not change its rate more than 0·01 or 0·02 vibration per second.

Fig. 6 represents the table at which the observer sits. The light from the heliostat passes through the slit at S, goes to the revolving mirror, etc., and on its return forms an image of the slit at D, which is observed through the eyepiece. E represents the electric fork, bearing the steel mirror, M; K, the standard fork on its resonator.

The lens was made by Alvan Clark. It was 8 inches in diameter, focal length 150 feet, not achromatic. It was mounted in a wooden frame, placed on a support moving on a slide about 16 feet long, placed about 80 feet from the building. As the diameter of the lens was so small in comparison with its focal length, its want of achromatism was inappreciable. For the same reason the effect of "parallax" was too small to be noticed.

The stationary mirror was one of those used in taking photographs of the transit of Venus. It was about 7 inches in diameter, mounted in a brass frame capable of adjustment in a vertical and a horizontal plane by screw motion. Being prismatic, it had to be silvered on the front surface. To facilitate adjustment, a small telescope furnished with cross hairs was attached to the mirror by a universal joint. The heavy frame was mounted on a brick pier, and the whole surrounded by a wooden case, to protect it from the sun.

The adjustment was effected as follows:—

A theodolite was placed at about 100 feet in front of the mirror, and the latter was moved about, till the observer at the theodolite saw the image of his glass reflected in the centre of the mirror. Then the telescope attached to the mirror was pointed at a mark on a piece of cardboard attached to the theodolite. Thus, the axis of the telescope was placed at right angles to the surface of the mirror. The theodolite was then moved to 1,000 feet, and, if found necessary, the adjustment repeated. Then the mirror was moved till its telescope pointed at the hole in the shutter of the building. The adjustment was completed by moving the mirror by signals, till the observer, looking through the hole in the shutter through a good spyglass, saw the image of the glass reflected centrally in the mirror.

Notwithstanding the wooden case about the pier the mirror would change its position between morning and evening, so that the last adjustment had to be repeated before every series of experiments.

(*To be continued.*)

ON THE MOUNTAINS OF THE NORTHERN AND WESTERN FRONTIER OF INDIA[1]

THERE are certain moot questions relating to the mountains of the north-west frontier of India upon which it appears desirable to elicit the opinion of geographers. On this occasion I propose to discuss the western limits of the Himalaya; the northern and southern limits of the Hindu Kush; the parallelism and lateral communications of the ranges between the Hindu Kush and the Aralo-Caspian plain and of other parts of the north-west frontier; and the limits of the Iranian group of highlands, at its junction with the Tibeto-Himalayan and Pamir groups. Finally the proper route of a railway to India between Mesopotamia and the Indus is indicated along a remarkable line of elevated valleys parallel to the coast.

[1] Paper read at the Sheffield meeting of the British Association by Trelawney W. Saunders.

The Himalaya ranges form a part of the great girdle of mountains which continuously encircle the central portion of the Asiatic Continent, and include the Chinese colonial dependencies of Ili, Mongolia, Kokonor, and Tibet.

This vast mountain girdle is naturally grouped into four parts corresponding with the outlets of its exterior drainage according to their connection with the Arctic, Pacific, and Indian Oceans, and the Aralo-Caspian Seas respectively. These four divisions of the great mountain girdle have been named from their chief features, (1) the Tibeto-Himalayan, (2) the Yunling, (3) the Altaic, and (4) the Pamir systems. The interlacing or overlapping of these systems at their junctions is not always easy to make out, and presents occasional difficulties like other systems of classification, no matter what the subject may be.

The question of the western termination of the Himalaya relates to two divisions of the great girdle, namely, The Tibeto-Himalayan and the Pamir, to which must be added another group lying outside those two, but impinging on them at its north-east corner. This group is formed by the Iranian highlands, a compact quadrilateral mass bounded by the lowlands of the Indus, the Arabian Sea and the Persian Gulf, the lowland of the Tigris and Euphrates, and the Aralo-Caspian plain. The only questions which can well arise with regard to the boundaries of the Iranian mountain system, relate to its north-west and north-east angles, where it unites with the Tauric system on the one hand and the Himalaya and Pamir on the other. It is with the latter only that we propose to deal now.

My Tibeto-Himalayan system was introduced in 1870 in "A Sketch of the Mountains and River Basins of India in two Maps, with Explanatory Memoirs." It was further developed in the *Geographical Magazine*, for July, 1877; and I am indebted to the distinguished chairman of this section for an appreciative account of it in two editions of his "Memoirs of the Indian Surveys in 1871 and 1877." It resolves the leading features of the vast mass of which it treats into four great chains with their outer slopes and intermediate valleys or plateaus. I am obliged to allude briefly to this bygone work, for the purpose of forming a logical basis for the argument which follows.

The northern and southern Himalaya are two of these great chains. The Karakorum-Gangri and the Kuenlun are the other two. The Southern Himalaya rises from the great plain of India, and its culminating summit is distinguished by an extraordinary chain of snowy peaks throughout the whole extent which is claimed for it. The catenary and close succession of these snowy peaks cannot be denied, for they have been fixed in position and altitude by the indubitable observations of the great Trigonometrical Survey of India. Nor can the existence be disputed of the line of valleys which forms the northern base of this snowy range and distinctly separates it from the Northern Himalaya.

Yet an antiquated theory conceived before the existence of this snowy range was demonstrable, is still held to be possibly tenable by the authors of the recently published manual of the Geology of India, although they do not condescend to any reason for their conclusion.

Now this is not merely a matter of dispute between geologists and geographers, but it is one of the greatest practical importance with reference particularly to the potent question of lateral communications about which much has been said lately in reference to the Iranian system in Afghanistan. In the successive valleys following one after the other in the same line, each of which I have specifically named in the *Geographical Magazine*, there is indisputable evidence of the separation of the two ranges, and of that lateral communication which is an ordinary feature of mountain systems, rather than otherwise.

The Northern Himalaya has its southern base in these valleys, while its northern base is found in the extended trough along which flows the upper courses of the great rivers Indus, Sutlej, and Sanpu.

It is usually said that the Himalaya extends up to the gorge of the Indus on the west and to the gorge of the Sanpu on the east, and this is the extent assigned to the Himalaya by the authors of the "Manual of the Geology of India." But this restriction falls short of the limits which we have already assigned to the Tibeto-Himalayan system, on the basis of the natural oceanic watersheds. It also falls short of the extension attributed to the Himalaya on the west by observers and geographers of celebrity; and we shall endeavour to prove that it falls short, on the west at least, of the plain and simple application of the same conditions as those on which the Himalaya is allowed to extend up to the gorge of the Indus.

The valley of the Upper Indus running from south-east to north-west, at the northern base of the Northern Himalaya, and between the Northern Himalaya and the Karakorum Mountains, is carried forward in the same direction by the valley of the Gilgit river up to Vassin, and thence over a relatively low water-parting into the upper valley of the Kunar river. Near the confluence of the Indus with the Gilgit, the Indus makes a rectangular bend on entering the gorge through which it intersects both ranges of the Himalaya to enter the plain of Peshawur. But the range of the Northern Himalaya which, it is allowed, dominates the left bank of the Indus as far as the gorge, does not cease there, but is continued across the Indus in the same direction as before, and proceeding westward forms the southern barrier of the Gilgit, Yassin, and Chitral valleys, until it meets the Hindu Kush on the west of the Kunar river. The separation of the Hindu Kush from the Himalaya will be discussed further on. The valleys of Gilgit, Yassin and Chitral, in which the base of the Northern Himalaya is found, are indeed a prolongation of the great trough which forms its northern base throughout. At the extremity of the Himalaya the Kunar river drives a passage through a gorge which remains unexplored, although it is probably not less accessible than the gorge of the Indus with which we have only recently been made acquainted.

Having now traced the Northern Himalaya up to the Hindu Kusb, the continuation of the Southern Himalaya west of the gorge of the Indus remains to be made out. It is defined by a series of peaks fixed by the Trigonometrical Surveyors in a line from that gorge up to the southern end of the Kunar gorge. Beyond the Kunar, the line of peaks bulges southward and bends again northward following the base formed by the Kunar, the Kabul and the Panjshir valleys, till it meets the Hindu Kush. Like the rest of the peaks of the Southern Himalaya, the peaks west of the Indus form the culminating summits of the southern slope which ascends in unbroken continuity along the whole extent of the Indian lowland, from the eastern extremity of the valley of Assam to the plain of Peshawur, and the line of the Kabul river. Lieut. Wood, the explorer of the Oxus, who as surveyor accompanied Sir Alexander Burnes' famous mission to Kabul, remarks that "the Himalaya, as is well known, bounds Hindustan on the north, and after crossing the river Indus, extends westward to the valley of Panjshir." The Trigonometrical surveyors have since defined the exact position of the great peaks which mark the culminating summit of the range along its whole extent. At the present time, we have still to await the exploration of the high ground between the northern and southern ranges west of the Indus. There is little doubt that it will be found to correspond with the rest of the interval between the ranges throughout their extended course.

We may now turn to the Hindu Kush. The ends of the axis of the Hindu Kush are well defined as that axis is the water-parting between the basins of the Indus and the Oxus. Its southern base is to be sought in the same line of watercourses which define the northern base of the Northern Himalaya with the addition westward of the Ghorband valley. The known parts of this line include the Ghorband and Panjshir valleys, and the Upper Kunar in Chitral. It remains for future exploration in Kafiristan to trace out a line of lateral valleys serving to connect the Panjshir with the Upper Kunar, in order to complete the line of contact and division between the Hindu Kush and the Northern Himalaya.

The northern base of the Hindu Kush may be traced from Bamian along the Surkhab to its junction with the Anderab valley, from the head of which, I have little doubt, a line of lateral valleys will be found connecting Anderab with Kuran, Zebak, the Panja, and the Sarbad-wakhan or southernmost head of the Oxus

The division between the Hindu Kush and the Himalaya is, so far as it goes, likewise the division between the Tibeto-Himalayan system and that of the Pamir. To complete the division of the latter systems we must find a line of watercourses from the Kunar river up to the Tagh Dumbash Mountain, which marks the common termination of the Karakorum and the Hindu Kush; and from the Tagh Dumbash Mountain the dividing line of the two systems must be carried down to the plain of Yarkand by an afiluent of the Yarkand river.

The Pamir group of mountains has the southern base of the Hindu Kush for a part of its southern limit. Its western base is in the plain of Gobi between the Yarkand and Kashgar rivers. Its northern base is in the plain of Kokand or Ferghana, watered by the Syr Daria or Jaxartes of the ancients. The western base strikes southward along the foot of the mountains; crosses the Zarafshan river and passes Bokhara; after which the group bends round to the eastward and finds its southern base along the right bank of the Oxus, up to its outlet from the mountains; then it follows the mountains crossed by the Lataband Pass, to the Akserai or Surkhab river, which it ascends to Bamian and Ghorband, where the continuation of the southern base of the Pamir group is found in the southern base of the Hindu Kush, as already mentioned.

We have heretofore defined the indisputable limits of the great quadrilateral Iranian group, and while the recollection of the limit of the Pamir along the course of the Surkhab or Akserai to Bamian and Ghorband, is fresh upon us, we will at once point to the same line as defining the separation and the contact of the Iranian and Pamir groups. From Ghorband by the line of the Kabul river to the Indus, is also traced, the separation and the contact of the Iranian with the Himalayan group. We cannot see that a more distinct or better limitation can be suggested for these important items of geographical nomenclature.

The principal ranges in the Pamir group are now fairly made out by British and Russian observers. The most easterly range is that of the Western Kuenlun, which rises in the plain of the Gobi above the cities of Yarkand and Kashgar, and culminates in snowy peaks, of which Togarmah is 25,500 feet in height above the sea, and Tash-balik is 22,500 feet. Westward of the Kuenlun range is the water-parting between the basins of Lake Lob and of the Oxus, a range which is in continuation with the Karakorum and Hindu Kusb, and the meeting of the three is at Tagh Dumbash. This range was long since pointed out by that grand geographer Baron Humboldt, and was identified by him with the Bolor of Oriental writers. An attempt has been made by a mistaken Russian geologist and some of his followers, and also by a critic distinguished for another reason, to do away with this well established and distinctive name; but such a feature parting two famous river basins and connecting other great ranges cannot go unnamed; and we contend that the name rendered classical by the labours of Alexander Humboldt, ought to be maintained. This Bolor range is separated from the Kuenlun by a series of valleys with streams that descend to the Gobi, including the Kizilyart Plain in the northern part, while in the southern part the repetition of the name Tagharmah is probably connected with the ancient Toghari, or Tochari. The Bolor range also forms the eastern limit of the Pamir or Roof of the World, a lofty plateau rich in summer pastures, drained by the Oxus and its affluents, and bounded on the west by another great range named Khoja Mohammed.

If we compare this part of the Pamir system with the western Himalaya, a certain similarity will be observed. Thus the Upper Oxus between the Khoja Mohammed and Bolor ranges, flows at an altitude similar to that of the Upper Indus, between the Northern Himalaya and the Karakorum ranges, or about 10,000 feet. West of the Khoja Mohammed range, is the range crossed by the Lataband pass, the latter separating the lowland of Kunduz from the elevated valley of Lower Badakshan, just as the southern Himalaya separates the elevated valley of Kashmir, from the lowland of the Punjab.

Lieut. Wood represented the Khoja Mohammed range as extending from the great bend of the Oxus to the Kokcha or river of Badakshan, and beyond that river in a south-westerly direction, that is, nearly parallel with the Hindu Kush. We shall consider its further extension presently. Similarly the Lataband range must be regarded as extending all along the Aralo Caspian plain from Kunduz to the Caspian Sea, and along the south of that sea to the Armenian plateau. Like the southern Himalaya it has its outer base in the great plain, but the inner base, has so far only been made out at intervals, and is an object that well deserves observation with reference to the existence of natural facilities for lateral communication along the side of the highland.

In pursuing this interesting subject we have to point to two well determined parallel lines already set out forming respectively the great waterparting and the base in the plains. The waterparting in question is formed in continuation of Karakorum westward, (1) by Hindu Kush, between the Oxus and Indus basins; (2) by Koh-i-Baba between the Oxus and Helmund basins; (3) by Siah Koh between the Murghab and Helmund. We will not pursue the culminating line further at present. A succession or chain of lateral valleys follows we believe both sides of this summit. On the north side we follow the Upper

Oxus as far as it flows parallel with the Hindu Kush; then cross over the pass of Ishkashm to the Upper Kokcha from which in all probability the Anderab valley is accessible, and also Bamian. From Bamian Capt. Conolly passed to the upper waters of the river of Balkh and thence into the valley of Hari Rud, which expands westward to the meridian of Herat.

Between the meridian of Herat and Kabul, at least three lines of lateral communication are partially delineated. These are the parallel valleys of the Hari Rud, of the Murghab, and of the route traversed by Vambery, and the Russian officer Grodekov. Indeed it can be still further demonstrated that practical lateral communication exists throughout the whole length of the Iranian and Himalayan systems, and probably offers greater facilities of transit than the transverse routes.

On this point a few words appear to be called for, by the statements of a recent writer, a member of parliament, and formerly an Indian Governor of great distinction, who has denied the existence of lateral communication along and within the Sul'man Mountains which form the easternmost part of the Iranian system and extend nearly from the Kabul River to the sea.

So far from lateral communication being wanting in this locality, which is now of much importance on account of its being brought by treaty within the scope of British administration—so far from the lateral communication being deficient and much less altogether absent—it constitutes as in the other mountains which we have discussed, a characteristic and marked feature of them. Indeed the outermost slope or scarp of the eastern Suliman has been delineated like a rising series of parallel gutters, terraces, or troughs, in the beautiful maps of the Derajat prepared by the surveyors under the guidance of Major-General Sir Henry Thuillier, who for so long a time filled the office of Surveyor-General of India, and whose presence here is such an advantage to the section.

In the heart of the mountains two lines of lateral communication can be already traced, even with our present very scanty information. Both are on the east of the waterparting of the Helmund and Indus basins, which is formed by the western range of the Suliman. One skirts the very summits of the range and is formed at its northern limit by the uppermost valleys of the Kurram, west of the Peiwar Kotul. It is watered by a stream which descends from near the Shutargarden Pass to the Kurram, where it meets another branch of the Kurram coming from the Mangal country on the south-western limits of the Kurram basin. From thence there is a communication with the district of Furmul which was known to the Turki Emperor, geographer, and conqueror of India—the famous Baber. Furmul lies at the head of the Dawar valley and river, which descends from it straightway to the Indus, but has never yet been wholly traversed by Europeans. Furmul is occupied by the Karoti tribe of the famous Povindah merchants, unless the Waziri have driven them out.

From Furmul this lateral line passes on to the Dwa Gummul another haunt of the Karoti people, who, as Povindahs and periodical visitors and traders to India, should have a clear interest in being friendly with us. From the Dwa Gummul we pass on to a southern headwater of the Gummul, and so on to the head of the Zhob valley, which is connected with the Thal-Chotiali route to Peshin.

There is another very important lateral line, a part of which was made known to Lieut. Broadfoot of the Royal Engineers as far back as 1842, by a native name, signifying "the road of the Waziri," a dominant tribe in those parts. This also connects the Kurram valley with the Dawar and Gummul valleys; and it is prolonged from Gummul up to the Chotiali route, by the great Zhob valley, which has at least been distinctly seen from both ends, in a direction nearly meridianal. We all know the great road which has been traversed by British troops between Kabul, Ghazni, Kandahar, and Kelat, and eastward of this, on the western side of the western Suliman range, a route has been traversed from Zurmul to lake Abistada, and from the lake to Kelat, British troops have marched over the Toba highland.

So much by way of proof of abundant lateral communication along the mountains west of the Indus.

One word more relating to the lateral communication through the hills and valleys of the south slope of the great Iranian highland. For it relates to the construction in the near future of a railway to India. From sheer ignorance some have proposed to carry such a line along the coast in a deadly climate with the atmosphere of a permanent hot bath. But the true route is found in one of those elongated lateral valleys which at a considerable elevation above the sea and in a better climate than that of the lowland on the coast, stretch all along from the Pubb river on the borders of India to Mesopotamia. Among these is the line of the Kej valley and a succession of others leading to Shiraz, from whence there is little doubt that a practical line may be found up to Bagdad.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Professorship of Experimental Physics has been formally continued by the Senate, and there is now no doubt that if Lord Rayleigh is willing to undertake this onerous office, he will be elected Professor. A memorial requesting him to be a candidate signed by almost every elector in a very short time seems like a command. It shows that there is no fear, and every hope for a beneficial result to education following. Lord Rayleigh's knowledge of the working of the University and the Scientific Commission will give him a most commanding position. It is a clear "call" from the University when such men as Adams, Besant, Cayley, Dewar, Ferrers, Frost, Garnett, J. W. Glaisher, Hughes, Liveing, R. K. Miller, Peile, Pendlebury, Routh, Salvin, Skeat, Stoke, James Stuart, Todhunter, Venn, James Ward, W. Aldis Wright and others unanimously record their view that it would tend greatly to the advance of physical science and to the advantage of the University that Lord Rayleigh should occupy the chair of Experimental Physics at Cambridge.

Messrs. C. W. Moule (Corpus) and S. H. Vines (Christ's) have been appointed members of the Botanic Garden Syndicate till November 20, 1882; Drs. Power and Phear have been appointed on the Museum and Lecture Rooms Syndicate; Mr. Henry Sedgwick and Mr. V. H. Stanton are again on the Local Examinations Syndicate; Messrs. W. D. Niven and G. H. Darwin are appointed on the Observatory Sydicate; Messrs. Bradshaw, Bensly and Peile, and Dr. Hart and Mr. Aldis Wright are on the University Press Syndicate; the two latter are special elections in view of the publication of the Revised Translation of the Bible; P. T. Main and F. M. Balfour on the State Medicine Syndicate.

Mr. S. H. Vines is also appointed on the Natural Science Studies; and Dr. Paget has been elected on the Council of the Senate, as a Professor, in Prof. Maxwell's place, for one year, and by only one vote over Prof. Stuart. Dr. Paget has on previous occasions been unwilling to come forward for such an onerous post, and would hardly now have done so, but for the short term of office required, and the importance of the medical and natural science rearrangements at Cambridge demanding his aid if the University showed its confidence in him.

An amended schedule for 2nd M.B. Camb. to come into operation in June, 1880, as far as regards comparative anatomy differs from that at present in force in introducing *excretory* and *reproductive* organs, as being required to be known in addition to the other principal systems: the tapeworms parasitic in man, cockroach, fresh-water mussel, whiting, and rabbit are introduced, while the spider and the cockchafer, oyster, perch, and rat disappear. In the specification as to the vertebrate skeleton, the cod displaces the perch, the dog replaces the rat. These changes all seem to be in the direction of providing larger and more conspicuous and accessible specimens to be studied, or those more necessary for a medical student.

SCIENTIFIC SERIALS

Journal of Botany, September, October, and November.—The last three numbers of this journal are mainly occupied with articles on descriptive and systematic botany, extracts, and reviews, with the exception of two, to which special attention may be called.—In the September number Mr. S. Le M. Moore has a "preliminary notice" on mimicry of seeds and fruits, and the functions of seminal appendages. He points out the number of seeds or fruits that bear a striking resemblance to coleopterous or other insects, by means of which he believes they may often escape from their seminivorous enemies by being passed over as insects, or, being picked up and thrown away by insectivorous birds, may thus become disseminated. He adduces striking instances of this mimicry in Polygalaceæ, Leguminosæ, Umbelliferæ, and especially Euphorbiaceæ, in which the carunculus of the seed closely resembles the head of the insect, and the raphal line the line between the closed clytra, the seed being often besides symmetrically striped or spotted. The main object of the fleshy carunculus has been generally assumed to be the supplying of food to the young embryo; but this, Mr. Moore believes, is not confirmed by actual experiment. It also no doubt serves to attract seminivorous birds, through whose body the seed passes to be prepared for germination.—In the November number Mr. S. H. Vines has an article on alternation of generations in Thallophytes, the main object of which, however, is to show that it does not exist, except in a very few cases. This is indeed in accordance with the general view of botanists. Mr. Vines still holds to his view that alternation of generations occurs in Characeæ; though why he now returns to the very doubtful position which he had previously abandoned, that the Characeæ are Thallophytes, is not explained.

Nuovo Giornale Botanico Italiano, October.—Sig. Borzì continues his series of papers on the morphology and biology of the Phycochromaceæ, the present portion being devoted to the structure and classification of the Scytonemaceæ, which he makes to consist of seven genera, viz., Coleodesmium, Bzi.; Tolypothrix, Ktz.; Hilsea, Kirchn.; Scytonema, Ktz.; Stigonema, Ag.; Capsosira, Ktz.; and Hapalosiphon, Näg. The various modes of increase he defines to be (1) by pseudoramuli, or portions of filaments which deviate from the ordinary direction, heterocysts being sometimes interposed between these and the filament from which they spring; (2) by spontaneous fraction of the filaments, the different portions remaining united in a bundle within a common gelatinous envelope, where they increase independently; (3) by hormogonia, or fragments which become detached from the filament, and which move slowly in the water in a rectilinear direction, light exercising no influence on the movement; (4) by spores, or isolated cells capable of resisting cold and excessive drought. In the same number A. Bertolini describes a new disease of the cherry-laurel, caused by a parasitic fungus, to which he gives the name *Oidium passerinii*, and which attacks the fruit. It makes its appearance in the form of irregular white spots, composed of filaments which invest the epicarp of the fruit, and from which rises a delicate down. The former is the mycelium of the fungus, the latter consists of the ovoid conidia arranged in moniliform filaments.

THE *Revue Internationale des Sciences* (September) contains the following among other papers:—The plant and man in their reciprocal relations, by Dr. Ernest Hallier.—On the geology of the Japanese Archipelago, by M. G. Maget.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 20.—"On Definite Integrals involving Elliptic Functions." By J. W. L. Glaisher, F.R.S.

"Values of the Theta and Zeta Functions for certain Values of the Argument." By J. W. L. Glaisher, F.R.S.

"On Certain Definite Integrals." No. 5. By W. H. L. Russell, F.R.S.

"On the Action of Nuclei in Producing the Sudden Solidification of Supersaturated Solutions of Glauber's Salt." By Charles Tomlinson, F.R.S.

"The Geometric Mean, in Vital and Social Statistics." By Francis Galton, F.R.S., and Donald McAlister, B.A., B.Sc., Fellow of St. John's College, Cambridge.

"On the Normal Paraffins. Part III." By C. Schorlemmer. F.R.S., Professor of Organic Chemistry in Owens College, Manchester.

Zoological Society, November 18.—Prof. Flower, F.R.S., president, in the chair.—An extract was read from a letter addressed to the Secretary by Mr. H. O. Forbes, on the subject of the distribution of the badger-headed Mydaus in Java.—The Secretary read an extract from a letter received from Dr. A. B. Meyer, in which the habitat of *Cervus alfredi* was stated to be Samao and Leyte Islands, of the Philippine group.—Mr. Edward R. Alston exhibited some mammals collected by Mr. Wardlaw Ramsay, 67th Regiment, including examples of some species new to the faunas of Burma and Afghanistan.—Mr. Alston also exhibited one of the typical skulls of *Tapirus dowi* (Gill), which had been entrusted to him by the authorities of the U.S. National Museum. He remarked that the young tapir from Corinto, Nicaragua, which was formerly alive in the Society's Gardens, was really an example of *T. dowi*, and not, as had been hitherto supposed, of *T. bairdi*.—Prof. Flower exhibited and made remarks upon the skull of a White Whale (*Delphinopterus leucas*), recently obtained in Sutherlandshire.—The Secretary exhibited on behalf of Mr. Rowland Ward, the head of a chamois, with two pairs of horns.—Communications were read from Mr. L. Taczanowski, C.M.Z.S., containing descriptions of a new *Synallaxis*, from Peru, which he proposed to name *Synallaxis fruticola*; and of a new *Myiarchus*, from the same country, proposed to be called *M. cephalotes*.—A third communication received from Mr. Taczanowski contained a notice of some birds of interest recently received from Turkestan.—A communication was read from Captain Shelley, containing an account of a collection of birds made in the Comoro Islands, received from Dr. Kirk, H.B.M. Consul-General at Zanzibar. The collection contained 186 specimens. A *Zosterops* which appeared to be new was named *Z. kirkii*, in acknowledgment of the assistance rendered to ornithology by Dr. Kirk.—A second paper by Captain Shelley, gave the description of two new species of African birds.—Lieut.-Col. H. H. Godwin-Austen, F.Z.S., read a description of the female of *Lophophorus sclateri*, Jerdon, from Eastern Assam.—A communication was read from Dr. Goodacre, F.Z.S., on the question of the identity of the common and Chinese geese.—A communication was read from the Rev. O. P. Cambridge, C.M.Z.S., on some new and rare spiders from New Zealand; with characters of four new genera.—A communication was read on some African species of Lepidoptera, belonging to the sub-family, Nymphalinæ, by Mr. W. L. Distant. In this paper several instances of great variation were given, and some corrections made in the nomenclature. A new genus, five new species, and the male of *Halma lucasi*, Down, were also described.—Mr. R. G. Wardlaw Ramsay read the description of a new oriole, from N. E. Borneo, which he proposed to call *Oriolus consobrinus*.

Royal Microscopical Society, November 12.—Dr. Beale, F.R.S., in the chair.—Ten new Fellows were elected and eleven proposed for election at the next meeting. Prof. Weismann and others were elected Hon. Fellows.—A paper by Mr. H. E. Forrest, on the anatomy of *Leptodora hyalina*, was read; also papers by Mr. J. Fullagar, on a supposed new species of freshwater *Freia*; by Col. Woodward, on amplifiers and the use of chloride of cadmium and glycerine as a fluid for homogeneous immersion, and by Mr. J. Mayall, jun., on his immersion stage illuminator, which was exhibited to the meeting. Among the objects exhibited were anomalous forms of *Acinetæ*, by Mr. Badcock, an improved micratome, by Mr. Ward; various algæ and infusoriæ, by Mr. Bolton, a new compressorium, by Mr. Graham, and Zeiss's travelling-microscope, by Mr. Crisp.

Anthropological Institute, November 11.—E. B. Tylor, F.R.S., president, in the chair.—The following new Members were announced:—A. Tylor, F.G.S., Baron von Hugel, Capt. R. C. Temple, and G. W. Bloxam, F.L.S.—Mr. E. W. Brabrook, secretary to the Anthropometric Committee, exhibited two albums of photographs collected by that body.—A report on the Bheel tribes of the Vindhyon Range was read by Col. Kincaird, fully describing the manners, customs, and superstitions of these little-known people, from experience derived during many years' residence amongst them. The Bheels are very dirty in their habits: their principal diseases are enlarged spleen and small-pox.—A paper was read by Mr. A. H. Keane on the relations of the Indo-Chinese and inter-oceanic races and languages, to show that Further India is occupied by two types, the fair and tbe yellow (Caucasian and Mongolian), the former speaking polysyllabic-untoned, the latter monosyllabic toned, languages; that both of these types, intermingled with the Papuan or dark races, constitute the whole of the population of Malaysia; that the Caucasian alone appears in the Eastern Pacific as the "*Sawaiori*," or "large brown Polynesian race." The absence of the monosyllabic languages from the oceanic area was accounted for, the expression "Malayo-Polynesian" shown to be misguiding, and the Malay type itself was considered to be, not fundamental, but essentially mixed—the result of fusion in the Eastern Archipelago of the fair and yellow elements.—Mr. S. E. Peal exhibited a fine collection of ethnological drawings made in Assam.

VIENNA

Imperial Academy of Sciences, October 9.—The vice-president made reference to the deaths of Dr. Fenzl, of Vienna, and Dr. v. Brandt, of St. Petersburg.—The following among other papers were read:—Earthquakes in Canea on the night of August 9-10, by Herr Miksche.—On the decline of water in springs, rivers, and streams with simultaneous rise of high-water in cultivated lands, by Herr v. Wex.—Reply to Prof. Heer (with regard to the task of phyto-palæontology), by Prof. von Ettingshausen.—Further investigation of spark-waves, by Prof. Mach and Herr Simonides.—On rational plane curves of the third and fourth order, by Herr Ameseder.—On the development of back-vessels and specially of the muscular system in Chironomus and some other insects, by Herr Jaworowski.—Determination of altitude of the pole at the Observatory of the Technical High School in Vienna, by Dr. Tinter.—Studies on a plane conic section of rotation, whose parameters are of the same size, by Herr Rotter.—Discovery of two comets by Herr Palisa and Herr Hertwig.—On combinations from animal tar. II. Non-basic constituents, by Dr. Weidel and Herr Ciamician.—On the phenomena in Geissler tubes under external action (first part), by Prof. Reitlinger and Urbanitzky.—On a species of configurations in the plane and in space, by Herr Kantor.

Paris

Academy of Sciences, November 17.—M. Daubrée in the chair.—The following papers were read:—Meridian observations of small planets at the Greenwich and Paris Observatories during the third quarter of 1879; communicated by M. Mouchez.—On the temperature of decomposition of vapours, by M. Sainte-Claire Deville. He supports M. Berthelot's views in opposition to M. Wurtz. The quantity of heat liberated by formation of a compound substance has no known relation with its temperature of decomposition.—Observations on M. Cochin's note on alcoholic fermentation, by M. Berthelot.—Observation of the ultra-violet limit of the solar spectrum at different altitudes, by M. Cornu. Fifty-two *clichés* were obtained at three stations: Riffelberg (2,570 m. alt.), Rigi (1,650 m.), and Viège (660 m.) The extreme ultra-violet limits were, severally, λ 293·2, 294·8, and 295·4; the difference between Riffel and Viège (1,910 m.) being thus only 2·2 units (or millionths of a millimetre), or about 1 unit for 900 metres' altitude, a small amount of variation.—Explosion of carbonic acid in a coal-mine, by M. Delesse. This occurred in a coal-pit at Rocheville (Gard), where there is much carbonic acid (no fire-damp). Two men at 345 m. depth heard two successive detonations (without flame), had their lamps blown out, became faint, and were just able to throw themselves into the cage, when they were pulled up. Three others, at 246 m. depth, perished. It is the first time the CO_2 has been so compressed and condensed in the coal as to cause explosion. Some seventy-six tons of coal were disengaged; and the CO_2 liberated is estimated at a maximum of 4,546 cubic metres. It is thought that a new stratified mass of iron pyrites being very strongly oxidised and decomposed, the resulting sulphuric acid dissolving in subterranean water reaches the triassic limestone, and so produces CO_2, which diffuses through the fissures of the coal. M. Dumas supported this view.—Second note on the effects and mode of action of antiseptics; effects on pus, by MM. Gosselin and Bergeron. Rightly used camphorised brandy, carbolic acid ($\frac{1}{50}$) and alcohol at 86° are, in the same degree, moderators of inflammation and preventives of septicæmia.—Climatological conditions of the years 1869-1879 in Normandy, and their influence on ripening of the crops (continued), by M. Mangon. In the north-west of La Manche, the low temperature of the end of 1878, of the first six months, and especially of July, 1879, and the abnormal rains of February and June, retarded the harvest about twenty-two days for corn, twenty for barley and beans, and ten to twelve for buckwheat. By noting the sum of degrees of temperature in each year since sowing, we may, with aid of the tables here given, calculate very exactly a month or six weeks in advance the time of harvest for the crops named.—On the true number of fundamental co-variants of a system of two cubics, by Prof. Sylvester.—Critical reflections on the experiments concerning human heat, by M. Hirn.—M. de Lesseps presented communications relating to a railway from Algeria to Senegal and Soudan, Belgian expeditions in Central Africa, and the public laws applicable to international rivers.—Atmospheric polarisation and the influence of terrestrial magnetism on the atmosphere, by M. Becquerel. He proves that a variable divergence exists between the plane of the sun (meaning thereby a plane passing through the observer's eye, the point looked at, and the centre of the sun) and the plane of polarisation of the atmosphere at any point, and thinks the influence of the earth's magnetism appears in rotating the plane of polarisation.—On a class of functions analogous to the Eulerian functions studied by M. Heine, by M. Appell.—New principle of meteorology furnished by an examination of earthquakes, by M. Delauney. Earthquakes seem to pass through a maximum when Jupiter and Saturn are about the mean longitudes of 265° and 135°. A recrudescence of earthquakes in winter the author attributes to streams of cosmic meteors, and the influence of Jupiter and Saturn in the positions stated to their passage through such streams.—Remarks on M. Boiteau's paper about winter eggs of phylloxera in surface-layers of the ground, by M. Balbiani.—On the causes of reinvasion of phylloxerised vineyards, by M. de Lafitte.—A telegram from General Ibanez announced completion of the geodetic connection of Spain with Algeria (November 16).—Observations of a satellite of Mars (Deimos) at Paris Observatory, by M. Bigourdan.—On doubly-periodic functions with singular essential points, by M. Picard.—Spots and protuberances observed with a spectroscope of great dispersion, by M. Thollon. The displacements and alterations of lines in observations of spots are specially striking. They are always in the same direction, and seem to indicate a motion from periphery to centre. A brilliant protuberance observed with narrow slit, illuminated vividly portions of the line C, which presented numerous solutions of continuity. The prodigious velocity of 25 km. per second indicated by the line, and lasting some time, suggests doubt as to the reality of the supposed cause.—The problem of the Euripus, by M. Forel. He traces the action of seiches as well as of soli-lunar tides in the currents of these straits.—On chlorophyll, by M. Gautier. He describes how he obtained chlorophyll pure and crystallised in 1877. He regards it as closely related to bilirubin, in aptitudes, reactions, and elementary constitution, and consequently to hematine.—Viviparity of *Helix studeriana* (Ferussac), by M. Vignier.—On the relative distribution of mean temperatures and pressures in January and July, by M. Teisserenc de Bort.—M. Le Bon gave some results of measurement of crania of eminent men in the Museum of Natural History. The high average figure of 1,732 cc. (capacity) was got from twenty-six skulls.—M. De Coiney described a meteor observed by day at Jevah (Dordogne).

CONTENTS

THURSDAY, DECEMBER 4, 1879

YALE COLLEGE AND AMERICAN PALÆONTOLOGY

ALTHOUGH notices have from time to time appeared in European scientific journals of the scientific expeditions sent out from Yale College to the Western Territories of the United States, probably only those palæontologists and geologists who have crossed the Atlantic and have had an opportunity of seeing all that is yet visible of the vast amount of material collected at New Haven can adequately realise the enormous additions which have been and are being there daily made to our knowledge of extinct vertebrate life. Thanks to the generous liberality of the late Mr. George Peabody, who has endowed centres of scientific progress in various parts of America, Yale College has been supplied with an admirable Museum of Natural History and with a fund for its maintenance. By his deed of gift the donor provided that after one portion of the money had been employed in erecting the museum, a certain sum ($20,000) should be set apart and invested until it should reach at least five times its original amount, when it might be employed for further building; while the interest of a further sum of $30,000 should be devoted to the maintenance and extension of the collections, in the proportion of three-sevenths to zoology, three-sevenths to geology, and one-seventh to mineralogy.

The wise intentions of the founder have been most faithfully and successfully carried out by his trustees. The building now erected, though forming only one wing of the magnificent pile which they will ultimately complete, is already amply filled with the collections of the several departments. The rooms open to the public are well-lighted, and the cases are carefully arranged and easy of consultation. But by far the larger part of the collections is still stored in the cellars, awaiting the growth of the premises. Unfortunately, however, the boxes are accumulating in these lower regions at a rate which one fears must be greater than that of the building fund.

The mineralogical cabinet has been entirely rearranged and displayed by Mr. E. S. Dana, who, with Prof. Brush, is amply sustaining the old mineralogical renown of New Haven.

The unique feature, however, in the Peabody Museum, is the vast collection of vertebrate fossils from the Western Territories, made by the enthusiastic labours of Prof. O. C. Marsh. Only a small portion of this enormous series has yet been placed in cases for public inspection. But the Professor, with infinite courtesy and patience, conducted the writer of these lines through the stores from cellar to roof, brought under his notice examples of the more interesting and important of the "finds," and furnished him with notes of the collection and permission to use them, of which he now gladly avails himself.

After having spent several years in bringing together, from the Cretaceous and Tertiary strata of the Atlantic coast, a very considerable mass of material, the Professor came to the conclusion that this field was essentially exhausted, and that it was to the unexplored territory beyond the Missouri River, that the palæontologist must now look for additional facts to help him to an intelligent comprehension of the progress of vertebrate life in the past. This conclusion having been confirmed by his own observations during a short trip to the Rocky Mountains in 1868, he, in 1870, organised the first of the Yale Scientific Expeditions. After spending five months in the field the party returned well laden with fossil treasures from the Cretaceous and Tertiary formations. The success of this experiment having been so marked the four succeeding years witnessed the departure of as many expeditions, all of which were likewise successful. The results may be briefly summed up in the statement that, altogether, within six years, these expeditions under Prof. Marsh brought to light more than four hundred species of vertebrate fossils new to science, of which only about two-thirds have as yet been described. At the time when these explorations began, the West was almost wholly unknown, and the investigators were exposed to great hardships and to no little danger from hostile Indians. It is to be hoped that Prof. Marsh may be induced to write down and publish a narrative of his life and adventures in the wild west in search of fossils. The samples which in friendly talk he communicated to the present writer were so entertaining, that the book could not fail to prove most interesting, and would no doubt help on the cause of palæontology in America.

Among the numerous extinct animals discovered during the progress of these explorations are many groups which differ widely from any forms of life previously known. Prominent among these, and extremely interesting from their bearing on questions of evolution, are the toothed birds of the Cretaceous formation, the *Odontornithes*, all the known specimens of which are in the Yale Museum. These constitute a new sub-class, and have been divided into two well-marked orders: the *Odontolcæ*, which have the teeth implanted in grooves, and the *Odontolormæ*, with the teeth in distinct sockets. The *Odontolcæ* were large swimming birds, somewhat resembling the Divers of the present day, but with rudimentary wings, of no possible use to their possessor. The vertebræ were as in modern birds. The typical genus is *Hesperornis*, and at least three species are known. The second order includes small birds, very different in appearance and characters from the preceding group, with large and powerful wings, and biconcave vertebræ. Two genera and several species are known, which belong to this order. The type genus is *Ichthyornis*. All the toothed birds known at present come from the upper Cretaceous of Kansas, and more than one hundred individuals are represented in the Museum. A memoir on this group, with forty quarto plates, by Prof. Marsh, is now in the press.

In the same formation this active explorer discovered the first American Pterodactyls, or flying reptiles. These animals are extremely interesting, not only on account of their enormous size—for some of them have a spread of wings of nearly twenty-five feet—but more especially from the fact that they were destitute of teeth; in this respect resembling modern birds. They represent a new order, *Pteranodontia*, named from the type genus, *Pteranodon*, of which several species are now known. Numerous anatomical points of much importance will, no doubt, be brought to light by a close study of this remarkable aberrant group, and the ample material now in the museum, representing more than six hundred individuals, will render their elucidation comparatively easy.

With the toothed birds and the Pterodactyls, have been found great numbers of Mosasauroids, a group of reptiles, which, during Cretaceous times, attained an enormous development both as to numbers and the variety of forms by which it was represented. Several new families, including a number of new genera and many species, here appeared, and flourished abundantly. The *Tylosauridæ* were very large, some of them being more than sixty feet in length, whle the *Edestosauridæ* were much smaller. The very abundant material secured, representing not less than twelve hundred individuals belonging to this order, has enabled Prof. Marsh to settle many doubtful points with regard to the structure of these reptiles, and to determine that they possessed hind paddles, and were covered with dermal scutes.

The Cretaceous formations of the West likewise have yielded numerous turtles and other reptiles, and many fishes, some of them of great interest, and very full series of specimens of all of these, representing not less than five thousand individuals, are at present in the Yale College Museum. The fame of these discoveries has led other explorers into the same field. A most formidable rival in enthusiasm and energy is Prof. E. D. Cope, who has filled the houses at Philadelphia with bones from the West, who has published some valuable memoirs upon them, and to whose work attention will be directed on another occasion.

Besides the discoveries made by Prof. Marsh and his parties in the Cretaceous of the West, the old Eocene lake-basins between the Rocky Mountains and the Wahsatch Range were, during the summer of 1870, explored with most interesting results, their age being then fully determined and announced. Many remarkable forms of life, most of them very different from anything previously known, have been disinterred. Of all of these, perhaps none are more extraordinary than the gigantic *Dinocerata*, a new order recently established by Prof. Marsh. These animals nearly equalled the elephant in size, but with shorter limbs. The skull was furnished with two or more pairs of horn cores, and with enormous canine tusks similar to those of the walrus, while the brain was proportionally smaller than in any other land mammal. Three genera and several species are known. These great creatures seem to have lived in considerable numbers about the borders of the old Eocene lakes, and their remains are found quite abundantly, buried in the dirt that once formed the muddy bottom. Remains of more than two hundred different individuals are now in the Peabody Museum, and a volume descriptive of them by their discoverer is now in course of preparation.

Another new order of mammals, made known by the same untiring anatomist from these same deposits, is that of the *Tillodontia*. These animals are in many respects very remarkable, and notably in presenting characters which seem to indicate affinities with several widely different groups. Thus the skull, feet, and vertebræ resemble those of some carnivores; the anterior incisors forcibly remind one of the corresponding teeth in the rodents; the lower molars are of the Paleotherium ungulate type. Two families of this order are known: the *Tillotheridæ*, in which only the incisors, and the *Stylinodontidæ*, in which all the teeth grow from persistent pulps. The largest specimens of this order were about the size of a tapir.

From these Eocene deposits, too, were obtained the first remains of fossil *Quadrumana* known from the New World. These early primates, according to their discoverer, seem to have relationships both with the lemurs of the Old World, and with the South American monkeys. Two families have been discovered: the *Lemuravidæ*, named from the principal genus, *Lemuravus*, which have forty-four teeth, and the *Limnotheridæ*, which have not more than forty. The large number of genera and species by which this group is represented in these Eocene deposits, show that, even at this early period, the American primates had reached a high degree of development, and enjoyed, up to that time at least, very favourable conditions for their existence. They are all, however, low generalised forms, the characters of their teeth and other portions of the skeleton bearing considerable resemblance to the corresponding parts in the ungulates and carnivores. Besides the groups already mentioned, the same Eocene lake-basins yielded the remains of marsupials and bats (neither of which had before been found fossil in America), together with many species of birds, serpents, lizards, and fishes.

Since the original account of American fossil horses given by Leidy, the Eocene strata of New Mexico and Wyoming have yielded two very important ungulates, which have helped to complete the history of the descent of the horse, so well worked out by Prof. Marsh. These relics carry back the ancestry of this familiar quadruped to the oldest Tertiary time. The earliest form, *Eohippus*, was about the size of a fox, had forty-four teeth, the molars having short crowns, and being quite different in form from the premolars. There were four well-developed toes, a rudiment of another on the forefoot, and three toes behind. The structure of the feet and of the teeth in *Eohippus* indicates, beyond question, that the direct ancestral line to the modern horse had already separated from the Perissodactyls. The second of these ungulates, *Orohippus*, is from the Wyoming Eocene, and is evidently next to *Eohippus*, which it now replaces in the line of descent. In size it about equalled its predecessor, but the rudimentary digit of the forefoot has disappeared, and the last premolar has gone over to the molar series. Another Eocene equine, discovered in Utah, is *Epihippus*.

The discoveries made by the Yale expeditions in the "Miocene" and Pliocene formations of the Rocky Mountains and the Pacific coast were scarcely less numerous and interesting. From these deposits were obtained the large series of specimens which served to complete the genealogical line of the horse from the four-footed Orohippus of the Eocene to the large *Equus fraternus* of the later Pliocene, which does not differ, appreciably, from the horse of to-day. From the "Lower Miocene" comes *Mesohippus*, which is about the size of a sheep, and has three usable toes of nearly equal size, and a long splint or rudiment of another, corresponding to the second digit of a five-toed foot. *Miohippus*, a somewhat later form, bears a close resemblance to *Mesohippus*, but the side toes are smaller, and the splint is very short. In *Protohippus*, from the lower Pliocene, there is a considerable increase in size, the splint has disappeared, and the two side toes have become so small that they no longer reach the ground, but are merely dew claws, like those of the deer or ox. *Pliohippus*, which is found in a still higher horizon of the Pliocene, is as large as a donkey, has lost the dew claws, but has the splints much longer than the same bones in the modern equines. Finally, at the top of the Pliocene comes a true *Equus*, which completes the line. Besides the forms mentioned, there are many intermediate ones, which show that the transition has taken place in the order indicated. Many additional characters of the skull, brain, and teeth, add weight to, and confirm, the evidence furnished by the feet.

Among the other treasures of the Museum are bones of mammals allied to the modern rhinoceros, which occur abundantly in strata, said to be of Miocene age, both in Oregon and the Rocky Mountain region. These remains furnish material for tracing the descent of these creatures from the upper Eocene to the close of the Pliocene, when they appear to have become extinct. A strange group of ungulates, found in the so-called Lower Miocene of the plains, were the huge *Brontotheridæ*, which appear to have been allied to the *Dinocerata*, and also to *Rhinoceros*. In size they equalled the *Dinocerata*, and, like them, had an elevated pair of horn cores on the maxillary bones. An immense quantity of the remains of these animals, representing several genera and over two hundred individuals, has been collected, and is now in the Museum.

Until within a year or two, no Tertiary edentates were known from America, although their remains were found in abundance in the superficial post-Tertiary deposits. Recently, however, the Museum has received, from the "Lower Miocene" of Oregon, the remains of two species belonging to this group and to the genus *Moropus*. These are of large size, and were, essentially, huge sloths. From the Pliocene deposits of Idaho and California, and from the same formations east of the Rocky Mountains, other large species have been discovered belonging to the genera *Moropus* and *Morotherium*. Many other groups of mammals, including primates, carnivores, suillines, camels, &c., have been collected in these formations, which also yield numerous birds, reptiles, and fishes.

Although observations had been made by previous investigators, on the size of the brain in Tertiary mammals, Prof. Marsh was the first to institute any systematic inquiry into the laws which governed and the causes which acted upon, brain-growth in these ancient animals. Some of his conclusions, based on specimens now in the Museum, have been already given to the world, but they may be fittingly cited here: (1) All Tertiary Mammals had small brains; (2) there was a gradual increase in the size of the brain during Tertiary time; (3) this increase was mainly confined to the cerebral hemispheres, or higher portion of the brain; (4) in some groups the convolutions of the brain have gradually become more complicated; (5) in some the cerebellum and olfactory lobes have even diminished in size.

Some of the additional conclusions already reached in regard to American Tertiary mammals, so far as they are now known, are stated as follows:—(1) All the *Ungulata* from Eocene and Miocene deposits had upper and lower incisors; (2) all Eocene and Miocene mammals had separate scaphoid and lunar bones; (3) all mammals from these formations had separate metapodial bones.

Although the Cretaceous and Tertiary fossils make up a large part of the geological collections of the Peabody Museum, the other formations are well represented in its store-rooms. This is especially true of the recently discovered Jurassic beds of the Rocky Mountains, which have yielded, since the summer of 1877, a great number of interesting forms. The parties that have been collecting for Prof. Marsh have been more than usually successful, and a study of the strange animals, many of them new to science, which have been sent to the Museum, has resulted in several discoveries of great interest. These Jurassic fossils are chiefly dinosaurs, crocodiles, turtles, and fishes. The first of these are extremely abundant, and the horizon from which they come has been named by Prof. Marsh, from one of the genera there discovered, the Atlantosaurus Beds. These dinosaurs varied widely in size and structure, for while some of them, *e.g.*, *Nanosaurus*, were no larger than a cat, others were, by far, the largest land animals of which we have any knowledge. Among the discovered remains of *Atlantosaurus immanis* is a femur over six feet in length. A comparison of this specimen with the same bone in living reptiles indicates that *Atlantosaurus*, if similar in proportions to the crocodiles, would have been more than one hundred feet in length. The anatomical points cleared up by the discovery of the bones of the feet in these dinosaurs are of great importance and interest. From these same Atlantosaurus Beds come the strange *Stegosauria*, recently described by Prof. Marsh; a new order of reptiles whose affinities are, as yet, but imperfectly understood, but which appear to have most relationship with the dinosaurs. The Atlantosaurus Beds have furnished, moreover, the only Jurassic mammals yet found in America. These remains, apparently all marsupial, belong, so far as known, to four genera and eight species, which Prof. Marsh has described. He has also recently made known, from the marine Jurassic beds of the Rocky Mountains, a peculiar group of reptiles (*Sauranodontidæ*) allied to *Ichthyosaurus*, but without teeth.

An enumeration of the fossil treasures of New Haven would, however, fail to do justice to this marvellous collection if it made no mention of the almost incredible state of preservation of the fossils. A European student is lucky if he finds a tooth or a jaw; most fortunate should he stumble upon a cranium; the envy of the whole tribe of collectors should he disinter a whole skeleton. But even when most successful he meets with the bones often in a fragmentary, or badly preserved condition, or imbedded in so tough a matrix that they cannot be adequately cleared for study without almost certain detriment. The vast regions open to American research in the West, however, are the very paradise of palæontologists. Almost as fresh as if the animals had only recently died, the bones protrude sometimes in great numbers from the edges of the escarpments. When the first explorers went into these tracts they found the skulls grinning at them from the faces of the bare dry verdureless cliffs of the "bad lands." The diligence of Professors Marsh, Cope, and their parties has no doubt cleared away a good many of the prominent objects. But the number still to be exhumed must be enormous.

Entire skeletons with almost every bone in place show how tranquilly and thoroughly the remains of the early Tertiary vertebrates were entombed in the mud of the lakes on whose shores and waters they lived.

A. G.

CHRONOLOGICAL HISTORY OF PLANTS

Chronological History of Plants: Man's Record of his own Existence illustrated through their Names, Uses, and Companionship. By Charles Pickering, M.D. (Boston: Little, Brown, and Co.; London: Trübner and Co., 1879.)

THIS is an extraordinary book, difficult alike to characterise and to review. It is a monument of enormous labour and erudition, but it is not easy to discover the plan upon which it is compiled, and it certainly does not fulfil the promise of its title. A "chronological history of plants" would be an interesting and valuable work, if understood to mean a history of the ages and countries in which particular plants have been introduced from abroad, or those of home growth first adapted to the use of man. This, indeed, is the work which Dr. Pickering seems to have contemplated; it is not, however, the work which he has accomplished.

Neither the historian, the philologist, nor the botanist will be satisfied with the huge volume now presented to them. Dates are given with a show of minute accuracy which the materials for ascertaining them unfortunately do not justify. Thus, to go no further than the second page, we find the mysterious paragraph, "Second generation, September 1st, 4234, among living men." As similar entries occur on the following page, with the names of Enoch, Irad, and other descendants of Cain attached to them, I suppose the paragraph must be interpreted to mean that the second generation of living men first saw light on the 1st of September, B.C. 4234. How Dr. Pickering knew this I cannot imagine. If we turn over a few leaves we find the dates of the early Egyptian kings set down with equal minuteness, and, it must be added, with an equally small show of reason. Dr. Pickering even knows the exact dates of the antediluvian monarchs of Babylonia, though he has forgotten the right name of the town of Pantibibla, from which several of them were said to have come. His knowledge of the heroic age of Greece is equally precise. Thus he tells us that in 1290 B.C. Jasus was "succeeded by Crotopus, son of Agenor, and now ninth King of Argos;" and then follows some interesting information about the Pelasgians and their wanderings.

Dr. Pickering's philology is not less remarkable than his chronology. He shocks the Hebrew scholar by calling *tzôn* ("sheep") *tzan*, of which, by the way, he says that it was "regarded even by Dicæarchus as probably the first animal domesticated"—a statement likely to be disputed by those who have occupied themselves with the history of the domestication of animals. Under the year 1720 B.C., he remarks that "the northern language from which certain Greek words were taken probably at this time in existence"—a statement which will be new to most philologists and Greek scholars. Naturally he has never heard of the explanation of the word *foxglove*, which makes it a popular corruption of *folk's-gleed*, or "row of bells."

But it is the botanist who has most reason to complain of Dr. Pickering's work. Instead of a "chronological history of plants," he finds the names and notices of various specimens of the vegetable world catalogued in the most arbitrary way under dates which have little or no connection with the age in which they were first known or used by man. So far as the earlier half of the book is concerned, the notices might in most instances have been as well entered on another page as that on which they are actually found. Why, for instance, should the *Artemisia absinthium* or the *Iris sambucina* be described under the date 1734 B.C., and what possible connection can there be between 1203 B.C and the *Phragmites communis?* The only relation that can generally be traced between the dates and the plants recorded under them is little better than a pun. Because the almond or *luz*, which Dr. Pickering calls *lwz*, is mentioned in Genesis xxx. 37, it is recorded under the year 1506 B.C., the year in which Joseph was "born to Jacob and Rachel;" because a brick from the small pyramid of Dashur was discovered to contain the straw of the jointed charlock and field-pea, an account of these plants is given under the year 2079 B.C., the assumed date of the building of the pyramid; and the mention of "Pelasgus establishing himself as king in Arcadia" in 1354 B.C. calls up a description of the *Quercus esculus*. As a set-off against this learned trifling, a vast quantity of matter is introduced which has nothing to do with plants and their history. Thus it would be quite intelligible if the author had given a list of those Egyptian hieroglyphics which represent plants, but the long, though imperfect, catalogue of hieroglyphic characters of all kinds which he actually has given, though fitted for a treatise on Egyptian grammar, is certainly out of place in a history of the vegetable world.

There is only one explanation that can be offered for the character of this extraordinary volume. Dr. Pickering was an able and learned scholar, trained in scientific methods and capable, as is proved by his "Races of Man," of producing good scientific work. But his "Chronological History of Plants" has been published since his death, and has consequently not had the benefit of his own compilation and revision. It consists simply of the notes he collected during a long course of voluminous reading, arranged, not upon any scientific plan, but under the convenient headings of his common-place book. The student may possibly construct a chronological history of plants out of them, but such a history does not exist at present. The volume is a mine of materials which, thanks to a careful index, can be easily used, though considerable caution is required in doing so. As it stands, however, it is hardly better than a mass of undigested and ill-arranged facts, mixed up with dates and statements calculated to send a shudder through the sensitive frame of the critical historian. Posthumous works are not unfrequently the most cruel injury that can be inflicted by friends upon the memory of the dead, and it is hardly likely that Dr. Pickering would have relished the appearance of his elaborate notes in precisely their present form.

A. H. SAYCE

CHALLIS'S "PRACTICAL ASTRONOMY"

Lectures on Practical Astronomy and Astronomical Instruments. By the Rev. James Challis, M.A., F.R.S., &c. (Cambridge: Deighton, Bell, and Co.; London: George Bell and Sons, 1879.)

AS LONG since as the year 1843 the Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge commenced a course of lectures upon practical astronomy and the use of astronomical instruments, the proximity of an observatory provided with instruments of first-rate quality appearing to him to give facilities for acquiring a knowledge of the practical branch of the science which ought to be taken advantage of. The syllabus of these lectures has been utilised as the groundwork of the present volume, but the progress of astronomy has necessitated the introduction of various modifications in the original plan and contents.

By far the larger portion of the volume is devoted to the description and use of instruments found in the larger fixed observatories, the illustrations being usually applicable to instruments in the Cambridge Observatory, and the work being therefore more especially adapted to the use of students in that university, who have frequent access to the observatory. Notwithstanding this circumstance, however, the treatise will be found to convey much information on practical matters and details, which is not of so limited an application.

The fixed instruments which are treated of at length are the transit instrument, the mural-circle, the transit-circle, incorporating in its employment the purposes of the two former instruments and the equatorial. The transit-circle may now be said to have wholly superseded the mural-circle and transit-instrument in most of the principal observatories, but the explanations of them given by Prof. Challis being applicable to the reduction of meridional observations generally, are also applicable in great measure to the transit-circle. The latest observations with a mural-circle which we remember to have seen were made at the Naval Observatory, Washington, and the instrument still figures in the last description of that establishment. Prof. Challis enters fully into such details as the mechanical adjustments of a transit instrument and the correction of errors by calculation, the construction and application of the collimating eye-piece, the azimuth-error obtained by astronomical observations, and correction for error of level, also upon a method of correcting the errors of a transit-instrument for deviation of the pivots from a cylindrical form, a defect which, if we are not mistaken, considerably exercised not only Prof. Challis, but his successor Prof. Adams, as exemplified in the Cambridge instrument. The computation of apparent and mean right ascensions follows, with reference to recent corrections of the more important astronomical constants entering into such work. Similarly the author describes the method of observing with the mural-circle, and the calculation of the mean polar distances of stars and the geocentric polar distances of the sun, moon, and planets with numerical examples. The equatorials of the Cambridge Observatory and their appliances are particularly described, and the adjustments of this form of astronomical instrument and the method of deducing the right ascension and polar distance of a celestial object from the observations. Reference is also made to the "counterpoise mounting" of an equatorial, and the arrangements, advantages, and disadvantages of this form of mounting.

Other fixed instruments of which some account is given are the altitude and azimuth instrument, with special reference to that at the Royal Observatory, Greenwich, the zenith sector, Airy's reflex zenith tube, and the transit in the prime vertical. There are also articles upon transportable instruments, as the theodolite and sextant, on the chronographical method of registering transit-observations, the different methods of determining terrestrial longitudes, the solar parallax, and miscellaneous additional subjects of less importance.

The volume, as we have already stated, and, indeed, as is hinted by Prof. Challis, may appear to be more especially adapted to students in the university who desire an acquaintance with the principles of astronomical practice, and in his preface the author urges the advantages of giving attention to a subject of this kind, "as a mental exercise of much educational value, inasmuch as it is altogether unlike any process of reasoning by abstract symbols, and may serve as a corrective to the effect of too exclusive an attention to reasoning of that kind." But there are few works of its nature in English astronomical literature, a circumstance which is likely to secure for it a wider circle of readers.

The volume has been published at the expense of the Syndics of the University Press.

OUR BOOK SHELF

The Carboniferous Limestone and Cefn-y-Fedw Sandstone of the Country between Llanymynech and Minera, North Wales. By George H. Morton, F.G.S., F.R.G.S.I., Honorary Secretary of the Liverpool Geological Society. (London: David Bogue, 1879.)

IN this excellent monograph, which is now reprinted from the *Proceedings* of the Geological Society of Liverpool, Mr. Morton has brought together a vast amount of valuable information concerning the lower carboniferous rocks, as displayed in a district where they have been but little studied. The splendid escarpment of the Eglwyseg rocks, near Llangollen affords a series of magnificent sections, the interpretation of which, however, requires considerable patience, care, and caution on the part of the field geologist. Mr. Morton shows that the succession of the lower carboniferous rocks in North Wales presents marked points of difference from that which is observed either in Yorkshire or Derbyshire. He divides these lower carboniferous rocks into two groups—the carboniferous limestone below and the Cefn-y-Fedw sandstone above; and in the correlation of these he adopts the views originally put forward by Prof. A. H. Green, and since supported by Mr. D. C. Davies, namely, that the conglomerate and sandstone strata overlying the carboniferous limestone represent not only the millstone grit, but also the Yoredale rocks of Prof. Phillips and the Geological Survey.

Mr. Morton shows that the carboniferous limestone of this district attains a thickness of 1,200 feet, and he gives detailed descriptions of the several members of which it is made up, with lists of the fossils obtained from each. The overlying arenaceous formation is 723 feet thick, and consists of alternations of sandstone conglomerate and shale; these beds contain marine shells, with some plant-remains. The sections which are given in this monograph enable us to trace the numerous and rapid changes which these carboniferous strata undergo within comparatively limited areas. The manner in which the several members of the series overlap one another, as has already been pointed out by Mr. Davies, is also admirably illustrated in this work of Mr. Morton's.

Perhaps no part of this excellent memoir will prove of more general interest to geologists than Mr. Morton's account of the numerous faults which traverse the district; the positions and effects of these being illustrated by a map and several sections. The isolated patch of carboniferous rocks faulted down among the Silurian strata near Corwen is also more fully described than by any previous author. Besides the numerous woodcuts and lithographic plates, the work is illustrated by three admirable photographs by Mr. W. H. Wilson. We heartily recommend this exhaustive monograph to the attention of our readers, as a model of the kind of work which may be advantageously undertaken by the members of local scientific associations. J. W. J.

Magnetism. The High School Series. (London: T. Murby, 1879.)

THE anonymous author of this little work of sixty-eight pages has produced a very readable and in many ways admirable primer of Magnetism for boys and girls. Clearly written, well illustrated, and dealing with such matters of experiment as boys and girls can verify for themselves, it will be sure to command popularity. The experiment on p. 22, which suggests the form of the curve of magnetic intensity along a bar-magnet by the length of the chain of nails which can be hung on at equidistant points, thus building up visible ordinates on the abscissæ is new to us, and as neat as novel. One cannot help wondering, however, why the author has assumed that "high-school" pupils must have mathematics and even arithmetic kept almost entirely out of sight. Why the separate chapters are entitled as "Lectures" is not very evident. The "Lecture," for example, on "Diamagnetism"—the ninth of the ten—is just thirty-seven lines long, and takes just two minutes to read aloud!

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.*]

To Astronomers

I HAVE the honour to inclose to you a copy of a circular which I have lately sent out from my observatory to upwards of 200 observatories, public and private, scattered over the face of the globe. I have long felt that it was highly desirable that some means should be found whereby the discoveries in astronomy should be made public in a rapid and systematic manner, more especially in this country, where I am proud to say we number so many among all classes who take an intelligent and earnest interest in this the highest of the studies of nature. After much thought as to the best means of carrying out the plan, I determined, it may be presumptuously, to endeavour to do the work myself, and to that end I issued the circular to all directors of observatories whose addresses I could lay my hands upon. Should I have the fortune to receive favourable replies from abroad, I hope to make the matter successful. Now as to the distribution of the news in the British Islands: I am making a list of those who apply to me for the circulars and I will endeavour to post these within 24 hours of receiving the notice myself. I have made arrangements with the telegraph officials, that any telegram addressed (as below) shall be sent out at whatever hour it may arrive: I have further set up a small printing press in my observatory from which to pull the circulars, as I feel sure that this is the most convenient method and the least liable to error.

In conclusion I may add that should any devise a better means for doing this work, I will at once place my experience at their disposal and do all I can to assist them. LINDSAY

Haigh Hall, Wigan,
November 29

"The Observatory, Dun Echt, Aberdeen,
"November 1, 1879.

"SIR,—I am very anxious to form some system whereby information of astronomical interest may be rapidly and widely disseminated among English observers; and I would beg to ask for your assistance in carrying out my plan.

"In the event of your discovering a comet, new star, or other object of immediate interest, I would ask you to send me a telegram announcing the discovery and giving such details as are usual.

"I have purposely omitted to mention minor planet discoveries, inasmuch as this branch is already admirably carried out by the Berlin Observatory.

"For convenience, the telegram should be in the form recommended by the Vienna Academy in the 75th vol. of the *Astr. Nachr.*, No. 1785, page 142, as follows:—'Comet (new star, &c.,) Discoverer, Date, Local Mean Time of Observation (in hours and minutes), Place of Discovery, Right Ascension *in Arc* (degrees and minutes), North Polar Distance (degrees and minutes), Daily Motion in R.A. and N.P.D. (minutes of arc) plus or minus, Description, Diameter of Comet, &c. (in minutes of arc).

"Thus a telegram would run:—

"'Comet Winnecke 5 April. 1445 Strassburg 33157 07508 Motion 0 minus 60.'

"This would read:—

"'Comet discovered by Winnecke, 5th of April, 14 hours 45 minutes Mean Time Strassburg, R.A. 331° 57′, N.P.D. 75° 8′. Daily Motion, stationary R.A., minus 60′ in Polar Distance.'

"Noughts should be put in where are no significant figures, so as to make three figures for degrees, and two for minutes (five in all), in R.A. and in N.P.D., similarly four in the Local Time.

"Telegrams, &c., should be addressed—

"'*Observatory, Dun Echt, Aberdeen.*'

"I will engage to distribute the notices of discovery within 24 hours of receiving the telegram, by means of a circular, sent out by first post from my Observatory, to all those who would be likely to make useful observations, and who will also favour me with their addresses.

"At present, it is only by accident that private observers hear of the discovery of Comets, &c., and it is obviously greatly to the advantage of astronomy that early and reliable information should be spread over the British Islands, without having to wait for its publication in some of our scientific journals.

"I should feel much gratified if I may feel assured of your valuable co-operation in this matter.

"Believe me, yours very faithfully,
"LINDSAY,
"Pres. Roy. Ast. Soc."

The Cresswell Cave Exploration, 1876

IT seems to me proper to notice the statements made by Mr. Heath in a pamphlet on the bone-caves of the Cresswell Crags, published in August last, and since more broadly put in the Manchester press, calling in question the results of the exploration carried on by the Committee in 1876.[1]

It is insinuated that the engraved bone now in the British Museum, discovered by the Rev. J. M. Mello, and the tooth of Machairodus, discovered by myself, are not *bonâ fide* discoveries in the caves of the Cresswell Crags, but were placed there by some one, not specified, and were derived from some other locality, which also is not specified. With regard to the engraved bone, it is only necessary to say that Mr. Heath was not in the Robin Hood Cave when Mr. Mello's discovery was made, while

[1] Committee:—President: Sir John Lubbock, Bart., F.R.S., M.P. Secretary: Prof. Boyd Dawkins, M.A., F.R.S. Treasurer: Fredk. Longden, Esq. Members: Prof. Busk, F.R.S.; Prof. Prestwich, F.R.S.; John Evans, Esq., F.R.S.; A. W. Franks, Esq., F.R.S.; the Rev. J. Magens Mello, M.A., F.G.S.; Rooke Pennington, Esq., LL.B., F.G.S; William Bragge, Esq., F.G.S.; R. D. Darbishire, Esq., B.A., F.G.S. The work is under the direction of the Rev. J. M. Mello, Prof. Boyd Dawkins and Mr. Heath, F.R.H.S, being superintendents. The Report will be prepared for the Geological Society of London by the Rev. J. M. Mello and Prof. Boyd Dawkins.

it so happens that I was present, and can testify to the accuracy of Mr. Mello's statement. With regard to the tooth of Machairodus, which I discovered and afterwards showed to Mr. Heath, it is asserted that it was without adherent matrix, and without the moisture which it would possess had it been imbedded in the cave for ages. These assertions are disproved by the facts that the tooth unfortunately split in pieces in process of drying, and that the matrix of red earth, only partially removed when it was repaired and gelatinised in the Owens College Museum, is still to be seen in the pulp cavity.

In the exploration of the caves, in 1876, the discoverer, Mr. Mello, was director, while I undertook to name and classify the remains, and we drew up a report published in the *Quart. Geol. Soc. Journ.*, 1877, p. 475. Mr. Heath and myself acted as superintendents of the work, under the direction of Mr. Mello.

It was Mr. Heath's duty as superintendent to hand over to the director the notes on which the above assertions are based, as well as any other notes relating to the work entrusted to him. He did not do so. If he had any fault to find, it was his duty to lay it before the committee, and in the interest of truth to make his statement when the report was read at the meeting of the Geological Society, at which he was present. He did neither of these things. Nor when he had many opportunities of saying what he liked at the meeting of the British Association at Sheffield, after my paper before the Geological Section, and our addresses at Cresswell, did he say one word, although he was present at both. The pamphlet in question was to us the first intimation that he differed with us as to the facts.

In conclusion it only remains for me to add that Mr. Heath was *not* a member of the Exploration Committee, that he was merely a subordinate to Mr. Mello, and that, on his own showing, he kept back for nearly three years notes considered by him to be valuable, which he was in honour bound to communicate at once to the director for the information of the committee—notes which were as much the property of the committee as the fossil remains discovered in the caves at their expense. I am instructed that the only notes which he gave to the director were certain measurements of the inside of the Robin Hood Cave, which it was found necessary to have done over again.

W. BOYD DAWKINS,
Secretary of the Cresswell Caves Exploration Committee, 1876

"The Society for the Encouragement of Literature and Science"

THE attention of the Council of the Geological Society has been called to the prospectus of a "Society for the Encouragement of Literature and Science," in which the letters "F.G.S." are appended to the name of one of the vice-presidents and to that of the "Secretary-in-Chief." I have been directed by the Council to make it generally known that neither of these gentlemen is a Fellow of the Geological Society, as would naturally be inferred from their use of these letters, and I shall feel greatly obliged by your insertion of this note in your columns.

Geological Society, Burlington House, November 27 — W. S. DALLAS, Assist. Sec. Geol. Soc.

THE attention of the Council of the Linnean Society of London has been called to a paper or prospectus of a "Society for the Encouragement of Literature and Science," whereof W. Sarjeant-Rodway is stated to be "Secretary-in-Chief," and wherein the names Lewis Biden, A. Ware, and Joseph Blackburn Leslie each appear followed by the letters F.L.S., which letters are those appointed to indicate "Fellow of the Linnean Society"—a chartered society. Its attention has also been called to another paper apparently put forth by a "Conchological Society of London," wherein the name W. Serjeant-Rodway appears as "Secretary and Founder," with the addition of the letters F.L.S. (Lond.).

As no one of these four gentlemen is a Fellow of the Linnean Society, the Council of the same Society has requested me to make the fact known, and I shall therefore be much obliged if you will be so kind as to give insertion to this letter in NATURE.

Linnean Society, Burlington House, Piccadilly, W., November 27 — ST. GEORGE MIVART, Zool. Sec. Lin. Soc.

Does Sargassum Vegetate in the Open Sea?

IF the correspondent in NATURE, vol. xxi. p. 80, under the above title, would again refer to my communication in vol. xx. p. 578, which I much regret he finds so unsatisfactory, he will see that the several statements and quotations it contains are exclusively based upon "personal" observations made by myself and by the naturalists on board the *Challenger* during our cruise in the North Atlantic in the year 1873. In replying to his inquiries in vol. xx. p. 552, I was only anxious to supply him with what I considered to be the latest and the most reliable information available on the subject, and which hardly deserves to be qualified as "old reports" and as "a mixture of the prevalent opinion since Columbus and observed facts."

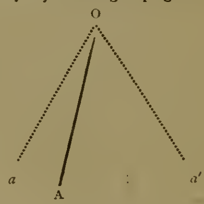
The term *Sargasso Sea* has been extended by geographers, and not incorrectly so, to all oceanic areas where large aggregations of sea-weed are met with, and it does not necessarily imply the presence of Sargassum, *i.e.*, *Sargassum bacciferum* in these regions, since the original Spanish word *Sargazo* (in Portuguese *Sargaço*) simply means "sea-weed." I am, therefore, not surprised that the correspondent should not have found any gulf-weed while crossing the Pacific Sargasso Sea.

Nor can the obscurity in which so many details connected with the gulf-weed are still involved be fairly ascribed to want of observation on the part of the few naturalists who have had the opportunity of studying this interesting alga *in situ*, that is to say, in the middle of the North Atlantic, but rather to the great difficulty, if not impossibility, of ascertaining the life-history of a specimen accidentally found floating on the surface of the ocean. For this reason I fear that some time may elapse before the numerous questions put by the correspondent in vol. xxi. pp. 80–81 can be satisfactorily answered. A botanist stationed for several seasons at Bermudas, or on one of the Bahama Islands, might probably succeed in throwing some light upon the successive stages in the growth and decay of *Sargassum bacciferum*.

J. J. WILD

The Paces of the Horse

I VENTURE to offer the following illustration of the effect produced on the eye by a horse galloping.



I take a pencil, O A, and oscillate it rapidly between the positions O *a* and O *a′*. The impression produced on my eye is an indistinct fan-shaped figure, *a* O *a′*, bounded by two rather distinct images of the pencil in its extreme positions O *a* and O *a′*. The indistinctness of the fan-shaped figure is caused by the rapid change of position of the pencil, which is reduced to a minimum at O *a* and O *a′*, where the pencil swings up to, and returns back from, its extreme positions, passing over the same ground twice in successive instants of time, and thus seeming to pause in the immediate neighbourhood of those positions. An artist representing this effect would draw the indistinct fan-shaped figure; and the two rather distinct images of the pencil at O *a* and O *a′*.

The relative motion of the legs of a horse galloping may be looked upon as that of rapidly oscillating pendulums with this very important addition; that besides their pendulum-like oscillations, they go through rapid *internal* changes of form, owing to the bending, or doubling up, of the legs at the knees, hocks, and fetlocks, at every stride. The rapidity of these internal changes is reduced to a minimum when the leg is in its extreme *outstretched* position. Again, it is in this same position that the rapidity of change of position owing to the pendulum-like oscillation is also at a minimum. The two minimums are, as it were, *coincident*, and, as a consequence, every leg as it reaches its outstretched position, seems for an instant to pause, leaving a rather distinct impression on the eye. The other legs on successively reaching their respective outstretched positions produce corresponding impressions on the eye. It is a fact that the legs do not reach these positions *simultaneously*; they reach them *successively*, but the image produced by one leg in its outstretched position has not time to be obliterated before the images of the other legs are produced in their corresponding outstretched positions. Therefore they appear to us to be all simultaneously in those outstretched positions, and it is thus that the artist should represent them. It is his duty to represent things as they *appear*, rather than as they actually *are*, at a given instant of time.

The fan-shaped form noticed in the case of the oscillating pencil becomes exceedingly indistinct, if it does not disappear altogether, in the case of the galloping horse's legs. This is owing to the rapid internal changes of form of the legs.

Your correspondent, Sir W. G. Simpson, Bart., states in his excellent letter produced in NATURE, vol. xxi. p. 55, that a galloping horse might be represented with all its legs gathered under it. I venture to disagree with him for this reason: the two "minimums" to which I have referred in a former part of this letter are *not* coincident when the legs are in their extreme position gathered under the body, and therefore no such distinct image of them in that position is produced. The "minimums" are only coincident in the other extreme, viz., the outstretched, position.

The artistic representation of a horse's paces other than galloping, as also that of other objects in motion, can be determined by similar reasoning. V. B. BARRINGTON-KENNETT

15, Hyde Park Gardens, W., November 26

Force and Momentum

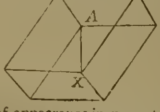
IT is commonly said that change of momentum is evidence that force has acted or is acting on the mass, and that the rate at which the momentum is changing is the measure of the force. Thus, in his lecture on "Force," Prof. Tait says: "Force is the rate of change of momentum" (NATURE, vol. xiv. p. 462). This is not true if the mass be variable. Suppose a sphere of ice moving with constant velocity in a straight line through hot space. The mass, and therefore the momentum, is changing at every instant by the evaporation of the ice. The evaporation being supposed uniform over the entire surface, any force impressed on the sphere by the mutual repulsion between it and a particle of vapour thrown off at a point, p, is balanced by an equal force at the other end of the diameter through p. Hence, the resultant of all these forces is nothing. Here, then, we have change of momentum of the sphere, although no force acts on it. In like manner the change of momentum of a rocket and of a locomotive engine is partly due to change of mass. Does it not hence appear that change of *velocity* is the proper evidence of the action of force? When a variable mass, m, is in motion, the proper measure of the force acting on m at any given instant in any given direction is—not the rate of change of momentum, but—the product of the value of the mass at that instant, and the value of the rate of change of the velocity at that instant and in that direction, *i.e.*, the measure of the force is not $\frac{d(mv)}{dt}$, but $m\frac{dv}{dt}$.

E. G.

[There is no such thing in nature as a "variable mass"; and our correspondent's difficulty arises from his omitting to take account of the momentum of each of the parts (however small) into which a mass may be divided. In most good works on dynamics he will find the motion of a rocket, or of a descending rain-drop (which gathers mass as it falls), accurately treated on the assumption that the momentum produced per unit of time is the measure of the force acting.—ED.]

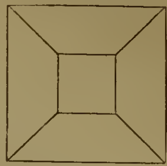
Change in Apparent Position of Geometrical Figures

THE perplexing illusion to which Mr. Bellamy refers (NATURE, vol. xx. p. 362) has long been known, and various explanations have been given of it by physicists. Sir Chas. Wheatstone, in 1838, showed clearly that it is a mental operation, while combating the idea of Prof. Necker, of Geneva, who attri-



buted the alteration of appearance in geometrical figures, not to a mental operation, but to an involuntary change in the adjustment of the eye for obtaining distinct vision. Necker's experiment is substantially the same as that described by Mr. Bellamy. The solid angles at A and X being alternately looked at, sometimes one and sometimes the other appears the nearer, the entire figure at the same time changing in unison; and as Wheatstone points out, "the change of figure frequently occurs while the eye continues to look at the same angle."

In the following experiment it is seen more clearly still that the operation is a mental one, because there is neither movement of recti, oblique, nor ciliary muscles. Two concentric squares have their corners joined by straight lines. The lesser square



will appear in a plane anterior, or posterior to the larger, according as we regard the figure as the representation of a truncated pyramid, or as the representation of a room with its sides all sloping away to the distant square wall. Here no eye muscles are concerned; the image on the retina remains unaltered, and the only operation is a mental one, a turning to the results of past experience. WM. ACKROYD

Mutual Attraction of Spectral Lines

I DO not know that it has been remarked that a line in the diffraction-spectrum (whether bright or dark) must be shifted from its normal position in case another line falls very near it. Neighbouring lines must be attracted if both are bright or both dark, and repelled if one is bright and the other dark. The reason is that the lines are only maxima or minima of light, and the differential coefficient of the sum does not vanish at the same points as the differential coefficients of the separate terms. The shifting will be the greatest in the case of a faint line near a very intense one. I have succeeded in this way in shifting the positions of lines by measurable amounts (1″ to 2″).

Baltimore, Md., November 14 C. S. PEIRCE

EXPLORATION OF TIMOR

IT will be perhaps of some interest to the readers of NATURE to hear that Mr. Riedel, the Dutch resident on Timor (Timor Kupang), who formerly lived on Celebes, and collected a great deal on this island for European museums, and who is known by his various writings on different scientific questions concerning the East, has just returned from a twenty-five days' journey through Central Timor from 123° 30′—125° E.L., as he wrote to me in a letter dated October 6. No European has made such a journey through Timor before, and it has been very troublesome. But the country is, Mr. Riedel remarks, a splendid one, and very suitable for coffee and cinchona cultivation. The traveller did not see any Negritos, who, according to the assertion of M. Hamy, live in the interior of Timor, nor did he hear anything of a Casuary which was reported from there recently. Mr. Riedel collected many geographical notes, and sketched a map of the parts which he visited. A small collection of plants was forwarded to me by Mr. Riedel, and I have sent them to Kew, as Prof. Oliver formerly had the kindness to determine several botanical collections of Mr. Riedel's from Celebes. A. B. MEYER

Dresden, November 29,
Royal Zool. Museum

LAND SHELLS OF THE AUSTRAL ISLANDS

THE small island of *Rurutu* (Oheatora of Capt. Cook) is about 320 miles south-south-west of Tahiti; it is eight miles in length, and has an elevation of 1,500 feet, over 100 feet consisting of old coral reefs which have been upheaved to that altitude. Mr. Charles de Gage, a resident and experienced naturalist, has collected a number of land-shells, which have been studied by Mr. Andrew Garrett, and described in the *Proc.* Acad. Nat. Sci. Philadelphia. One of the most interesting species is *Partula hyalina* (Broderip), found abundantly in three groups of islands. In Tubuai, 100 miles east of Rurutu, it is abundant, and the Austral group appears to be its metropolis. It is found, though sparingly, in nearly every valley in Tahiti. It was also obtained by Mr. Garrett at Mangaia, one of the Cook's, or Hervey Islands, 400 miles *west* of Rurutu. The variation in examples from the three groups is remarkably slight. It is a strictly arboreal species, and has a uniform white colour.

Another species, *Stenogyra juncea*, Gould (sp.), is found very widely through Polynesia, in all groups north of the equator, and south of all islands from the Marquesas and Paumotus, to the Viti group, and probably ranging further west; they are found under loose stones, beneath decayed wood, among dead leaves, &c., and range from near the sea-shore to 2,000 feet above the sea. Another well-known genus, *Succinea*, is now recorded from Rurutu, slightly differing from a Tahitian species, *S. pudorina* (Gould).

Chondrella (Pease) is remarkable for having no tentacles; during locomotion the animal is nearly or quite concealed by the shell, which is carried diagonally. In creeping, only the extreme tip of the muzzle is seen from above, while the eyes are plainly visible through the transparent shell. The extreme interest of the fauna of oceanic islands becomes continually more evident.

DISTINGUISHING LIGHTS FOR LIGHT-HOUSES

SIR WILLIAM THOMSON writes a long letter on this subject to the *Times* of Tuesday, the letter being the result of a most interesting experimental cruise of ten days on board Her Majesty's ship *Northampton*, in the English Channel, from which he has recently returned, having had many good opportunities of observing the lights on the south coast of England. This has revivified his conviction of need for a threefold reform in our lighthouse system, which he has been urging and re-urging since 1872 with hitherto but partial success:—A great quickening of nearly all revolving lights; the application of a group of dot-dash eclipses to every fixed light; and the abolition of colour as a distinction of lighthouse lights, except for showing dangers and channels and ports by red and white and green sectors. Of about 120 revolving lights on the English, Scottish, and Irish coasts, there are in all eighteen in which the periods are ten seconds or less and the times of extinction seven seconds or less. In these quick revolving lights the place of the light is not practically lost in the short intervals of darkness; the eye sweeping deliberately along the horizon, with or without the aid of a binocular, to "pick up the light," passes over less than the breadth of its own field of view in the period of the light, and thus picks it up almost as surely and quickly as if it were a fixed light. And so in respect to compass bearings, whether taken roughly and quickly by inspection or more accurately by azimuth compass, the bearing of the ten-second or quicker revolving lights is taken almost as easily and accurately as if the light were continuous. Sir William contrasts this with the case of the ordinary minute-period revolving light, or even the half-minute period to which some formerly slower lights have been quickened. He shows how difficult it is to pick up these slow lights, and his own experience proves that a fixed light like the Eddystone is much more valuable than the slowly revolving Start.

The Wolf light he found most irregular in its periods, the successive periods of light varying from nineteen to forty seconds, and of darkness from nineteen to thirty-four. These irregularities are apt to lead to most serious mistakes, as Sir William shows.

"Except in one unimportant case—the Dungeness Low Light, which flashes every five seconds—all the revolving lights of the English Channel are too slow, and it would be an unspeakable improvement if, with that exception, every one of them had its speed sextupled. There is no mechanical difficulty in the way of doing this. Generally the same mechanism would suffice with a mere change of adjustment of the governor; but the lightkeeper would have to wind up the weight oftener or longer.

"Revolving lights are, however, but a small minority of all the lighthouses of the world. Of the 623 lights of the British and Irish coasts, just 110 are revolving lights, and the remaining 513 are fixed, and there is a crying want of distinction for fixed lights. The distinction by colour alone ought to be prohibited for all lighthouse lights, on account of its liability to confusion with ships' and steamers' side-lights. Southsea Castle, with its red and green port and starboard side lights, seems as if actually planned to lure on to destruction an unsuspecting enemy carefully approaching the coast with Thomas Gray's happy rule well impressed on his mind:—

> " 'Green to green, and red to red,
> Perfect safety, go ahead.'

He does so, and is wrecked on Southsea beach.

"My proposal for supplying the want is to distinguish every fixed light by a rapid group of two or three dot-dash eclipses, the shorter, or dot, of about half a second duration, and the dash three times as long as the dot, with intervals of light of about half a second between the eclipses of the group, and of five or six seconds between the groups, so that in no case should the period be more than ten or twelve seconds. This proposal has been carried into effect with perfect success in Holywood Bank Light, Belfast Lough, now the leading light for ships entering the Lough, but which until 1874 was inclosed in a red glass lantern and was only visible five miles, and was constantly liable to be mistaken for a sailing vessel's port side light entering or leaving the harbour of Belfast, or the crowded anchorage of Whitehouse Roads. In 1874 the red glass was removed, and the light was marked by dot, dot, dash (— — ———, or letter U), repeated every ten or twelve seconds, and has been so ever since. It is now recognised with absolute certainty practically as soon as seen in ordinary weather from the mouth of the Lough, ten miles off, and has proved most serviceable as leading light for ships bound for Belfast or entering the Lough.

"It is much to be desired that the dot-dash system should be seriously considered by the lighthouse authorities of our islands. Hitherto, when attention has been called to it, it has been dismissed with a pleasantry, 'Winking lights won't do,' or else something utterly different has been gravely considered and justly condemned. It is satisfactory now to know that the Deputy-Master of the Trinity Board, Sir Richard Collinson, K.C.B., has, after its character was correctly put before him by the recent Select Committee of the House of Commons on Electric Lighting, given it his approval in the concluding answers of his evidence."

The *Times*, in commenting on Sir William Thomson's letter, speaks of the subject as one of great national importance, Sir William speaking with the twofold authority of a distinguished man of science and of a practical yachtsman. The *Times* endorses emphatically all Sir William's recommendations, and insists especially on doing away with colour as a distinctive feature of lights.

"If," the *Times* concludes, "the recommendations of Sir William Thomson should eventually lead to a reform of this importance and magnitude, he will be a benefactor to humanity; but even without this his advice cannot fail to commend itself to navigators. It bears one of the most distinctive marks of genius—simplicity; and now that it has been brought fairly under the notice of the public, we may confidently hope that in the future, whatever may have been the case in the past, it will not have to contend against that love for 'the thing which has been' which in all periods of history has afforded a distinguishing characteristic of the average official intelligence. In a nation of sailors and yachtsmen a suggestion for the improvement of lighthouses and for the greater safety of shipping ought to be certain of speedy and complete consideration upon its merits alone."

THE TURKOMANS

AT the meeting of the Anthropological Institute on November 23, there was read a short but suggestive paper on these wayward children of the desert, contributed by Prof. Arminius Vambéry. The learned writer, who has perhaps as great a personal knowledge of Eastern nations as any man living, regarded the Turkomans as on the whole the purest and most representative branch of the widespread Tûrki family and described their outward features as quite distinct from the Mongolian. His account was somewhat vague, but the inference evidently was that they belonged in his opinion ethnically to the Caucasian rather than to the Mongolian group. Nor did he attribute this to the gradual absorption of Iranian elements, but, on the contrary, stated that intermarriages with Persian women were much less frequent than is usually supposed, and that the Turkomans are now what they always have been, men of medium stature, like the Kirghizes and unlike the Usbegs and Osmanlis, amongst whom tall individuals are far from rare, with straight or but very slightly oblique ("almond-shaped") eyes, handsome regular features and fair complexion. He further stated that the Turkoman language was also one of the very purest Tûrki tongues still spoken, so much so, that an ordinary Seljukian Turk of Asia Minor would have less difficulty in conversing with a Tekke or Yomut Turkoman than with his nearer neighbours the Turki nomads of Azarbijan and other parts of Persia. In fact, such is the purity of their speech, that the Rev. James Bassett, of the American Mission at Tehrân, is now putting through the press in London his translation of St. Matthew's Gospel in the Jagatai Tûrki for the special use of the Tekke Turkomans. Jagatai, it need scarcely be remarked, is one of the most cultivated of all the Tartar tongues and is still current in Bokhara, Khiva, Ferghana, and parts of Kashgaria. In it are written the Emperor Baber's memoirs, and being less affected by Arabic and Persian elements than the Osmanli of Constantinople, it may be taken as, on the whole, the most representative of Tûrki idioms. On the other hand, the Tûrki belongs undoubtedly to the same great linguistic connection as the Mongolian, both being recognised by modern philologists as collateral, though independent, members of the so-called Finno-Tataric or Ural-Altaic family of languages. Hence Vambéry's description of the physical characteristics of the Turkoman race places them in a sufficiently anomalous position from the anthropological point of view, in so far as they would seem to belong ethnically to the Caucasian, but linguistically to the Mongol stock. Such anomalies are, no doubt, common enough, and instances abound of peoples having changed their language and adopted that of the races by whom they may have been subdued or otherwise influenced. But in the present case the difficulty cannot be got over in this way, nor is it pretended that the Turkomans have adopted a Mongolian form of speech, or indeed that they ever spoke any other language than Tûrki. But Tûrki and Mongolian being offshoots of the same organic tongue, it follows that both races must have had a common origin, and that the Turkomans have since become differentiated from the ethnical, while retaining the linguistic connection. Now this is entirely at variance with the commonly-accepted doctrine that physical traits are always more persistent than speech, in other words that, assuming absolute isolation, the process of linguistic will always be more rapid than that of racial evolution.

In the abstract this is no doubt true enough, but practically there is no such thing as absolute isolation in the present stage of the world's history. Least of all can it be predicated of the Turkomans, who are intruders from the east or north-east in their present habitat, who must have absorbed far more Iranian blood than Vambéry is inclined to admit, and who, instead of being the purest representatives of the Turki race, seem really to be a mongrel people, the outcome of fusion of Mongolian and Caucasian elements in Hyrcania, Bactriana, and the Lower Oxus basin. It must be remembered that the whole of this region, as far north at least as the 40th parallel, formed an integral part of the ancient Persian Empire, and the presence of numerous Iranian communities still speaking Persian dialects both in the lowlands and highlands of Turkestan (Tajiks and Galchas) sufficiently proves that this region was fairly occupied by peoples of Iranian stock, if, indeed, it was not their primitive home, before the arrival of the Turki race driven still westwards by the Mongolians of the Gobi. When the Persian power was finally broken by the Arabs, Turki hordes easily took permanent possession of the Atrek and Murghab Valleys, as well as of the Lower Oxus; but in so doing they gradually absorbed as much Iranian blood as to have in course of time become largely assimilated to the Caucasian type. The same fate overtook their Seljukian brethren in Asia Minor and the Balkan peninsula, all of whom have everywhere become largely Aryanised, and have thus collectively contributed to produce the impression, shared by Vambéry with many ethnologists, that the Tûrki and Mongol types were originally distinct. They themseves have always rightly looked on each other as brethren, and although no importance can be attached to the tradition of a legendary Tûrk, son of Japhet, whence both sprang through the twin brothers Tatar and Mongol, it nevertheless points, like so many other national myths, at a fundamental truth.

Nor are the Mongolian traits so far effaced from the Turkoman race as Vambéry would have us suppose. In "Clouds in the East" Valentine Baker, an equally careful observer, describes them as "muscular, heavy-limbed men, with large hands, rather flat, broad faces, and small eyes, thus showing much of the Tatar type" (p. 212). He even expresses his surprise that it should still be so distinctly marked, "as they constantly capture Persian girls, who become their wives, and so must bring a strong infusion of Persian blood into the race" (*ib.*).

The genuine Tûrki type, however, is still best exhibited in the Kazaks, or, as they are more frequently called, the Kirghizes and Kara-Kirghizes of the West Siberian steppes and Pamir table-land. These Kirghizes speak a pure Tûrki dialect, and because of their distinctly Mongolian features—square, flat face, high cheek bones, oblique eyes, large mouth, &c.—they are supposed to be Mongolised Tatars by those who hold the two types to be originally distinct. But the supposition is entirely gratuitous, and although they may have been to some extent affected by Mongolian elements during the incessant migrations of the Central and Eastern Asiatic nations, there is nothing in their appearance to imply any profound modification of their outward features, while their Tûrki speech militates against the assumption. They resemble the Mongolians because both were originally one, and because in their present homes between Kulja and the Ural Mountains they came in contact with no foreign elements by which the race could be seriously affected. In the Kirghizes we therefore recognise a living proof of the primordial identity of Turk and Mongol.

The transition between the Kirghizes and Turkomans is formed by the Kipchaks of Khokand and other parts of Eastern Turkestan, who, though often classed with the

Mongolian Buryats,[1] are of the genuine Tûrki stock, and speak a pure Tûrki language, though rude and marked by some distinct features.

Touching the numbers and strength of the Turkoman tribes proper, opinions vary considerably. While Behm and Wagner reckon them at no more than 450,000, Vambéry still adheres to the number of one million given in his "Travels in Central Asia," adding that further research may tend to increase, but certainly not to diminish that figure. This estimate is partly borne out by Gen. Obrutcheff,[2] who makes them amount in 1874 altogether to about 930,000, exclusive of the "Eski-Turk" and other scattered members of the family in Asia Minor, North Syria, the Euphrates Valley, and Persia.

In view of recent and pending political events, the subjoined list of the Turkoman tribes with their localities and approximate numbers may be acceptable:—

Tribe.	Population.	Locality.
Tekke: Akhal	300,000 (Akhal and Merv)	N. slopes Kuren-dagh and on Tejend River (Lower Heri-rûd).
Tekke: Merv		Merv Oasis.
Goklan	55,000	Upper Atrek, Gurgan, and Simbur, and in Mazanderan.
Yomut: Atabai	135,000 (Atabai and Jaffarbai)	S.E. Coast Caspian, eastwards to Kizil-Arvat, and on Lower Oxus below Khiva.
Yomut: Jaffarbai ...		
Ersari	300,000	Left bank Oxus, about Char-jui; hence called "Lebâb" or "River" Turkomans.
Al-Ili	15,000	Between Oxus and Afghan frontier.
Chaudor	30,000 ?	Ust Urt plateau, east from N. end Caspian.
Salor	20,000	About the Murghâb between Merv and Herat.
Sarik	40,000	Merv Oasis.
Sakar	10,000	About Sarakhs.
Essen-Ili	115,000	South from the Chaudor.
Amr-Ili.........	15,000	About Middle Oxus.
Ui and Aimak	7,500	N. frontier Hazarajat.
Kara Dashli...	7,500	N. frontier Hazarajat.
Kozanli.........	20,000	Kozen Dagh (Taurus).
Pekmeshli...	30,000 (Pekmeshli to Rehanli)	Euphrates Valley and N. Syria.
Genkani ...		
Kecheli......		
Bejeli		
Rehanli......		
	1,100,000	

The discrepancy between this estimate and that of Obrutcheff is due to the fact that in the above list are included the Turkoman nomads of Asiatic Turkey, besides a large branch of the Goklans, some 8,000 families, now settled in Mazanderan.

A. H. KEANE

DISCOVERY OF A GASEOUS NEBULA

THE Rev. T. W. Webb writes as follows to the *Times* on the subject of Lord Lindsay's letter in NATURE last week:—

On the night of November 14, while sweeping in the constellation Cygnus with a low power on my 9·38 inch silvered speculum by With, I perceived an object resembling, but not quite identical with, a bluish 9 magnitude star. The use of higher magnifiers at once detected the existence of an ill-defined bright disk, subtending about 4″, and surrounded perhaps with a slight amount of glow. It has since been identified at other observatories as No. 4,004 in Argelander, + 41, the place for 1880 being R.A., 21h. 2m. 31s.; D., + 41° 45′·3. Through the kindness of Dr. Copeland, by whom it has been carefully examined under the greatest instrumental advantages at Lord Lindsay's observatory at Dunecht, North Britain, I am enabled to add the following interesting particulars. It is not circular, and has a sharp nucleus near the north-preceding edge, with a faint effusion of light in the opposite direction. Three very measurable bright lines were found in a powerful spectroscope, of which the positions, as given by two sets of measures, were respectively 500·1, 495·7, 487·0, and 500·1, 495·6, 486·0. When these values are compared with those deduced by D'Arrest from the results of several observers of known objects of this nature—500·4, 495·7, 486·1—there can be no remaining doubt that the object in question is of the very interesting and mysterious class termed planetary, or, more correctly, gaseous nebulæ. Dr. Copeland assigns 8, 5, and 1, as the approximate intensities of these lines, reckoning from the least refrangible direction. It can occasion no surprise that its true characters should have escaped the piercing and practised gaze of Argelander, as it would require a much larger instrument than that which he employed to give any intimation of its nature.

[1] "Le nom de Bouroute leur est absolument inconnu" (Ch. de Ujfalvy in *Bul. de la Soc. de Géographie* for June, 1878.

[2] In the Russian statistical work, "Sbornik," iii. p. 80.

A NEW PLANETARIUM

SIGNOR N. PERINI, of Garrick Chambers, Garrick Street, has invented a planetarium, which, so far as we are aware is in all respects superior to, more *vraisemblable* than, any apparatus of the kind hitherto attempted. The structure, for such it really is, consists first of a hemispherical dome, fourteen feet in diameter at the base and the same in height, resting on twelve columns. Getting underneath the dome, one sees the vault overhead coloured so as to represent the starry sky, with the milky way and the constellations in their proper places. Suspended from the top by a narrow hollow rod is an opal globe lit up by gas or electricity to represent the sun, and around this, at their proper proportional distances, are suspended by almost invisible wires, the planets from Mercury to Uranus. By a slight turn of a key Signor Perini sets the solar system in motion, when the sun revolves on its axis, and all the planets in their proper *elliptical* orbits and at their proper axial inclination, and with proportionate velocity. Saturn has his rings and the other planets their moons; the earth, about the size of a walnut, by a mechanism peculiar to itself, revolves on its axis at a rate accurately proportioned, the same mechanism causing the moon, a small pearl, to revolve round the earth in its own proper orbit. Round the base of the dome the various signs of the zodiac are indicated, and the paths of the planets are shown by ellipses traced around the vault. The spectator is supposed to be standing somewhere underneath the solar system, and the general effect is very striking. To us it seems the most effective method hitherto devised to convey to old or young a realistic conception of the arrangement and motions of the planets. During the working of the mechanism not a sound is heard, though above the dome, and concealed from view is an elaborate arrangement of machinery. This machinery is of the nature of clockwork, with, however, a special feature by means of which the elliptical motions of the planets are effected. Inside the earth is a watchwork arrangement, which could easily be adapted to the other planets were it not for the expense. When wound the machinery can be kept going continuously for upwards of five hours; it can be stopped at any moment. The invention has, we believe, cost Signor Perini seven years' unremitting work and seven hundred pounds expenditure. We believe that the work has all been done at night and during early morning hours, as the inventor has to give his daytime to his profession of teacher. Signor Perini informs us that he could without difficulty make his planetarium as large as the Albert Hall and small enough to become a school apparatus for teaching. He showed us a table, like a small writing-table, between the tops of which he had arranged his machinery on a small scale to give motion to a tellurium which he fits on to the table. Of course the invention, as indeed Signor Perini admits, may be capable of improvements in detail, but as it stands it seems to us a triumph of ingenuity and determined perseverance, for which its inventor deserves the highest credit.

A MICROSCOPIC SERENADE[1]

O COME, my love, and seek with me
A realm by grosser eye unseen,
Where fairer forms will welcome thee,
And dainty creatures hail thee queen.
In silent pools the tube I'll ply,
Where green conferva-threads lie curled,
And proudly bring to thy bright eye
The trophies of the protist world.

We'll rouse the stentor from his lair,
And gaze into the cyclops' eye;
In chara and nitella hair
The protoplasmic stream descry,
Forever weaving to and fro
With faint molecular melody;
And curious rotifers I'll show,
And graceful vorticellidæ.

Where melicertæ ply their craft
We'll watch the playful water-bear,
And no envenomed hydra's shaft
Shall mar our peaceful pleasure there;
But while we whisper love's sweet tale
We'll trace, with sympathetic art,
Within the embryonic snail
The growing rudimental heart.

Where rolls the volvox sphere of green,
And plastids move in Brownian dance,—
If, wandering 'mid that gentle scene,
Two fond amœbæ shall perchance

[1] From *Scribner's Monthly Magazine* for November.

Be changed to one beneath our sight
By process of biocrasis,
We'll recognise, with rare delight,
A type of our prospective bliss.

O dearer thou by far to me
In thy sweet maidenly estate
Than any seventy-fifth could be,
Of aperture however great!
Come, go with me, and we will stray
Through realm by grosser eye unseen,
Where protophytes shall homage pay,
And protozoa hail thee queen.

JACOB F. HENRICI

JOHN ALLAN BROUN

IT is only a few weeks ago that it became our painful duty to record the untimely death of a distinguished mathematical and experimental physicist, and we have now to mourn the loss of one equally distinguished in observational inquiry. John Allan Broun was born at Dumfries, where his father had, we believe, a normal school especially intended for young men about to enter the navy. Upon the death of his father, Mr. Broun, then about twenty years of age, went to the University of Edinburgh, and speedily became a successful student in more than one branch of knowledge. But his strongest attachment was always to physical science, and the late James D. Forbes, who was at that time Professor of Natural Philosophy at Edinburgh, considered Mr. Broun as one of his very best pupils. A friendship was thus formed which lasted through life.

About 1842 the scientific world began to perceive the necessity of conducting cosmical inquiries, and Sir Thomas McDougal Brisbane, in the most generous manner, agreed to establish and maintain a magnetical observatory at his residence at Makerstoun. Prof. Forbes had thus the opportunity of recommending his pupil, Mr. Broun, to Sir Thomas, who gave him the directorship of his observatory. In this capacity he continued to reside at Makerstoun for some years, where the delight of pursuing an occupation congenial to his tastes was enhanced by the great pleasure he derived from the society of Sir Thomas Brisbane, and of his amiable family, and their loss one after another was a very severe trial to him. It was no slight task to superintend an institution such as this in a branch of science then comparatively new, and Mr. Broun laboured so hard at his duties that he began to have palpitation of the heart, caused, probably, by his constant night watches. In consequence of this he obtained as his assistant Mr. John Welsh, who became one of his warmest friends, and who afterwards, as Director of the Kew Observatory, won for himself a high reputation in the course of a life that was, unhappily, very short.

Mr. Broun left Makerstoun in 1850 and went to Paris, where he formed the acquaintance of the lady who was afterwards his wife, Isaline Vallouy, the daughter of a clergyman in the Canton du Vaud, and belonging to an old Protestant family of Dauphiné (du val Louise) who had fled from France at the Revolution. This lady is now left to mourn his loss. From this marriage he had three sons and two daughters. Of his sons one is an architect, one has just left this country to enter upon his duties as civil servant in the North-West Provinces of India, while another, in preparation for the Indian forest department, is finishing his studies at Nancy. In 1851, through the influence of his friend, Col. Sykes, Mr. Broun was appointed director of the Trevandrum Observatory, an institution supported by His Highness the Rajah of Travancore, and he left this country for India in the same year. Of the scientific value of his work in India we will speak later on; but we may remark that it was attended with many difficulties. He wished amongst other things to have observations at different heights, and the great difficulties which the carrying out of this plan required have been more or less recorded in his various reports. We say more or less, for it may be questioned whether his reports, so admirable in every other respect, do full justice to himself and to those difficulties which he successfully overcame. Mr. Broun, we believe, advanced on his own responsibility the funds necessary for this experiment, but he was afterwards reimbursed. A deafness which never left him began in one of his excursions on the hills with these objects in view. He had been observing all day in the hot sun—in the evening he took a bath and got a chill from the hill breeze after it. He came back to Europe in 1866 in the hope that medical treatment might remove his deafness, returning to India for three years more.

After having finally left India he resided first in Lausanne in Switzerland, and then in Stuttgart in Germany, where his whole time was devoted to the preparation of the first volume of the results of the Trevandrum observations. This cost him an immense amount of labour without rest or recreation of any kind, except perhaps an hour or two devoted in the evening to music with his family. He was a skilled violinist, and was particularly fond of Beethoven's music. In London, where he resided for the last six years of his life, he gave his whole time and energy to the prosecution of the work he had in hand, so much so that even in taking a walk the subject would always be present to his thoughts. Two years ago his health began to give way, and he left London for the New Forest, a change which seemed for a time to be of service to his health. But again, after another year, he found that continued work was affecting his brain, and during a stay at Lynton (Devonshire) he had in 1878 a kind of nervous attack, which was the beginning of his last illness. He never altogether rallied after this attack, and was much distressed last winter at being obliged to cease from all work, but he bore this trial with much meekness and gentleness of manner to all around him.

Being rather worse in the spring, he made up his mind to go to Switzerland in search of strength, and after a few weeks of much weakness spent at Bex, he began to rally and to enjoy the walks in that beautiful neighbourhood. From there he went to Finhaut, Chamouny, and Tête Noire, and greatly enjoyed his daily excursions in the mountain paths and over the hills; indeed he used to say that they made him feel quite young again. At first after his return to London he complained of his head, but he seemed stronger again just before his death, and worked a few hours daily. He had begun an article for NATURE, and assured his family that he did not overfatigue himself. On the 22nd of last month he died suddenly. He took up the newspaper in the morning to glance at it near the fire. He had not done so for five minutes when he said, "I think I am going to faint." Medical aid was at once procured, but he had a kind of suffocation for two or three minutes, and all was over.

In reviewing the life and labours of John Allan Broun it is impossible to fence off that portion of his character which relates to science, and discuss it without reference to the other parts of his nature. To do so would be to throw away the key of the very chamber which we wish to enter.

He was a man of the most scrupulous integrity, of the most sensitive conscience. But this extreme scrupulosity did not prevent him from appearing in the most amiable character to his fellow men; for he was at the same time a man of the most delicate social instincts, and eminently qualified to shine in society; a very warm friend and a very good companion. If any one suffered from his scrupulous nature it was himself, or, to speak more properly, it was that portion of his surroundings which goes by the name of "material interests." It is of course a mistake to suppose that the highest interests of any man can ever suffer from his being honest.

He was a devoted adherent to the Free Church of Scotland, and at a time when subscription to certain formulæ was insisted on from the professors at the Scottish Universities, his conscientious scruples stood in the way of his obtaining any appointment of this nature. Had it not been for these he might, no doubt, have had the chair of Practical Astronomy at Edinburgh, or that of Natural Philosophy at St. Andrews.

And here we may be permitted to quote a few sentences from a letter written by Prof. Forbes to Sir James Graham (then Home Secretary) urging the claims of Mr. Broun to the former of these posts. After describing the scientific qualifications requisite for an astronomer, he goes on to say:—"But beyond all these may be reckoned a conscientious zeal in the discharge of a duty, often irksome, generally solitary, without which the observatory establishment is not only useless but injurious. In these respects I can cordially recommend Mr. Broun to the favourable notice of Government from more than six years' intimate acquaintance with him. . . . He was subsequently selected by Sir Thomas Brisbane to direct the noble magnetical and astronomical observatory, erected and maintained by his liberality at his seat near Kelso. . . . You are aware how much labour and ingenuity have been expended in devising magnetic instruments and experiments. You must be aware of the skill and patience required to conduct such experiments, of a kind almost new, and with instruments whose actions and errors are almost untried. Now from frequent examination of Mr. Broun's methods, I think I am justified in saying that not one of the magnetical observatories under the direction of Her Majesty's Government has been more vigorously managed than that of Sir T. Brisbane, conducted by Mr. Broun, and probably none with more intelligence and ingenuity."

We cannot help feeling that during the latter years of his life, while he resided in London, Mr. Broun might have received a somewhat larger measure than was accorded him of generous and sympathetic treatment from those specially interested in the progress of observational inquiry. Possessed of no considerable amount of private means, he was living upon a small pension which he had from the Rajah of Travancore, and which has now expired with him. He had been led to believe that one of his labours after leaving India would be to superintend the reduction of his observations. But the publication of these reductions was discontinued after the first volume of results appeared, and, in consequence, a large mass of valuable observations made at considerable cost is now lying absolutely useless.

Surely the course of action which will establish and maintain an observatory, and then decline to make public the records is only comparable in folly with that of a man who begins to build a house which he is not able to finish.

It was a source of great sorrow to Mr. Broun that he was thus prevented from completing what he might justly consider to be the work of his life, and he then endeavoured to procure some employment by which, while advancing his favourite science, he might likewise add to his somewhat slender resources. About that time the meteorological office of this country was in process of reconstruction and he had thoughts of offering his services as one of the meteorological council. It was clear however that his deafness would be considered by those in power as a fatal disqualification for such an appointment, and in consequence he did not press his claims. It certainly seems a great pity that a national institution of this nature so liberally endowed by government should have allowed a man like John Allan Broun to die in their midst without attempting to avail themselves in some becoming and honourable manner of those large stores of information peculiarly suited to their purpose which he alone of all men living possessed, and which he was particularly anxious to communicate to others.

About this time too, Sir E. Sabine resigned his office of magnetical superintendent, and it might naturally have been supposed that Mr. Broun was the very man to succeed him. The office was, however, discontinued. He now made application to the Government Fund of the Royal Society for a sum of money to enable him to improve and complete the reduction of the Colonial magnetic observations. But the immediate and apparent responsibility from quarter to quarter of the possessor of such grants, was peculiarly fatal to a man like Broun. The work seemed to go on growing the more he examined it, and he was never satisfied without going still more deeply into the subject than he had already gone.

Then his health began to give way, and the thought that he had received money for which he had rendered no equivalent hastened still more the progress of his malady.

At last the end came, and we can now hope no longer to complete his labours as he would have himself completed them had he been spared to us but a little longer.

It has been said of an eminent experimentalist that great as were his successes, his failures must have cost him even more thought. If this be true in experimental research, it is peculiarly true in observational inquiry where every idea in order to be tested entails a laborious investigation. Mr. Broun, whose mind was very fertile, must have often spent great labour apparently to no purpose, but on the other hand his successes were very marked, and he did not hesitate to consider a new fact as abundant compensation for a large amount of failure. We cannot attempt to give here an exhaustive catalogue of his various labours. But we may allude to the volumes embracing the results of the Makerstoun observations as pre-eminent for the skill employed in the development of new methods. These volumes alone must have cost him an immense amount of thought.

In 1861 he communicated to the Royal Society of Edinburgh, two papers of marked value. In one of these the errors and corrections of the bifilar magnetometer were discussed, including the determination of its temperature coefficient, which Mr. Broun showed might be found in a more correct method than that hitherto adopted.

The second of these papers was on the horizontal force of the earth's magnetism, for which he established the annual laws from a discussion of observations taken at various places. He likewise discovered that the variations of this element from day to day are nearly the same over all the world.

For these discoveries he was awarded the Keith Medal of the Royal Society of Edinburgh. We have already alluded to the great labour he spent upon the first volume of the "Results of the Trevandrum Observations." In this volume conclusions of the greatest scientific interest are deduced, and Mr. Broun has been able to give in a complete form the laws which regulate the solar-diurnal variation of magnetic declination near the equator. But his researches regarding the lunar-diurnal variation of this element form perhaps the most original and interesting part of the volume. He has claims to be considered as an independent discoverer of this variation, and he has certainly increased our knowledge of its laws more than any other magnetician. We may mention his observation that the lunar action was reversed at sunrise and that it was much greater during the day than during the night, whether the moon was above or below the horizon, as particularly noteworthy and likely to throw much light on the theory of the subject. We have already alluded to Mr. Broun's discovery of the similarity, all the world over, of the changes from day to day of the earth's horizontal force. Certain of these changes he found to be due to the moon, while others had a period of twenty-six days. These last he attributed to solar action, and in discussing the subject he found that the greater magnetic disturbances were apparently due to actions proceeding from particular meridians of the sun. This is a subject of very great importance, and its exact meaning has yet to be discovered.

Mr. Broun was no less eminent as a meterologist than as a magnetician. His observations regarding the barometer are of the greatest importance. In this branch of inquiry he has shown the apparent simultaneity of the changes of mean barometric pressure over a great part of the globe, and he has likewise discovered a period of twenty-six days. He was the first to commence those systematic observations of clouds at various altitudes that are now so extensively made, and in a paper read not long since before the Royal Society of London, of which body he was an old member, he pointed out certain relations between atmospheric motions and the directions of the lines of equal barometric pressure. For his various researches, he obtained in 1878, just one year before his death, the Royal Medal of that Society.

These are only a few of the many labours of one whose loss, so deeply felt by all his friends, may be regarded as a calamity by the cultivators of meteorology and magnetism, branches of knowledge in which he was second to none who has yet appeared.

BALFOUR STEWART

NOTES

DR. WARREN DE LA RUE, F.R.S., has just sent to the Chemical Society Research Fund a third donation of 100*l.*, the whole amount to be devoted to a single research.

IN the person of Lady Sabine, who died at Ashley Place on the 28th ult., at the age of seventy-two years, a woman of most remarkable clearness of intellect and of power of memory has passed away. In 1827 she married Sir Edward (then Captain) Sabine, and for more than fifty years her main occupation and her chief enjoyment was to assist him in his investigations, especially in terrestrial magnetism. None but her most intimate friends can know how much of the laborious calculations in the "Contributions" were really effected by her, while she translated Humboldt's "Cosmos" and "Ansichten der Natur," besides numerous smaller papers. One of their oldest friends has truly said, "I deeply sympathise with Sir Edward; the death of his wife has rendered the number of beautiful lives in the world one less."

THE following are the probable arrangements for the Friday evening meetings before Easter, 1880, at the Royal Institution:— January 16, Prof. Dewar, F.R.S.; January 23, Dr. W. B. Carpenter, C.B., F.R.S., "Sea and Land in Relation to Geological Time;" January 30, John Marshall, F.R.S., "Proportions of the Human Figure;" February 6, William Huggins, D.C.L., F.R.S.; February 13, W. H. Preece, C.E., "Wheatstone's Telegraphic Achievements;" February 20, Rev. H. R. Haweis, "Old Violins;" February 27, Frederick J. Bramwell, F.R.S.; March 5, H. N. Moseley, F.R.S., "Deep-Sea Dredging and Life in the Deep Sea;" March 12, C. William Siemens, D.C.L., F.R.S.; March 19, Prof. Tyndall, D.C.L., F.R.S. The following are the lecture arrangements before Easter:—Christmas Lectures (adapted to a juvenile auditory): Prof. Tyndall, D.C.L., F.R.S., six lectures on "Water and Air," on December 27 (Saturday), 30, 1879, January 1, 3, 6, 8, 1880; Prof. Edward A. Schäfer, F.R.S., ten lectures on "The Physiology of Muscle," on Tuesdays, January 13 to March 16; H. Heathcote Statham, two lectures on "Modern Architecture since the Renaissance," on Thursdays, January 15 and 22; Prof. Dewar, F.R.S., eight lectures on "Recent Chemical Progress," on Thursdays, January 29 to March 18; Prof. T. Rupert Jones, F.R.S., three lectures on "Coal," on Saturdays, January 17, 24, 31; Ernst Pauer, three lectures on "Handel, Sebastian Bach, and Joseph Haydn" (with musical illustrations), on Saturdays, February 7, 14, 21; four lectures on "History of Literature," on Saturdays, February 28, March 6, 13, 20.

At the request of the Government of the Cape Colony and the trustees of the South African Library at Cape Town, Sir Bartle Frere has desired Prof. Max Müller and Prof. Sayce to select a qualified successor to the late Dr. Bleek, to continue his labours as colonial philologist and as custodian of the valuable library presented to the colony by Sir George Grey. The salary will be 500*l*. a year, of which 300*l*. will be contributed by the Government, and 200*l*. by the committee of the South African Public Library. Applications and testimonials only may be sent to Prof. Max Müller, Oxford.

The lectures in connection with the Brown Institution will be delivered by Mr. W. S. Greenfield at the University of London on December 17, 18, 19, 22, and 23 at 5.30 P.M. The subject will be "Recent Investigations on the Pathology of Infective and Contagious Diseases."

The French Minister of Public Instruction has appointed a section of the Commission of Historical Monuments for the purpose of establishing an official record of all megalithic constructions and erratic blocks discovered in France and Algiers.

The grants voted by the Legislative Assembly of France for 1880 have been sent to the Senate, and according to every probability will be voted without any material alteration. The sum of 59 millions of francs was voted for public instruction, 2½ millions more than were asked for by the Government. In 1870 the grants for educational purposes were 26 millions and in 1851 only 16 millions. Among the items in the grants are the following:—The grant for the National Institute is 707,762 fr., for the Academy of Medicine 75,000 fr., the College of France 466,000 fr., the Museum of Natural History 835,000 fr., for astronomical and meteorological observatories 835,000 fr., for the National Library 674,000 fr., for the National Library and Museum of Algiers 296,000 fr., travelling expenses for explorers 200,000 fr., École des Hautes Études (conducting experiments, &c., &c.) 300,000 fr.

The Edinburgh Liberals, who have had a week of almost uninterrupted oratory from their idol, Mr. Gladstone, have been impressing science into their service, in order that Mr. Gladstone's voice might reach a much larger audience than any single hall in Edinburgh could hold. On Saturday he addressed an audience in the largest hall in Edinburgh, the Corn Exchange; but as this could not anything like hold the multitude that wanted to hear him, it was connected by telephone with another hall at some distance. We shall let the *Daily News* correspondent describe the result of the arrangement:—"The audience distinctly heard the cheering and singing of the meeting in the Corn Exchange, and also the strains of the band. Lord Roseberry's voice was also recognised, and it was gathered that he was saying pleasant things about Mr. Gladstone. Next came a burst of cheering, the sound of which was suddenly stopped, and a long interval of silence followed, varied from time to time by the murmur of distant cheers. Then as suddenly as silence had fallen, there came the sound of Mr. Gladstone's voice, and he was followed pretty well through 'some remarks on corn averages and the condition of India.' All this, which greatly mystified the telephonic audience, is capable of easy explanation. Observers of Mr. Gladstone's manner in the House of Commons will remember what an important part the right hon. gentleman's hat plays in his great speeches. He invariably places it on the table, a little to one side of him, and on the top of it he places his notes, which he rapidly shuffles and re-arranges as the oration progresses. This afternoon, bringing his hat to the table in his accustomed manner, he unconsciously planted it right in front of the cylinder of the telephone which had been fixed on the table, thus, of course, cutting off the means of communication. As the speech proceeded, he began the re-arrangement of the papers and the movement of the hat, which latter he finally drew away from the telephone, and then became audible in another building a quarter of a mile off, 'some remarks on corn averages, and the condition of India.'" It is a pity Mr. Gladstone had not been put up to the arrangement; we are quite sure, had he known, he would not have adopted so "obstructive" a line of action with his hatful of papers.

A new light company has started a public subscription in Paris for 80,000*l*. The inventor proposes to dispense with magneto-electric machines, by resorting to Bunsen elements of special construction, and to dispense with regulators by incandescent light. An immense number of prospectuses have been circulated amongst the peasantry, and the funds are collecting with an amazing rapidity.

Scribner's Monthly, one of the best monthlies anywhere, has an interesting illustrated article in the December number on the Johns Hopkins University.

A competition having been opened for erecting a memorial of the siege of Paris on the Rond Pont of Courbevoie, M. Bartholdi, the author of the gigantic statue representing the French-America alliance, has executed a model representing a balloon with a sailor aëronaut and the beseiged city receiving messages from a carrier-pigeon. The *ensemble* is grand and picturesque. It has raised the enthusiasm of Paris aëronauts, who are to make a public demonstration in support of M. Bartholdi's schemes.

The *Colonies* of November 22 contains a long and valuable list of works on Commercial Botany, drawn up by Messrs. G. J. Symons and P. L. Simmonds.

The new part of Mr. Bentham and Sir Jos. Hooker's "Genera Plantarum" will be published in January, and will complete the Dicotyledonæ. Only one other part, the Monocotyledonæ, will remain to be published.

On November 21 M. Mariette-Bey read, before the Academy of Inscriptions of Paris, a long report on the new excavations which are to be executed in Egypt. This address having been delivered in a solemn meeting of the Academy, it is certain that the illustrious Egyptologist will obtain a grant from the French Government.

The *Kölnische Zeitung* says that a rack railway, of the Righi type, will be erected on the Drachenfels, one of the seven hills situated on the left bank of the Rhine. The survey of the intended line is proceeding with activity.

The Kane Geyser, or spouting water-well, has lately attracted much attention from the sight-seeing public. Some exact data regarding it are furnished in a recent notice by Mr. Ashburner (*Amer. Jo. of Sci. and Arts*, November). The well is situated in the valley of Wilson's Run, near the Philadelphia and Erie railway-line, and four miles south-east from Kane. It was drilled in the spring of 1878 to a depth of 2,000 feet, but, as no petroleum was found in paying quantities, the casing was drawn and the hole abandoned. In drilling, fresh-water veins were met with down to 364 feet, which was the limit of the casing. At 1,415 feet a very heavy "gas-vein" was struck, and this gas was allowed free escape while the drilling was continued to 2,000 feet. When the well was abandoned, the fresh water flowed in, and the conflict between the water and gas commenced. The water flows into the well on top of the gas till the pressure of the confined gas becomes greater than the weight of the superincumbent water, when an expulsion takes place, and a column of water and gas is thrown up to a great height. This occurs at present at regular intervals of thirteen minutes, and the spouting continues for one and a half minutes. The column, according to measurement, varied in height from 108 to 138 feet. The gas of the mixture can be readily ignited. After nightfall the spectacle is grand. The antagonistic elements of fire and water are so promiscuously blended that each seems to be fighting for the mastery. At one moment the flame is almost entirely extinguished, only to burst forth at the next instant with increased energy and greater brilliancy. During sunshine the spray forms an artificial rainbow, and in winter the columns become incased in huge transparent ice-chimneys.

WE have received the numbers for October and November of the *Natural History Journal* "conducted by the Societies in Friends' Schools." This journal continues to sustain its reputation, and several papers in these numbers are highly creditable.

THE *Colonies and India* states that a new store of guano has lately been discovered in a series of caves about 100 miles east of Cape Town. It is described as being a light-brown powdery mass, in which a number of solid nodules occur. An analysis shows that it contains 68 per cent. of ammonia compounds, 16 per cent. of phosphates, and 2 per cent. of nitrogen. In the same caves are considerable quantities of salts, forming a crystalline mass, and containing 33 per cent. of phosphoric acid, 11 per cent. of sulphuric acid, 15 per cent. of nitric acid, 19 per cent. of potash, and 7 per cent. of ammonia.

CONSUL CALVERT, reporting on the trade and commerce of Alexandria for 1878, thus refers to the new fodder plant, the Téosinté (*Euchlæna luxurians*), which has attracted so much attention lately in tropical countries. During the last three or four years experiments have been made at Cairo and attended with complete success, and it is expected that it will eventually prove to be a great acquisition to Egyptian agriculture. The plant attains the height of from thirteen to sixteen feet, and so rapid is its growth that in an experiment made in July at Cairo the plant after having been mown down grew one foot in four days. On analysis the plant is found to contain much saccharine matter, and to be much more nourishing for animals than the native clover or *verseem* (*Trifolium alexandrinum*).

UNDER the title of "Notes on the Flora of Surrey," a list of plants known to occur in the five adjoining counties, but not really known in Surrey, has been published by Mr. A. Bennett, of 107, High Street, Croydon, who has issued the list "as a first step towards a proposed supplement to the flora of the county, and with the wish that those botanists who may be able to help will kindly do so, either in confirming by specimens any doubtful plants reported for the county, or by giving the localities where they may be gathered, so that search may be made next season." Mr. Bennett's list is a useful one, though the botanical nomenclature has been very carelessly corrected, if indeed corrected at all.

MR. CHARLES GILBERT, of Bedford Street, has published "Tables of Metric Measures and their English Equivalents," by G. M. Barns, for use by engineers, architects, contractors, and others.

WE some time ago announced the death of the librarian of the "Leopoldino-Karolinische" Academy for Natural Sciences, Dr. Behn, of Dresden. The statutes of the Academy prescribe that the library must be at the librarian's place of residence. Consequently the whole library, consisting of some 40,000 volumes, has been transferred to Halle, where Dr. H. Knoblauch is the new librarian.

IN a lecture delivered at Bristol by Mr. Lant Carpenter, he spoke of his recent visit to the United States, and remarked that amongst the various improvements and things which were being tried there, one that struck him as much as anything was the extraordinary development within the last two or three years of the application of electricity to the purposes of practical life. He gave several remarkable examples of the way in which the system is applied in the United States for the protection of safes, vaults, and other valuable property, alarms being rung in a central office whenever a forcible entrance was attempted in any one of, say, 500 vaults, the alarm indicating which one. In many cities and towns in the States, he said, there were district telegraphs established. From a central office wires ran to every private house in the district which wished to be connected, and by this means you could communicate with the central office, and by a prearranged set of signals on a bell, the inmates of the house could call a cab, a policeman, a messenger, or a doctor, by simply pulling a handle. The lecturer, in speaking of the practical application of electricity to a system of fire alarms, explained the general system pursued in all large towns in the United States, and spoke of the extraordinary rapidity with which fire-engines are turned out ready for use on receipt of the electric signal. Six or eight seconds was the usual time. Electric signal boxes were fixed in the streets, and any person, on becoming aware of a fire, could turn a handle and communicate at once with the central stations, where the officials would know from which box the signal came. An automatic system was at work in New York, where 500 shops, stores, and warehouses were protected by an apparatus which sounded an alarm in a central office whenever the temperature of any place rose above a given point. Mr. Carpenter stated that in all large towns in the United States of America there was a system of telephone exchanges established. It was a system by which a large number of persons had these telephones in their houses, the wires of which all converged in a central office, and by such an arrangement any one of the subscribers to the exchange could talk to any other person who was also a subscriber through the central office. The wire from each house ended in the central offices, and by simple arrangements any one wire could be readily joined to any other, thus putting two people into communication. The lecturer gave instances of this arrangement, explaining that so perfectly were these telephones constructed that a person's voice could be readily and easily recognised. The lecturer proceeded to comment upon their recent extraordinary and rapid development in every large town in the United States. The subscribers to these exchanges were numbered by thousands, and their uses and advantages were many. Not only were they now connecting different parts of one town by means of these exchanges, but steps were being actively taken to connect towns together by similar means. In conclusion, the lecturer urged that if science, practically applied, was to form so large a portion of our daily life, was not that a very strong argument for so arranging our educational work that every child should be instructed in the rudiments of science? Dr. W. B. Carpenter, having been invited to address the meeting, said he felt convinced that in the next generation the telephone would become almost as generally used as the telegraph was now, though he did not mean to say the latter would be superseded.

AN interesting Roman structure has recently been discovered at Regensburg (Ratisbon). It consists of a subterranean aqueduct of some 10 metres in length, 1½ metres in height, and 60 centimetres in breadth, built of colossal blocks of stone.

THE additions to the Zoological Society's Gardens during the past week include a Common Wood Owl (*Syrnium aluco*), European, presented by Mr. W. J. Smith; a Turquoisine Parrakeet (*Euphema pulchella*) from New South Wales, presented by Mr. A. Battescombe; a Macaque Monkey (*Macacus cynomolgus*) from India, a Barbary Falcon (*Falco barbarus*) from North Africa, deposited; a Reeves's Muntjac (*Cervulus reevesi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

A SEVENTH STAR OF THE ORION-TRAPEZIUM.—In addition to the well-known fifth and sixth stars in the trapezium of Orion, the former detected by Struve with the Dorpat refractor on November 11, 1826, and the latter by Sir John Herschel with Sir James South's large refractor at Kensington, on February 13, 1830, the elder Bond, soon after the mounting of the Harvard instrument, perceived, roughly in the direction of the sixth star, a fainter and more distant one, which is No. 24 of his memoir on the nebula published in 1848. M. O. Struve, with the telescope of similar dimensions at Pulkowa, could not see this star, a circumstance which might be attributable either to variability, or to the difference of altitude of the object at Pulkowa and at Harvard College. It was repeatedly observed by G. P. Bond, and is No. 636 of his catalogue printed in *Annals* of the Astronomical Observatory of Harvard College, vol. v., where its magnitude is estimated to be 13·3 on Argelander's scale. The Pulkowa measures gave for the sixth star position 128°·8, distance 3″·73 at the epoch 1858·78; from the Harvard differences of right ascension and declination we find, for the seventh star, position 136°, distance 12″·1. In Bond's later notes the following references to this star, amongst others, occur:—1863, January 19 and 23, difficult; January 30, easy, though faint; February 14, not difficult, though requiring attention and effort. 1864, February 3, under fine definition, though easily seen, probably fainter than in the previous year; February 29, readily seen and possibly brighter. Referring to the notes in 1850 and 1851, it is remarked that the star is "often mentioned in these earlier observations; as *certainly* seen on the dates 1850, February 7, March 2, March 5, March 11; it is not mentioned March 10, and was not seen March 12; not mentioned 1850, December 27, but seen again 1851, February 3." It was observed on several occasions in 1859 and 1860. On January 28, 1861, seen by glimpses, and on February 13 easily. On January 31, 1862, not seen. Some of these observations might appear to point to variability, but others seem to afford "another and quite different explanation of the phenomena." If we are not mistaken, this seventh star has been recently caught up with the Ealing reflector; but there are other telescopes in this country which should be competent to cope with it, and the star may deserve some attention.

LUNAR ECLIPSES.—In the small eclipse of the moon (magnitude 0·17) which will occur on the 28th of the present month, the first contact with the shadow takes place at Greenwich at 3h. 37m. P.M., and the last contact at 5h. 15m.; the moon rises at 3h. 46m. Of the eight lunar eclipses occurring within the following five years, only one, that of October 4, 1884, will be wholly visible in this country. The circumstances of these eclipses may be thus very briefly indicated:—

1880, June 22.—Invisible, the middle at 1h. 50m. P.M.
Dec. 16.—Total; beginning of total phase at 2h. 54m. P.M., the moon rising at 3h. 46m.
1881, June 12.—Invisible, the middle at 6h. 54m. A.M.
Dec. 5.—Nearly total (0·97); first contact with the shadow at 3h. 28m. P.M., the moon rising at 3h. 50m.
1883, April 22.—Invisible, the middle at 11h. 39m. A.M.
Oct. 16.—First contact with shadow at 5h. 59m. A.M., the moon setting at 6h. 25m.
1884, April 10.—Invisible, the middle near noon.
Oct. 4.—Total, visible throughout, the middle soon after 10 P.M.

PARALLAX OF A SMALL STAR.—Dr. Geelmuyden, of the Observatory at Christiania, by a series of observations extending over more than twelve months, finds "a notable parallax" for the ninth magnitude star, No. 11677 in Oeltzen's Catalogue from Argelander's northern zones. This star has a proper motion of 3″·04 in the direction 274°. The parallax appears to amount to about 0″·25, but the result is considered far from definitive. The position of this star is in R.A. 11h. 13m. 49s., N.P.D. 23° 30′ 2 for 1880.

NEW NEBULÆ IN ERIDANUS.—M. Block has detected at Odessa two nebulæ in this constellation, which are not found in Sir John Herschel's General Catalogue, the first in R.A. 3h. 28m. 9s., N.P.D. 116° 16′·5, the second in R.A. 3h. 33m. 48s. N.P.D. 116° 43′·7 for 1880. The former is pretty bright, and five minutes in diameter, the latter "considerably bright," with strong central condensation, and readily observed even with the moon above the horizon. The repeated discovery of uncatalogued nebulæ in these days becomes of much interest in connection with the question of variability.

PHYSICAL NOTES

PROF. STEINHAUSER, of Vienna, has recently pointed out that there exists a determinate relation between the size and relative position of the two views of a stereoscopic picture, the lenses of the camera with which it is taken, and the optical arrangements of the stereoscope in which it is to be viewed. If these relations are observed rightly, the effect of relief will be much more perfectly attained for all parts of the picture than if they are neglected. The eye-pieces of the stereoscope above the plane of the photographic pictures ought to be made as nearly as may be equal to the focal length of the objective of the photographer's camera, and this again should be about equal to the mean distance of easy vision, or, from ten to twelve inches. Herr Steinhauser, after developing the theory of the instrument in relation to this point, throws out three very definite and simple suggestions for the photographers. Firstly, that all stereoscopic pictures should be taken with lenses of equal focal length, say 15 centimetres; secondly, that all should be made of equal breadth, or about 75 millimetres; thirdly, that the distances between the centres of the objective-lenses should always be kept constant.

THE *passivity* of iron when employed as the positive pole of a nitric acid battery, or as positive electrode of a voltameter cell containing nitric acid, has recently been studied by M. Louis Varenne, who concludes that the passive state is due to a film of nitric peroxide which collects upon the surface of the iron and protects it from further chemical action. M. Varenne states that this film is apparent when the surface of the iron is examined under the microscope. He finds that the passive state ceases if a stream of carbonic dioxide or of hydrogen is passed through the liquid, and that solution proceeds apace. He also finds that nitric peroxide gas is evolved from the passive iron when it is placed *in vacuo*.

ANOTHER new instrument may shortly be expected from the *atelier* of Dr. König, which will probably settle for ever the dispute between himself and Mr. A. J. Ellis as to the correctness of his tuning-forks of normal pitch. It will indicate a variation of one vibration in ten thousand from the assigned pitch.

M. PELLAT finds that Latimer Clark's standard cell is not entirely free from variations in its electromotive force. He has found two similar cells may differ from one another by a quantity equal to the $\frac{1}{100}$th part of the electromotive force of a Daniell's cell. M. Pellat employs an electrometer to measure the residual difference of potential when the two cells are connected up in opposition to one another, and believes that by this means his observations are free from possible errors due to polarisation when the galvanometer method of comparison is adopted.

HERR EDLUND has drawn attention to an electrical experiment that has not hitherto been thoroughly explained. Let an open metal tube or cylinder, capable of rotation about its axis, be placed over a magnet of double its own length, so that its lower end is opposite the middle of the magnet, while its upper end is opposite the magnet pole. Then let a current of electricity of sufficient strength be passed from one end of the tube to the other. The tube is found to rotate with a velocity which is independent of the resistance of the metal of which it is composed and of its thickness. Longitudinal slits cut in the tube do not affect its rotation. There is therefore here a complete conversion of electromotive force into ponderomotive force. W. Weber inferred that the resistance of the movable conductor to the passage of the current is the medium of this transfer of the energy, and argued that the first tendency is to rotate the current in the conductor, but that as this could not be done without moving electricity through the substance of the conductor, and therefore against its resistance, the principle of least heat requires that the energy should be transferred in an indefinitely short time to the conductor itself, which therefore rotates. Herr Edlund, however, sees in the experiment a confirmation of his "unitary" theory of electricity.

SIGNOR GUIDI, an Italian engineer, has suggested the employment of electricity in the preparation of steel in the following manner:—A dynamo-electric machine driven by steam or water power is caused to electrolyse water; the oxygen and hydrogen gases thus furnished are to be employed in smelting the carboniferous ore of iron, which is reduced by the hydrogen at the high temperature of the flame, thus producing at one operation either steel or pure malleable iron at will. Signor Guidi states, however, that to turn out two tons daily would require the constant employment of a 120 horse-power engine.

GEOGRAPHICAL NOTES

THE Lisbon correspondent of the *Daily News* telegraphs that Ivens and Capello have arrived ill at Loanda, after two years' exploration. They are suffering from fever and other complaints induced by privation, and were almost without clothes. According to government instructions, they have completed a general map of Loanda. They explored the rivers Quango and Quanza, and the territories bordering on their basins. They could not descend the Quango to its confluence with the Zaire on account of the resistance of the hostile tribes. Capello appears quite old, and hardly recognisable. Ivens is better, though ill. Both are thorough scientific men. They bring important notes extending over 32 degrees, plans of the territories and the roads, and meteorological, magnetic, and geographical observations made with the excellent instruments they carried. They were well received by the chief of the Motiango territory, from which the German explorer, Schultz, was excluded; but the chief would not allow any white man to pass east at the peril of his life. They visited the highlands of Bihé, and explored several rivers to their sources. Nearly all their followers deserted them. They were received with great enthusiasm on their arrival at Loanda, and will go to Mossamedes to recruit, prepare their plans, and write out their observations. The period of their return to Lisbon is uncertain.

AT a late meeting of the Russian Geographical Society some details were communicated as to the expedition exploring North-Western Mongolia under M. Potanin. In a letter the traveller describes his route during July and August, which first led from Tsoosilan to the River Kharkiri, and thence to the Lake of Khirghisnor, layers of coal being found on the way. The banks of that lake being barren, the explorers halted near Lake Baganor, only six versts distant from the other sheet of water. Khirghisnor is a great deal larger than Lake Kharaous, and the Mongols asserted the existence of only two such immense reservoirs in the country—namely, the Oobsa and the Kirghisnor. From the latter the expedition marched south, with intent to strike the point where the waters of Lakes Kharaous and Durganor fall into Dzabchin. On August 4 the travellers came to the salt lake Dzerennor, and not till the 9th did they reach the banks of the River Tachteteli, that being the name applied to the mingled volumes of the large lakes flowing into the Dzabchin. Marching round the southern part of Lake Kharaous, the explorers then arrived at the town of Kobda on September 1, with rich scientific collections of all kinds. M. Potanin intended again making for Oolangol, thence proceeding to Oolookem.

THE committee of the Dutch Arctic Expedition have made known their determination to fit out, for the third time, their little sailing schooner *Willem Barents*. The cost of the new expedition is estimated at a little over 1,000*l*.

AFTER the presidential address and the paper on Sumatra read at the first meeting of the session, the new number of the Geographical Society's periodical gives us some notes on the Cocos or Keeling Islands, from the pen of Mr. H. O. Forbes, who went out to the East in October of last year for the purpose of investigating the fauna and flora of certain districts in the Malay Archipelago. While in Java, before commencing this work, he availed himself of an opportunity of paying a visit to these far-away islands, in order to ascertain what changes had occurred since the visit of H.M.S. *Beagle* in 1836; these are shown on the map accompanying his paper. Next we find a note on the boundary line between Chili and Bolivia, illustrated by a map, which explains to some extent the existing disturbances in South America. The geographical notes furnish an account of the progress being made towards Lake Tanganyika by Dr. Mullen's successors, the late Mr. Frank Oates's researches in Matabeleland, and Major Biddulph's tour in Chitral and Yassin. There is also some information of interest respecting Transcaucasia.

A CONTRACT has been concluded by the Molala Shipbuilding ompany, Sweden, to construct a steamer of Molala Bessemer teel, of 100-horse power, to trade between China and Siberia.

FROM the Abstract Report of the Indian Surveys for 1877-8 we see that a large amount of work was done during the season by the various departments, all now united under one organisation. Some interesting and important details are given of various trans-frontier explorations.

THE October *Bulletin* of the Paris Geographical Society begins with a long and valuable paper by M. Wiener on the Dead City of Gran-Chimu and the city of Cuzco. The paper is accompanied by large and careful plans of the two cities, and we believe is a valuable contribution to a puzzling problem. Admiral Fleuriot de Langle has a paper on African migrations, and M. Jules Girard on the subsidence of the surface of the Low Countries. M. Hamy gives an interesting *compte rendu* of M. G. Retzius's recent work on Finnish Ethnology.

THE ROYAL SOCIETY

THE anniversary meeting of the Royal Society was held on December 1, and a somewhat long address was read by the President Mr. Spottiswoode. After referring to some of the losses by death which the Society had sustained, he passed on to business which has occupied the attention of the Council during the current year.

Two important contributions to the Society's funds are announced. First, an unconditional bequest of 1,000*l*. by the late Mr. Sidney Ellis, of Leicester; and secondly, a legacy by the late Sir Walter Trevelyan, "the interest of which is to be applied to the promotion of scientific research."

The Royal Society, as is well known, possesses a rather extensive gallery of portraits, almost exclusively of Fellows of the Society, but among them also a fine painting of Lord Chancellor Bacon. Many of these portraits, however, have, through the lapse of time, begun to show signs of decay. Acting under the advice of Mr. F. W. Burton, F.S.A., Director of the National Gallery, the Council has entrusted the pictures which seemed most to require attention to the care of Mr. Dyer, of Orchard Street, who is now engaged upon them. Some of the portraits require lining, and others cleaning, or partial restoration. As will be seen from those which have been returned to their places, the work appears to have been done in a satisfactory manner. The present appearance of the pictures has been much improved, and it is hoped that these interesting portraits of those who have gone before us may now be passed on in an unimpaired condition to future generations.

Among other acquisitions 973 portraits of Fellows of the Royal Society, formed by the late J. P. Gassiot, Esq., F.R.S., have been bought during the past year. The collection consists mainly of engravings, many of which are of great artistic merit, and in excellent condition.

During the past year a small but perhaps not unimportant change in the mode of dealing with the papers to be read at the weekly meetings has been made. This consists first, in deciding a week earlier than heretofore, what papers should be advertised for reading: and secondly, in reading each week as many as practicable of those in hand, so as to leave as few as possible to stand over. The weekly journals are now able to announce to the public the papers which will be read at the Royal Society (as has in fact long been the case with other Societies) during the next week. But the main object of this arrangement has been early publication; that is to say, publication both in its technical sense of reading before the Society, and in its more widely accepted sense of appearance in the Society's Proceedings. When this was first proposed, it was feared there would soon arrive a period of scientific famine, and that occasions might occur when the Society would meet with no papers before it. Whether this would be so great a calamity as was at first imagined is still an open question, for such has been the scientific fertility of the season, that the threatened catastrophe has never yet actually occurred.

"But so far from suffering by a deficiency of matter we have more often found our difficulties in the number of papers to be read in a single evening. And on such occasions the Secretaries have been good enough to take especial pains to make themselves masters of the contents of the papers, and to communicate in a few words to the meeting the substance of each. It is, I believe, not too much to say that the 'reading' of papers carried out in this way has been the most agreeable and instructive, and has been particularly provocative of intelligent and pertinent discussion. . . . .

"There is a possible alteration in our arrangements which has often appeared to me to be worthy of consideration, and which from conversations with some of our Fellows appears to meet with sufficient support to justify my bringing it before this our anniversary. I refer to the hour at which our weekly meetings are held. Hitherto, in accordance with the usage of scientific societies in London, we have met in the evening. But changes in the habits of society, and the increasing distances from Burlington House at which many of our Fellows reside, seem to render a large weekly attendance difficult. On this account it appears to me desirable to inquire whether an afternoon hour might not better suit the convenience of our members. In that case, I should suggest 5.0 P.M.; and as our meetings seldom extend to two hours in duration, it would generally be practicable for Fellows to reach home by about seven o'clock. . . .

"These changes, if adopted, would require the alteration of the Statute relating to the hour of meeting. But if the suggestion were adopted before the end of the year, there would still remain nearly half the Session of our Society after complying with the necessary formalities. . . .

"It has often been suggested," we read, "that our weekly meetings might be rendered more interesting if the communications were more often accompanied by experiments, or by other modes of optical illustration. The Council has hitherto met these requirements by supplying, from time to time, such appliances as appeared necessary. But that important element, the electric light, and batteries on a large scale, have generally been avoided, on account of the inconveniences attending them. It has, however, been thought that authors would be much encouraged to illustrate their communications experimentally if the main appliances were known to be always ready to hand. . . .

"Again, the mode of lighting our meeting-room by means of sunlights has proved inconvenient to many of our Fellows, on account of its heat and glare; and it is considered undesirable to adopt ordinary gas-burners in its stead for fear of injury to the pictures. We are, however, no longer driven to this alternative, as we may now look to the electric light as a possible mode of illumination.

"These considerations have led me to make an offer, as I now do, to the Society, of a gas-engine of eight horse-power, which, in the opinion of those best qualified to judge, will be amply sufficient both for experimental illustration and for illumination. And I have much pleasure in adding that, on hearing of this offer, our Fellow, Mr. Siemens, immediately expressed his wish to add a dynamo-machine, or rather a pair of such machines, of improved construction (one for alternate, the other for direct currents), the principle of which he had already contemplated bringing before the Society. The other requisites, such as an optical lamp and a few instruments of frequent use, will doubtless soon follow. But, in proposing thus to promote experimental illustration of papers read before the Society, I think it right to add that I do not contemplate, nor do I think it desirable, that the Society should in any sense establish a laboratory; all that is here intended is, that the main appliances for illustration should be found ready to hand here, while the special apparatus would be furnished by the authors themselves."

With regard to the government grant and fund, it is in the opinion of the President desirable that the minds, not only of the Council, but also of the Fellows generally should during the present year be turned to the question, whether it is advisable, in the interests of science, that the fund should be maintained: and if so, whether in its present or any altered form?

In May last the Secretary of State for India asked the advice of the Royal Society on the question of deputing to this country Major J. Herschel on the subject of pendulum observations. The subject is one in which the Royal Society has on more than one occasion taken an active interest; and a reply, prepared by Prof. Stokes was sent. Major Herschel is on his way to England, to carry out the proposed work.

The Publications of the Society. — The Catalogue of Scientific Papers.—The second volume of the supplementary decade, viz., 1863–73, has been brought to a close, and copies are now in the hands of the Fellows and the public. It exceeds in bulk any of the earlier volumes of the work, and extends to 1,310 pages. In this supplement, 343 additional scientific serials have been catalogued, making the total of such serials now comprised in the whole no less than 1,938. The donation list for this volume has been the same as that for former volumes, with the addition of a few societies and institutions sanctioned by the Treasury at the recommendation of the Council. The Fellows have the right to purchase the supplement at the same reduced price per volume as the original work. The Council has authorised the preparation of titles for another decade; and some progress has already been made in the work.

An extra volume of the *Philosophical Transactions* (vol. 168) has been issued, in which the observations made by the naturalists who accompanied the Transit of Venus Expeditions to Kerguelen's Land and Rodriguez, and descriptions of their collections by persons specially acquainted with the several subjects are brought together. The volume is divided into four sections, viz., the Botany and Zoology of each of the two islands respectively.

In estimating the affinities of the flora and fauna of Rodriguez, the authors were under great difficulties owing to our imperfect knowledge of the plants and animals of the other Mascarene Islands. But almost all their observations point strongly to the conclusion that the present animals and plants are the remains of a once more extensive flora and fauna which has been gradually broken up by geological and climatic changes, and which more recently has been greatly interfered with by the agency of man.

The papers presented to the Society, and read at the evening meetings, are stated to have been more numerous than in any previous year of its existence, and have during the last twelve months reached a total of 118. Some of them appear to have excited unusual interest among the Fellows and their friends; for, on more than one occasion the meeting-room was filled to an almost unprecedented degree.

The President took the opportunity of expressing his own impressions of a few which fall, more or less, within his own range of study, first of all referring to the assiduity and success with which Mr. Crookes has continued his labours.

The work of the Institution of Telegraph Engineers, the Iron and Steel Institute and other similar associations was then referred to.

The justification for the award of the medals for the present year was thus stated:—

The Copley Metal has been awarded to Rudolph Julius Emmanuel Clausius, Foreign Member of the Royal Society, for his investigations in the Mechanical Theory of Heat.

The mechanical theory of heat as at present understood and taught has been so essentially a matter of growth, that it would be difficult to assign to each investigator the precise part which he has taken in its establishment. It will, however, be admitted by all, that the researches of Clausius rank high among those which have mainly contributed to its development. These researches extend over a period of thirty years, and embrace important applications of the theory not only to the steam-engine, but to the sciences of electricity and magnetism.

Even to enumerate those who have contributed to one branch of the subject, viz., the kinetic theory of gases, would be beyond my present purpose and powers; but as Clausius himself states, both Daniel and John Bernoulli[1] wrote on the subject. And, even, to go back to earlier times, Lucretius[2] threw out the idea; while Gassendi, and our own Boyle, appear to have entertained it. Within our own recollection, Joule, Meyer, Kroning, Clerk Maxwell, and others have made invaluable contributions to this branch, as well as to the general subject of the mechanical theory of heat. But however great the value of these contributions, it may safely be stated that the name of Clausius will always be associated with the development of earlier ideas into a real scientific theory.

A Royal Medal has been awarded to W. H. Perkin, F.R.S. Mr. William Perkin has been, during more than twenty years, one of the most industrious and successful investigators of Organic Chemistry.

Mr. Perkin is the originator of one of the most important branches of chemical industry, that of the manufacture of dyes from coal-tar derivatives.

Forty-three years ago the production of a violet-blue colour by the addition of chloride of lime to oil obtained from coal-tar was first noticed, and this having afterwards been ascertained to be due to the existence of the organic base known as aniline, the production of the coloration was for many years used as a very delicate test for that substance. The violet colour in question, which was soon afterwards also produced by other oxidising agents, appeared, however, to be quite fugitive, and the possibility of fixing and obtaining in a state of purity the aniline product which gave rise to it, appears not to have occurred to

1 In the 10th section of his "Hydrodynamics."
2 "De rerum Naturâ," lib. ii. 111—140.

chemists until Mr. Perkin successfully grappled with the subject in 1856, and produced the beautiful colouring matter known as aniline violet, or mauve, the production of which, on a large scale, by Mr. Perkin, laid the foundation of the coal-tar colour industry.

His more recent researches on anthracene derivatives, especially on artificial alizarine, the colouring matter identical with that obtained from madder, rank among the most important work, and some of them have greatly contributed to the successful manufacture of alizarine in this country, whereby we have been rendered independent of the importation of madder.

Among the very numerous researches of purely scientific interest which Mr. Perkin has published, a series on the hydrides of salicyl and their derivatives, may be specially referred to; but among the most prominent of his admirable investigations are those resulting in the synthesis of coumarin, the odoriferous principle of the tonquin bean and the sweet scented woodruff, and of its homologues.

The artificial production of glycocol and of tartaric acid by Mr. Perkin conjointly with Mr. Duppa, afford other admirable examples of synthetical research, which excited very great interest among chemists at the time of their publication.

It is seldom that an investigator of organic chemistry has extended his researches over so wide a range as is the case with Mr. Perkin, and his work has always commanded the admiration of chemists for its accuracy and completeness, and for the originality of its conception.

A Royal Medal has been awarded to A. C. Ramsay, F.R.S. Prof. Ramsay has been for a period of nearly forty years connected with the Geological Survey of Great Britain, and during by far the greater part of that time either as Director or Director-General of the Survey. During this long period, in addition to his official labours in advancing our knowledge of the geology of this country, he has published works on the "Geology of Arran," "The Geology of North Wales," "The Old Glaciers of North Wales and Switzerland," and "The Physical Geology and Geography of Great Britain," now in its fifth edition. His papers in the *Quarterly Journal* of the Geological Society, and elsewhere, are numerous and important, especially those on theoretical questions in physical geology, such for instance, as "The Glacial Origin of Lake Basins," "The Freshwater Formation of the Older Red Rocks," and "The History of the Valley of the Rhine, and other Valleys of Erosion." There are, indeed, among living geologists few who can claim to have done more to extend our knowledge in the important fields of geology and physical geography.

The Davy Medal has been awarded to P. E. Lecoq de Boisbaudran. The discovery of the metal gallium is remarkable for having filled a gap which had been previously pointed out in the series of known elements. Mendelejeff had already shown that a metal might probably exist, intermediate in its properties between aluminium and indium, before Boisbaudran's laborious spectroscopic and chemical investigation of numerous varieties of blende led him to the discovery and isolation of such a metal.

The separation of the minute traces of gallium compounds from blende is an operation presenting unusual difficulty, owing to the circumstance that compounds of gallium are carried down by various precipitates from solutions which are incapable by themselves of depositing those compounds.

EXPERIMENTAL DETERMINATION OF THE VELOCITY OF LIGHT[1]

II.

FIG. 7 represents a plan of the lower floor of the building. E is a three horse power Lovegrove engine and boiler, resting on a stone foundation; B, a small Roots' blower; G, an automatic regulator. From this the air goes to a delivery pipe up through the floor to the turbine. The engine made about four turns per second, and the blower about fifteen. At this speed the pressure of the air was about half a pound per square inch.

The regulator, Fig. 8, consists of a strong bellows, supporting a weight of 370 pounds, partly counterpoised by 80 pounds, in order to keep the bellows from sagging. When the pressure of the air from the blower exceeds the weight, the bellows commences to rise, and in so doing closes the valve, V.

This arrangement was found in practice to be insufficient, and the following addition was made: a valve was placed at P, and the pipe was tapped a little farther on, and a rubber tube led to a water gauge, Fig. 9. The column of water in the smaller tube is depressed, and when it reaches the horizontal part of the tube, the slightest variation of pressure sends the column from one end to the other. This is checked by an assistant at the valve, so that the column of water is kept at nearly the same point, and the pressure thus rendered very nearly constant. The result was satisfactory, though not in the degree anticipated. It was possible to keep the mirror at a constant speed for three or four seconds at a time, and this was sufficient for an observation. Still it would have been more convenient to have kept it so for a longer time. The test of uniformity was, however, very sensitive, as a change of speed of 0·02 of a revolution per second could be detected.

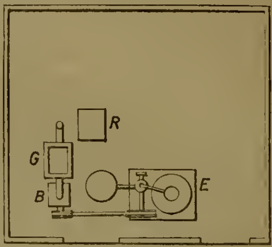


FIG. 7.

It was found that the only time during the day when the atmosphere was sufficiently quiet to get a distinct image was during the hour after sunrise or during the hour before sunset. At other times the image was "boiling," so as not to be recognisable. In one experiment the electric light was used at night, but the image was no more distinct than at sunset, and the light was unsteady.

The method followed in experiment was as follows:—The fire was started half an hour before, and by the time everything was ready the gauge would show 40 or 50 lbs. of steam. The mirror was adjusted by signals as before described. The heliostat was placed and adjusted. The revolving mirror was adjusted by being moved about till the light returned to it from the distant mirror. The axis of the revolving mirror was also inclined to

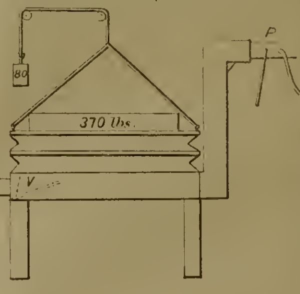


FIG. 8.

FIG. 9.

the right or the left, so that the direct reflection of light from the slit fell above or below the eyepiece, as otherwise this light would overpower that from the reflection from the distant mirror, &c., which forms the image to be observed. This inclination of the axis of rotation introduces a small error, which is duly allowed for in the calculations.

The distance between the front face of the mirror and the cross hair of the eyepiece was then measured, by stretching from one to the other a steel tape, making the drop of the catenary about an inch—when the error on account of the curve, and that due to the stretching of the tape, just counterbalanced each other.

The position of the slit, if not determined before, was then

[1] By Albert A. Michelson, Master, U.S. Navy. Read before the American Association. Continued from p. 56.

found as before described. The electric fork was then started, the temperature noted, and the beats between it and the standard fork counted for 60 seconds. This was repeated two or three times before every set of observations.

The eyepiece of the micrometer was then set approximately, and the revolving mirror started. If the image did not appear, the mirror was inclined forward or backward till it came in sight.

The cord connected with the valve was pulled right or left, till the images of the revolving mirror, represented by the two round spots to the left of the cross hair, came to rest. Then the screw was turned till the cross hair bisected the deflected image of the slit. This was repeated till ten observations were taken, when the mirror was stopped, temperature noted, and beats counted. This was called a set of observations. Usually five such sets were taken morning and evening.

The steel tape used was one of Chesterman's, 100 feet long. It was carefully compared with the copy of the standard yard made by Wurdemann, by a comparator. The result showed that the error of the tape was 0·006 foot. The true length was 100·006 feet.

The micrometer was also compared with the standard yard and the standard meter, the first giving for the value of one scale division,

division,	0·99650 mm.
and the second,	0·99642 ,,
Mean	0·99646 mm.

One turn of the screw was found equal to 1·0009 divisions. Hence the value of one turn was 0·99655 millimeter.

The distance between the pier for the revolving mirror and the stationary mirror was measured by means of the steel tape. Square lead weights were placed along the line, and measurements taken from one to the other, the tape resting on the ground and stretched by a force of 10 pounds. The measurements, five in all, were all made at about 62° F. The results are:—

	1985·13
	1985·17
	1984·93
	1985·09
	1985·09
Mean	1985·082

Correction for stretch of tape	0·33
,, ,, length ,, ...	0·12
Distance from pier to revolving mirror ...	0·70
Total correction	1·15
	1985·08
True distance	1986·23

The rate of vibration of the standard fork armed with a tip of copper foil was found by allowing it to trace its record on the lampblacked cylinder of a Schultz's chronoscope. The time was given either by a sidereal break-circuit chronometer or by a mean time clock. In the former case the break circuit worked a relay which interrupted the current from three Grove cells. In the latter, the circuit was broken by the pendulum. The spark from the secondary coil of a Ruhmkorff was delivered from a wire near the tip of the fork. The rate of the chronometer, the record of which was kept at the Observatory, was very regular. It was found, from observations of transits of stars during the week, to be + 1·3 seconds per day, which is the same as the recorded rate.

The correction for temperature was found by Prof. Mayer to be + 0·012 v.s. for a diminution of 1° F.

My own result was + 0·0125 v.s.

Adopted + 0·012.

The following is the table of results:—

	256·069
	256·089
	256·077
	256·012
	256·087
	256·074
	256·061
	256·100
	256·084
	256·066
Mean	256·072

In one of these observations I counted the beats between this fork and another, first while the former was tracing its record, and then when it was free and in position as for use. The difference, if any, was less than 0·01 v.s.

As the result obtained depends directly on the rate of vibration of the fork, I was not willing to trust entirely to my own work, and asked Prof. Mayer to make a determination.

He kindly offered to make it together with myself. Accordingly, I went to the Hoboken Institute, and a series of ten determinations were made under the following conditions:—

The fork was wedged into a wooden support, and the tip allowed to rest on lampblacked paper wound about a metal cylinder, which was turned by hand. Break-circuit clock was used, the rate of which was ascertained by comparison with the Western Union time-ball. The spark from the Ruhmkorff passed from the tip of metal attached to the fork, piercing the paper. Size of the spark was regulated by resistances.

Table of results was as follows:—

	256·072
	256·126
	256·091
	256·108
	256·068
	256·090
	256·112
	256·124
	256·080
	256·070
Mean	256·094

The effect of scrape was sought for again, and found to be 0·003 v.s.

The effect of the support, however, was greater, both combined being − 0·026 v.s.

Making this correction, the result becomes:—

	256·068
Former result ...	256·072
Mean	256·070 vibrations per second, at 65° F.

The formulæ employed in the calculations are:—

$$(1) \quad \dots \quad \dots \quad \dots \tan\phi = \frac{d_1}{r}$$

$$(2) \quad \dots \quad \dots \quad \dots \quad V = \frac{2592000'' \times D \times n}{\phi''}.$$

Where ϕ = angle of deflection.
d_1 = displacement, or $r.\tan\phi$.
r = radius of measurement.
D = twice the distance between mirrors.
n = number of revolutions per second.
α = inclination of plane of rotation.
V = velocity.

D and r are expressed in feet, and d_1 in millimetres.

Substituting for d_1 its value,

$$d \times 0{\cdot}99655 \times \sec\alpha,$$

where d_1 is the displacement in turns of screw, and $\log \sec\alpha = 0{\cdot}00008$, we have, reducing to kilometres:—

$$(3) \quad \dots \quad \dots \quad \tan\phi = c_1 \frac{d}{r} \qquad \log c_1 = 0{\cdot}51457$$

$$(4) \quad \dots \quad \dots \quad \dots \quad V = c\,\frac{n}{\phi} \qquad \log c = 0{\cdot}49670$$

In the calculations the effect of temperature on the screw, scale, and tape used in finding ρ was neglected. It can be applied to the final result for the mean temperature, which was 75·6° F.

Correction for tan ϕ is − 0·000003 × 13·1 = − 0·0004.

Correction for V is + 12 kilometres.

The direction of rotation was right-handed. To eliminate any possible error on this account, the mirror in eight of the later observations was inverted, thus making the rotation left-handed, and the deflection measured to the left. The results were the same as before, within the limits of error.

To eliminate errors due to a regular variation in speed during every revolution, if any such could exist, the position of the frame was changed in several experiments. The results were the same as before.

To test the question as to whether the vortex of air about the mirror had any effect on the deflection, the speed was lowered to 192, 128, 96, and 64 turns per second. If the vortex had any effect, it should have decreased with the lower speed, but no such effect could be detected.

Finally, to test if there were any bias in making the observations, the readings in several sets were taken by another, and the results written down without divulging them. The separate readings, as will be shown in the following specimen, were as consistent as when made by myself, and the final results agree with those of other observations:—

Specimen of Observations

June 17, Sunset. Image good (best in column 4).

	(1)	(2)	(3)	(4)	(5)
	112·81	112·80	112·83	112·74	112·79
	112·81	112·81	112·81	112·76	112·78
	112·79	112·78	112·78	112·74	112·74
	112·80	112·75	112·74	112·76	112·74
	112·79	112·77	112·74	112·76	112·77
	112·82	112·79	112·72	112·78	112·81
	112·76	112·73	112·76	112·78	112·77
	112·83	112·78	112·81	112·79	112·75
	112·78	112·79	112·74	112·83	112·82
	112·82	112·73	112·76	112·78	112·82
Means =	112·801	112·773	192·769	112·772	112·779
Zero =	0·260	0·260	0·260	0·260	0·260
d =	112·541	112·513	112·509	112·512	112·519

Temp. = 77°, B = + 1·500, cor. = − 0·144, diff. = + 1·356, added to 256·070 = 257·426 = n
28·155 = r

Results from the above.

299,660	299,740	299,740	299,740	299,720

Data for Working out Observations

Ut_3 fork makes 256·070 vibr. per sec. at 65° F.

D = 3,972·46 feet.

tan α = tangent of inclination of plane of rotation = 0·02.

c_1 = log = 0·51457.

c = log = 0·49670.

d = deflection as read from micrometer.

r = radius.

ϕ = angle of deflection.

n = number of revolutions per second.

V = velocity of light in kilometres.

B = number of beats per second between electric Ut_3 fork and standard Ut_3 fork. Electric fork makes $\frac{1}{2}$(256·07 + B + cor.) vibr. per second, and n is a multiple submultiple or simple ratio of this.

Cor. = correction for temperature of standard,
= − 0·012 v.s. per degree F.

Mean result[1]	299,728
Cor. for temp.	+12
Vel. of light in air	299,740
Cor. for vacuum	+88

Vel. of light *in vacuo* = 299,828 kilometres per second.

SCIENTIFIC SERIALS

American Journal of Science and Arts, November.—Mr. Stockwell, who has been systematically examining the physical theory of the moon's motion, here calls attention to a secular inequality in that motion, produced by the oblateness of the earth. For attracted points out of the plane of the equator, and not beyond the parallels of 35° 16′ (which is the moon's case), the attraction of the earth is less than it would be if the latter were spherical. The author says he has found several inequalities in the moon's motion, not recognised by existing theories, and of even greater practical importance than the foregoing.—The diamagnetic constants of bismuth and calc-spar in absolute measure have been determined by Prof. Rowland and Mr. Jacques. In their paper the former develops mathematical expressions for the various coefficients of magnetisation, while the latter describes the experimental method adopted: first, exploration of the field, and then noting the time of swing of little suspended bars of the substances in it. The constants for bismuth are

$$\left\{\begin{array}{l} k_1 = -\ ·000000012554 \\ k_2 = -\ ·000000014324 \end{array}\right\};$$

for calc-spar,

$$\left\{\begin{array}{l} k_1 = -\ ·000000037930 \\ k_2 = -\ ·000000040330 \end{array}\right\}.$$

—Mr. Gibbs's elaborate paper on vapour-densities is here concluded. The relation between temperature, pressure, and volume for the vapours of peroxide of nitrogen, formic acid, acetic acid, and perchloride of phosphorus, differs widely from that expressed by the usual laws, and the hypothesis of a compound nature of the vapour is probable. Mr. Gibbs had proposed equations to express the relations between temperature, pressure, or volume, and quantities of the components in such a "gas mixture of convertible components." In his paper he reviews all known experimental determinations of the vapour densities, and finds fair agreement with formula.—We note also accounts of Mr. Michelson's recent experimental determination of the velocity of light; of the remarkable Kane Geyser well (arising from a conflict between gas and water in a petroleum region), and of Mr. Edison's resonant tuning-fork.—Besides Prof. Marsh's recent address, there are further notes by him of new Jurassic mammals from the Rocky Mountains, showing a resemblance to known types of the Purbeck in England.

The American Naturalist, vol. xiii. No. 11, November, contains:—B. B. Redding, How our ancestors in the Stone Age made their implements; Isaac C. Martindale, Colorado plants; C. G. Siewers, Mould as an insect destroyer; W. N. Lockington, Notes on Pacific Coast fishes and fisheries; William Trelease, On the fertilisation of our native species of Clitoria and Centrosema; Recent Literature; General Notes; Scientific News; Proceedings of Scientific Societies.

Annalen der Physik und Chemie, No. 10.—A useful paper by Herr Fromme, in this number, treats of the electromotive force of the Grove, Bunsen, and Daniell batteries, as related to concentration of the liquids. The force of a Grove, whenever this cell is traversed by a very weak current, decreases continuously with concentration of nitric acid and approximately in proportion. That of the Bunsen, under like conditions, is, for the higher concentrations, about equal to that of the Grove, but from a concentration C = 55 greater, because it remains constant, while the decrease in the Grove goes on. The force of the Grove increases with increased concentration of the sulphuric acid to a maximum between C = 25, and C = 35, and thereafter decreases at a more rapid rate.—Herr Kundt and Herr Röntgen have succeeded in proving electromagnetic rotation of the plane of polarisation in several of the less easily condensed gases; and quantitative results for air, hydrogen, oxygen, carbonic oxide, and marsh gas, are here given. The rotation is in direction of the positive current (as with water and sulphide of carbon), and its amount is approximately proportional to the density. It is estimated that 253 km. air in the north-south direction would give a rotation of 1°. The author's apparatus (including a means of compression to about 250 atm.) is described.—Prof. Lommel contributes two papers; in one of them, on Newton's dust rings, he seeks to show the adequacy of the diffraction-theory to explain the phenomena, as against the diffusion theory (interference of diffusely reflected light); in the other paper, on Stokes's law, he controverts M. Lamansky's experimental support of the general validity of this law, which he (Prof. Lommel) had before impugned, as inapplicable to a certain "critical region" in which the fluorescence and absorption-spectra overlap.—Herr Wüllner describes a five-band spectrum of oxygen obtained both from the positive and the negative light in spectral tubes, to which was admitted oxygen produced by electrolysis. When the charge of gas was allowed to stand a quarter to half an hour, the spectrum was changed into that of carbon.—Herr Narr endeavours further to show that the loss of electricity by an insulated body in a gas cannot alone be explained by rise of temperature of the gas, or conduction through the insulating supports, or the presence of particles of foreign substances, as dust, water, or mercury vapour. Nor is there, apparently, a special conductivity of the gas in the ordinary sense.—The changes of density produced in steel by hardening and annealing, are indicated by Herr Fromme.—Herr Riecke has a mathematical paper on the doctrine of the poles of a bar-magnet; and Herr Gerland shows historical reason for believing that the caloric engine was conceived by Leibnitz in 1706, and that Papin is alone the inventor of the centrifugal pump.

[1] In the original a table of observations appears which we are obliged to omit for want of space, while we give the result of the same.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 27.—"A Memoir on the Single and Double Theta-Functions," by A. Cayley, F.R.S., Sadlerian Professor of Pure Mathematics in the University of Cambridge.

Chemical Society, November 20.—Dr. Gilbert in the chair.—The Chairman announced that a ballot for the election of Fellows would take place at the next meeting, December 4.—The following papers were read:—A chemical study of vegetable albinism, Part II. Respiration and transpiration of albino foliage, by Mr. Church. White foliage does not possess the power even in sunshine of decomposing the carbonic acid in the air. Experiments were made with leaves of the maple, holly, ivy, and Alocasia; 1,000 sq. ctm. of the leaves of the Alocasia evolved in two hours, 15·06 and 38·96 parts of carbonic acid per 10,000; 1,000 sq. ctm. of green leaves 1·14 parts. White holly sprays placed in water, gained in two hours five times as much in weight as green leaves, but when no water was supplied, the green lost about twenty times as much as the white.—Contributions to the history of putrefaction, Part I., by Mr. C. T. Kingzett. The author has examined dilute solutions of albumen, beef, and fish as to their oxygen-absorbing power in different stages of putrefaction, by titrating with permanganate. He finds that such substances require less oxygen as the putrefactive process proceeds; he also discusses the bearing of his results on the permanganate method of estimating the organic matter in potable waters.—Notes on manganese dioxide, by C. R. A. Wright and A. E. Menke. The authors have made an exhaustive study of the various methods for preparing manganese dioxide; in most cases the product contains potash and is deficient in oxygen; the methods which yielded the purest manganese dioxide were, heating manganese nitrate to 160° C., mixing a hot solution of a manganese salt with an excess of permanganate, or in the cold with the addition of zinc sulphate or ferric chloride. The volumetric processes of Kessler and Pattinson gave good results; the authors suggest some convenient modifications of these methods; they have verified the statements of Gorgeu, Guyard, and Pickering, but have disproved those of Morawski and Stingl.—On the reaction between sodium thiosulphate and iodine; estimation of manganese oxides and potassium dichromate, by S. Pickering. The author has carefully worked out the influence of dilution, excess of potassium iodide, heat, and other conditions, on the results obtained by Bunsen's volumetric method of estimating manganese oxide. He suggests a simplified method of procedure and compares results obtained by the two processes.

Linnean Society, November 28.—Prof. Allman, president, in the chair.—Messrs. Winslow, Jones, and Wm. Wickham were elected Fellows.—Sir J. D. Hooker exhibited a specimen and read a paper on the discovery of a variety of the cedar of Lebanon on the mountains of Cyprus (see *Science Notes*).—The president also laid on the table examples of a cone-bearing *Cedrus deodora*, grown by Mrs. C. St. Clair at Parkstone, Dorset.—Mr. E. M. Holmes exhibited and made remarks on a series of rare British lichens, Hepaticæ, and freshwater algæ. He noted that the so-called *Echinella articulata* which now chokes the filter beds of the reservoir at Bradgate, Leicester, was in reality an undescribed form, but bearing resemblances to Zooglœa.' Mr. Holmes likewise exhibited, and for the first time in England, the leaves, flowers and portion of the trunk of the tree (*Andira araroba*) yielding the so-called Goa powder. This vegetable secretion appears to destroy and replace the woody tissue of the heart-wood. The source of the powder was long enveloped in mystery, but from its containing chrysophanic acid it was believed to be the product of a fungus. Recently it has been found that the cane grows in Bahia, is sent to Lisbon, thence exported to the Portuguese colonies in the East where it is used as a specific for ringworm.—Mr. T. Christy showed two aboriginal Australian skulls with occipital thickening (forwarded by Dr. Bancroft), and supposed to have been induced by the blows of knobkerries.—Mr. Marshall Ward read a contribution to our knowledge of the embryo sac of phanerograms. In this paper, stages in the development of the ovule in *Butomus umbellatus*, *Alisma plantago*, *Anemone japonica* and other forms have been carefully observed and delineated from microscopic section. The views of Strasburger, Vesque and Warming are severally compared and reviewed, the author holding intermediate opinions. Mr. Ward advances the following:—The ovule so far as its nucleus is concerned arises as a group of cells which divide and become arranged in groups of sister cells symmetrically related to the shape of the whole organ. One cell group leads in growth and fulfilling a special purpose, becomes the embryo sac. Further feeble division of this latter produces a watery cell with two nuclei. Each nucleus again produces four nuclei by bipartite division followed by grouping, and a nucleus from the top group moves towards the middle sap cavity. Each group of four cells is a prothallus, and the cell producing this a macrospore. The two most successful macrospores behave similarly to those of some vascular cryptograms, and finally germinate, producing a ruddy prothallus of four naked nuclei. The egg-cell is an oösphere, all that is left of the lower part of the rudimentary archegonium, its upper part probably being represented by the two "synergidæ" which are to be looked upon as having acquired a secondary function from being merely protective and guiding neck-cells of an archegonium.—Mr. Alfred Haddon read a paper on the extinct land tortoises of Mauritius and Rodriguez. Examination of a large store of material obtained by Mr. Edward Newton, corroborates the two Mauritian species *Testudo triserrata* and *T. inepta* described by Dr. Günther; but it adds no fresh example to that apparently unsatisfactory species *T. leptocnemis*. Of remains from the Island of Rodriguez the species *T. Vosmæri* can alone be distinguished. The free coracoid of *T. inepta* is now for the first time recorded, while that of *T. Vosmæri* is wonderfully irregular in character. Great variation in the ankylosis of the coracoid with the shoulder girdle pertains in this extensive series in the Cambridge Museum.—The secretary read in abstract a communication by Mr. Edward J. Miers, viz.: On a small collection of crustacea made by Mr. Edward Whymper, chiefly in the N. Greenland Seas, with an appendix on additional species collected by the late British Arctic Expedition.

Entomological Society, November 5.—H. W. Bates, F.L.S., F.Z.S., vice-president, in the chair.—Mr. T. R. Billups, of Peckham, was elected an Ordinary Member of the Society.—Mr. W. C. Boyd exhibited a remarkable variety of *Aspilates citraria*, a specimen of *Cidaria testata* in which the hind wings were apparently absent, and a Noctua resembling *Hadena dentina*, but differing from that species in the form of the body. Mr. McLachlan read some remarks he had received from Prof. Forel relative to the sculptured stones on the shores of Lake Leman. Three principal types of markings were described, the first of which was ascribed to the agency of *Tinodes*.—Prof. Westwood exhibited a series of drawings illustrating the economy and transformations of several species of trichopterous and other neuropterous insects, also drawings of some undescribed species of exotic heteropterous-hemiptera contained in the Hopeian collection; he likewise drew attention to a modification of the professorship which had been proposed by the Oxford Commissioners, whereby the science of entomology would probably be neglected, and which would to a certain extent render nugatory the intentions of the founder of the professorship and donor of the collections. Prof. Westwood also referred to the affinity of the genus *Polyctenes*.—Mr. J. Jenner Weir exhibited some ants, apparently a species of *Atta*, which he had found in large quantities at Pisa, and which were peculiar in having collected around their nests, large quantities of small empty shells of *Helix caputata* and *H. virgata*; Mr. Weir also exhibited a specimen of an *Orgyia*, stated on the authority of Mr. Gates to have emerged from the larval skin, without passing through the pupal state.—Mr. W. L. Distant communicated a note relative to some Indian hemiptera which he had received from India through Mr. F. Moore for examination, with the names of the plants on which they were found.—The Secretary read a note and exhibited a photograph which he had received from Dr. Fritz Müller.—The following papers were also communicated:—"List of the Hemiptera collected on the Amazons by Prof. Trail," Pt. 1, by Dr. F. Buchanan White.—"Descriptions of new Genera and Species of Tenebrionidæ from Madagascar," by Mr. F. Bates;—and "Descriptions of new Coleoptera from East Africa and Madagascar," by Mr. C. O. Waterhouse.—Mr. Butler communicated a paper on the natural affinities of the lepidoptera hitherto referred to the genus *Acronycta* of authors.—From an examination, chiefly of the larval characters, the author proposed to distribute the British species of the genus among the Arctiidæ, Liparidæ, Notodontidæ, and Noctuites.

Meteorological Society, November 19.—Mr. C. Greaves, F.G.S., president, in the chair.—The following gentlemen were elected Fellows:—Capt. C. K. Brooke, Rev. E. Carr, M.A., Capt. R. A. Edwin, R.N., W. B. Fawcett, C. J. Harland, J. Lucas, F.G.S., H. Mellish, G. B. Nichols, the Earl of Northesk, Dr. J. Robb, T. H. Walker, and C. L. Wragge, F.R.G.S.—The reports on the phenological observations for 1879 were read, the Botanical being by the Rev. T. A. Preston, M.A., F.M.S., the Entomological by the Rev. C. H. Griffith, B.D., F.M.S., and the Ornithological by J. Cordeaux. With the exception of a few days in the earlier parts of February and of March, the whole of the year 1879 has been characterised by a temperature almost invariably below the mean, accompanied with much wet and little or no sun; the effect on vegetation has been consequently very great. Foliage has, as a rule, been excessively luxuriant and dark, "forming the most remarkable feature of the year;" but rarely has fruit been able to ripen, and the second shoots have frequently been weak and unhealthy. Flowering has invariably been very late, as much as a month in some districts, the hay harvest often not completed till nearly the end of August, some still in "cock" in the Moorland district of Staffordshire, as late as September 30; and the corn harvest not only extremely late, but the corn in very poor condition, not properly ripened. With regard to insects the two most notable occurrences of this most dismal season have been the swarms of *Pyrameis cardui* and *Plusia gamma*; both these species have been wonderfully numerous, especially the latter, which has absolutely swarmed. The great severity of the past winter caused an almost unprecedented mortality amongst birds, great numbers of various species succumbing to the cold. This mortality was perhaps most apparent amongst the Turdidæ and the starlings. Spring brought little or no improvement, birds nested much beyond their average time, and in a vast number of instances the first eggs have been addled and destroyed by cold rains and an abnormally low and continuous temperature. The scarcity of young partridges is probably unprecedented, on some manors not a young bird is to be found, and it will take several good nesting seasons to bring up the stock of their old numbers.—A paper on the meteorology of Zanzibar, by Dr. John Robb, was also read. The average annual rainfall is rather more than 61 inches, or only about double the average yearly fall in England; and the average number of rainy days is 120. The greater rains fall in March, April, and May, the lesser rains are from mid-October to the end of the year. The driest month is September, with an average rainfall of 1·86 inch; no month is rainless. The mean temperature of five years is 80°·6, and the average yearly range, from highest maximum to lowest minimum, is 17°·3. The hottest months of the year are February and March, with a mean temperature of 83°·1 and 83°·4 respectively; the cool months are July and August, averaging 77°·5 and 77°·7. This gives a small amplitude of the yearly fluctuation, rather less than 6°, and to this limited range of temperature is largely due the debilitating nature of the climate of Zanzibar, particularly as affecting the nervous system. The heat is constant and moist, and even gentle exercise is usually attended with excessive perspiration.

PARIS

Academy of Sciences, November 24.—M. Daubrée in the chair.—The following papers were read:—On the heat of formation of ammonia, by M. Berthelot. He was led to doubt previous data. The action of chlorine on ammonia cannot rightly be used (as it has been) for the purpose, nor that of hypobromites, though preferable. M. Berthelot resorted to direct combustion of ammoniac gas by means of free oxygen. He arrives at + 21·0 and + 12·2 cal. for the heat of formation of dissolved and gaseous ammonia respectively. Between + 12·2 and + 26·7 (the number previously adopted) there is + 14·5 difference (the largest experimental error hitherto made in thermochemistry).—On crystallised chlorophyll, by M. Trécul. A claim of priority; he described crystals of chlorophyll in 1865.—Geodetic junction of Algeria with Spain; international operation executed under the direction of Gen. Ibañez and M. Perrier, by M. Perrier. Science has now a meridian arc of 27°, the largest that has been measured on the earth and projected astronomically on the sky. M. Perrier gives interesting details of the work, which included transport of steam-engines and Gramme machines, &c., to four mountain tops, Mulahacen and Tetica in Spain, Filhaoussen and M'Sabiha between Oran and the frontier of Morocco. Military guards were required, and the parties watched for signals from August 20 till September 9, without success. The observations, commenced on the latter date, terminated October 19.—Experimental researches on a new property of the nervous system, by M. Brown-Sequard. Certain parts of the nervous system, when under irritation, cause suddenly, or nearly so, a notable increase of the motor or sensitive properties of other parts of the system. Thus transverse section of a lateral half of the base of the brain increases the motor properties of the parts of this centre before the section, while the opposite is produced on the opposite side; the same with section of the sciatic nerve, or a lateral half of the dorsal or lumbar cord.—Researches on nitrification, by MM. Schlœsing and Muntz. They appear to have isolated the organism which effects the oxidation of nitrogen, *the nitric ferment*. The corpuscles are abundant, very small, and slightly elongated. The ferment is killed infallibly by a temperature of 100°, and 90° seems to stop its action. Deprivation of oxygen and desiccation are unfavourable to it. In media rich in organic matters, mucor is its chief enemy. It is not found normally in air; mould is its most favourable medium.—Observations on the egg-laying of winged phylloxeras in Languedoc, by M. Mayet.—On quadratic forms, by M. Poincaré.—Determination of curves and surfaces satisfying the conditions of double contact, by M. Zeuthen.—Specific heat of solutions of hydrochloric acid, by M. Hammerl. He tabulates his results, and modifies M. Marignac's formula so as to make it applicable to concentrated solutions.—On a new mode of separation of nickel, and of cobalt, by M. Dirvell. This consists in mixing with a solution containing cobalt and nickel, a (cold) saturated solution of salt of phosphorus, mixed with a solution of bicarbonate of ammonia, no longer giving any ammoniacal odour.—Constitution of dibromised ethylene, by M. Demole.—New method of analysing with precision the potashes of commerce, by MM. Corenwinder and Contamine. This method (very rapid and exact) relieves the operator of the necessity of first separating the sulphuric acid, phosphoric acid, and silica, which form with soda insoluble combinations in alcohol.—On the alterations of the epidermis, in affections of the skin, or of mucous membranes, which tend to the formation of vesicles, pustules, or pseudo-membranous productions, by M. Leloir.—Observations on the salivary glands of the Echidna, by M. Viallanes. The parotid glands, so constant in mammalia, have in this case escaped the attention of Cuvier and Owen, and the latter denies their existence in Echidna; but the author found them well developed. Instead of being in front of the auditory canal they are far behind it, at the level of the middle of the neck. On either side there are two sub-maxillary glands, one deep, the other superficial, and the latter seems also to have escaped attention.—M. Chasles presented, from Prince Boncompagni, a portion of "Researches on the Manuscripts of Pierre le Fermat followed by unpublished Fragments of Bachet, and of Malebranche."—M. Larrey presented a Portuguese work by M. Ennes, "The Medical Life of Nations."

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THURSDAY, DECEMBER 11, 1879

CAMBRIDGE UNIVERSITY

THE draft of the proposed Statutes just issued by the Commissioners, will, if we mistake not, mark an era in the history of one, at all events, of our Universities. It indicates a large and wise view on the part of the Commissioners, and though it will scarcely place Cambridge on a level, so far as teaching power goes, with a second-rate German University, it will go far to remedy the present state of things, and on it a superstructure may in time be laid in true harmony with the wants of the time.

What the Commissioners have really had to do is to convert an assemblage of "Hauts Lycées" into a living University, and, of course, this had to be done, if it were done at all, at the expense of the Colleges. This has long been foreseen, and the way in which it has been approached leaves nothing to be desired, so far as the manner goes; if a minimum only had not been fixed many might have said that the proposal hardly went far enough. The Commissioners evidently have faith. It will be best to give in the first instance an analysis in the words of the Statutes as far as possible.

In order to obtain contributions from Colleges for university purposes, it is ruled that the Colleges shall pay to the University in every year, out of their revenues, a sum determined according to the following quota, viz.:—

For every 1,000*l.* levied,—

Peterhouse	23
Clare	47
Pembroke	47
Gonville and Caius	62
Trinity Hall	33
Corpus Christi	43
King's	126
Queens'	19
St. Catharine's	19
Jesus	57
Christ's	57
St. John's	169
Magdalene	7
Trinity	229
Emmanuel	33
Sidney Sussex	25
Downing	4

This quota, which must have cost somebody a vast amount of trouble, enables any one to judge of the effect of the scheme on any College. Thus, assuming that Peterhouse pays its non-Resident Fellows 230*l.* a year, the sacrifice of two of these will alone be required to enable that College to do its share towards providing 20,000*l.* annually for University purposes.

We mention this because we are sure to hear of the Colleges being crippled, and it is clear that only wooden legs are threatened.

The quota is subject to revision at any time not less than five years after the approval of the Statute by the Queen in Council, and again after intervals of not less than ten years from that or any subsequent revision, the revision at such times being made, on the requisition of any one or more Colleges, by the Chancellor of the University with assistants.

The sum to be contributed by the Colleges in any year from January 1 next after the approval of the Statute by

the Queen in Council to the end of the year 1882 is not to be less than 8,000*l.* nor more than 10,000*l.*; in each of the years 1883, 1884, 1885, and 1886 not less than 12,000*l.* nor more than 15,000*l.*; in each of the years 1887, 1888, 1889, and 1890, not less than 16,000*l.* nor more than 20,000*l.*; in each of the years 1891, 1892, 1893, and 1894, not less than 20,000*l.* nor more than 25,000*l.*; and in every subsequent year not less than 25,000*l.*

The Colleges will not be required to contribute in any year a greater sum than 25,000*l.* without the consent of a majority of votes at a meeting of Representatives of the Colleges called for the purpose of considering the question.

This money contribution, however, is not the only one. Taking advantage of a system which has, it may be said, been suggested by the best of the Colleges themselves, it is ruled that there shall be in every College one or more Fellowships assigned to Professorships, such Fellowships to be called Professorial Fellowships.

The Professor admitted into any Professorship to which a Fellowship is thus assigned shall thereby *ipso facto* vacate any Fellowship he may hold at any College; and he shall have the same privileges, dividend, and emoluments as any other Fellow of the College to which the Professorship is attached. A Professor admitted into any Professorship to which a Fellowship is assigned by this Statute shall *ipso facto* vacate any Mastership he may hold at a College other than that to which the Professorial Fellowship attached to the Professorship is assigned; and if the Professor be admitted to the Mastership of any College other than that to which the Professorship is attached, he shall vacate his Professorship.

If upon the vacancy of any Professorial Fellowship the College declines to elect as Fellow the Professor to whose office the Fellowship is assigned, the Fellowship will remain vacant, its dividend being paid to the University.

A Professor retiring from office after holding it for not less than twenty years, shall be deemed thereafter an Honorary Fellow of the College, enjoying such privileges and advantages as the College may from time to time determine.

The first vacancy in the Fellowships of a College after the election of a Professor to whose office a Fellowship at that College is assigned, is to be appropriated to the Professorship.

The next section of the new Statutes deals with the Financial Board of the rehabilitated University. We need not refer to this here, except to say that the scheme seems wisely drawn and that the Colleges are to be well represented on it.

We next come to the Boards of Studies.

Eleven such Boards are to be constituted for all important departments of study recognised in the University, and are to consist of the Professors hereinafter assigned to such boards severally, together with such Readers, University Lecturers, Examiners, and other persons as may be chosen from time to time by the Senate.

The Boards to be first appointed are for—

Divinity.	Medicine.
Law.	Classics.
Language.	History.
Mathematics.	Moral Science.
Physics and Chemistry.	Music.
Natural Science.	

But with great wisdom, and here it is to be added that the Commissioners have introduced as much elasticity as possible, the University is to have power to vary the number and designation of these Special Boards from time to time on the recommendation of the General Board of Studies, provided that the whole number of such Boards shall never be less than eight.

The Professors assigned to the said eleven Boards are as follows:—

Divinity	Regius. Lady Margaret's. Hulsean. Norrisian. Ely.
Law	Regius. Downing. Whewell.
Medicine	Regius. Downing. Anatomy. Pathology.
Classics	Regius of Greek. Latin.
Language	Regius of Hebrew. Arabic. Sanskrit. Anglo-Saxon.
Mathematics	Lucasian. Plumian. Lowndean. Sadlerian.
Physics and Chemistry	Jacksonian. Chemistry. Mechanism. Cavendish of Physics. Astronomy and Astronomical Physics.
Natural Science	Woodwardian. Botany. Mineralogy. Zoology and Comparative Anatomy. Physiology.
History	Modern History. Disney. Thirlwall. Dixie.
Moral Science	Knightbridge. Political Economy. Mental Philosophy and Logic.
Music	Music.

Power is again given to the University to vary the assignment of Professors to the several Special Boards on the recommendation of the General Board of Studies.

Each Special Board is to consult together from time to time on all matters relating to the studies and examinations of the University in its department, and in consultation with the Professors, Readers, and University Lecturers connected with its department, frame a scheme of lectures in every year; taking care to provide that the subjects of the said lectures be determined with regard to the general objects of every particular Professorship, so as to distribute the several branches of learning in the best manner.

These Special Boards are to be controlled by a General Board of Studies, consisting of the Vice-Chancellor, one member of every Special Board of Studies elected by that Board, and eight members of the Senate.

The duty of the General Board is to consult together on all matters relating to the studies and examinations of the University, including the maintenance and improvement of existing institutions, and the establishment and maintenance of new institutions.

Among the functions of the General Board are the superintendence of laboratory work and the subordination when necessary of the Readers and University Lecturers to the professors.

Those who know Cambridge at present will have seen in the foregoing lists some new Professorships. As a matter of fact six new Professorships are to be established in the University for the following subjects, viz.:—

Physiology.
Pathology.
Mental Philosophy and Logic.
Astronomical Physics.
History, Thirlwall.
Ecclesiastical History, Dixie.

The Professors in these subjects are to be appointed before the end of the year 1882.

Here again the Commissioners show a wise discretion in ruling that the University shall have power to establish from time to time Professorships for other departments of learning or science. The Professorships so established may either be limited to a definite term of years or to the tenure of office of one Professor only; and if not so limited, they may be suspended or discontinued on the occurrence of any vacancy.

The stipends of the Professors, it is suggested, should be raised from their present level to correspond with the following scheme:—

Professors.

	£		£
Regius of Law	600	Experimental Physics	750
Whewell	500	Mechanism	400
Regius of Medicine	400	Astronomical Physics	500
Anatomy	300	Woodwardian	500
Pathology	600	Botany	300
Greek	750	Mineralogy	300
Latin	750	Zoology and Comparative Anatomy	600
Arabic	500	Physiology	600
Sanskrit	500	Modern History	400
Anglo-Saxon	500	Thirlwall.	
Lucasian	750	Dixie.	
Plumian	750	Knightbridge	400
Lowndean	600	Political Economy	300
Sadlerian	600	Mental Philosophy and Logic	400
Jacksonian	600	Music	200
Chemistry	750		

It must not be forgotten that the above sums are exclusive of the dividend on the Fellowship which is held by each Professor; and, further, the University is given power to vary the stipends from time to time, *provided that no such variation shall affect the interest of a Professor without his consent, or diminish the aggregate amount of payment to the whole body of Professors.* That is to say, the scheme is perfectly elastic, only the Commissioners do not intend to have it improved into effeteness.

The actual increase to the Professoriate, it will have been seen, is small; the ultimate increase to the teaching power of the University is, however, great. This is accomplished by the appointment, in connection with the departments of study for which Special Boards of Studies are appointed, of a body of teachers called Readers.

The number of Readers to be appointed is twenty-nine, distributed as follows:—

Divinity	2
Law	3
Medicine	2
Classics	4
Language	4
Mathematics	6
Physics and Chemistry	4
Natural Science	2
History	1
Moral Science	2

Of these not less than fourteen are to be appointed before the end of the year 1882, and the rest before the end of the year 1886.

The University may vary the connection of the Readers with the several Special Boards of Studies, and increase their number, upon the recommendation of the General Board of Studies.

The stipend of a Reader is 400*l.* a year, subject to variation by grace of the Senate upon the recommendation of the General Board of Studies, but no such variation shall affect the interest of a Reader without his consent, *or diminish the aggregate amount of payments to the whole body of Readers.*

The University is to have power to give pensions to retiring Readers according to circumstances, as the Senate may think fit.

Another arrangement for increasing the teaching power in the University is the appointment of University lecturers.

The General Board of Studies acting in conjunction with any Special Board may choose as Lecturers in the department of study for which the Special Board is formed such College Lecturers as they may think fit, who are willing, with the concurrence of their respective Colleges, to throw open their lectures to all students of the University.

The Lecturers so chosen are to be called University Lecturers, and each of them shall receive from the University an annual stipend of 50*l.*

No one is to be appointed to this office who does not receive from his College an annual stipend of at least 200*l.* as Lecturer, irrespective of the income of a Fellowship or other College emolument; the office of University Lecturer becomes *ipso facto* vacant if the holder of it ceases to hold the office of College Lecturer or receives from such office a less stipend than 200*l.* a year.

The number of University Lecturers and their connection with the Special Boards of Studies shall be determined from time to time, provided that when fit persons can be found the whole number shall be not less than thirty [one-half to be appointed before the end of the year 1882, and the rest before the end of the year 1884].

There is only one other point of the Statutes which we need analyse on the present occasion; this refers to the duties of Professors and Readers.

It is laid down that it shall be the duty of every Professor and Reader *as well to devote himself to research and the advancement of knowledge in his department* as to give lectures in every year.

It is impossible to estimate the good these words will do to the cause of research in England, where so many of our Professors sink to the level of mere traders. They should, though perhaps less necessary at Cambridge than elsewhere, be put up in letters of gold on the Senate House.

It will be sufficiently clear from the foregoing that with the great increase of teaching power which the Statutes confer the University should rise phœnix-like from its ashes, and that the present condition of things will be entirely changed.

How Cambridge in the new order of things will stand as compared with other Universities, and the lines along which future work and reforms may run, are questions so interesting that we may return to them and others on a future occasion.

AURORÆ

Auroræ: their Characters and Spectra. By J. Rand Capron, F.R.A.S. (London: E. and F. N. Spon, 1879.)

IN Mr. Gore's delightful book on the "Art of Scientific Discovery," it is said that "during the prosecution of an original investigation, the area of question and discovery enlarges as we proceed, and the research in some cases develops into such complexity and magnitude, that solution of its questions appears for a time hopeless. Generally, however, when that discouraging point is attained, the subject begins to clear, and by persistent research is gradually reduced to order, and is found to conform to a few general laws or principles."

The first part of this paragraph is only too apt a description of the present stage of the inquiry into the causes and nature of the Polar aurora. The striking character of the phenomenon itself, its evident connection with electric and magnetic disturbances, its unaccountable spectrum, and the relations which various observers have believed they had detected with solar spots, and coronal rays, are powerful stimulants to scientific curiosity. But so far the most painstaking researches have failed to seize the connecting link which should unite these various aspects into one organic whole; and we can only hope that the concluding sentence which we have quoted may be a prophesy of ultimate success. Under such circumstances Mr. Capron has done good service to science by collecting in a compact form the whole information which we possess on the subject, for it is only by careful study of what is already known that we can decide on the point of attack which gives the best hope of further conquest.

The first four chapters of the book are taken up with descriptions of specific auroræ. Among these we are sorry to miss a fuller account of the careful and accurate observations made by Lieut. Weyprecht during the Austrian Arctic Expedition of 1872-4. His description of arctic auroræ, as quoted from Payer's "New Lands Within the Arctic Circle," is exceedingly graphic and picturesque, but the original paper[1] as read before the Imperial Austrian Academy of Science, with its accurate classification of auroral forms, seems to have escaped the author's notice, as it is not even named in the list of papers in the appendix.

In Chapter V. the question of sound produced by the northern lights is discussed with the result that the balance of evidence is against it. Upon the height o

[1] "Die Nordlichtbeobachtungen der österreichisch-ungarischen arctischen Expedition 1872-74," von Carl Weyprecht, vorgelegt 17 Mai, 1877.

auroræ the most diverse conclusions are quoted, trigonometrical measurements giving results varying from a few thousand feet up to 1,000 miles, while there are several well attested instances in which auroral rays have been seen actually between the observer and terrestrial objects. If these latter observations are correct it is evident that auroræ may be produced near the earth's surface, and consequently in air of considerable density. They are supported by the fact that the lower trigonometrical measurements are less liable to fallacy than the higher, since in the latter it may always be objected that observers at different stations might have seen different arches, or that the auroral arch in general is merely a perspective illusion produced by the termination of vast numbers of parallel rays at the same height. Additional observations of auroræ seen between the observer and mountain-tops or other elevated objects would be of great scientific interest.

Another very important line of inquiry noted by Mr. Capron is that of the connection of clouds and auroræ, some types of cirrus cloud so much resembling auroræ in their forms and arrangement that it is very probable that in some of the reported cases of daylight auroræ the observers may merely have noted arches of cirrus. On the other hand, it is by no means unlikely that some form of cloud, especially that which consists of small particles of ice, may be illuminated by electric discharges, and be the actual material basis of the phenomenon. In this connection the coincidence of auroræ with mock suns and similar appearances is of interest, since these indicate the presence of minute ice-crystals in the upper air. The Whitby fishermen, on September 23 of this year, reported a considerable aurora, and on the same night the moon, "prior to being obscured by clouds, seemed to shed a radiant glow straight up and down" (probably a rudimentary *paraselene*).[1] If aurora really is ever visible by daylight, it would seem almost incontestable that it must consist in some form of mist capable of reflecting as well as of emitting light, for the light of the brightest aurora is very inferior in *intensity* to that of the moon's surface, and the moon by daylight only appears like a faint white cloud. An aurora is a very brilliant one which lights the earth as brightly as the full moon, and yet it probably covers a great part of the sky, while the moon's diameter is only half a degree.

On p. 47 Mr. Capron summarises a most interesting investigation of Donati's on the time of appearance of the great aurora of February 4, 1872, in which he shows that it did not appear everywhere really simultaneously, but *at the same local hour*, as if it depended, like celestial phenomena, on something fixed and external to the earth and its rotation. If this were more than a mere coincidence it would be of the utmost importance, as proving the cosmical character of the aurora, and it is very desirable that the investigation should be repeated as soon as a sufficiently extended display presents the opportunity. Probably there is already such information stored in meteorological registers for whoever will take the trouble to seek it out.

In Chapter VII. some observations of the moon during eclipse are described, and it is suggested that the curious red lighting of the shadowed portion may be due to lunar aurora. Spectral observations, however, seem to lend no support to the theory. It is noted that the colours of Jupiter's bands seem brightest during periods of auroral frequency.

[1] *Friends' Schools Nat. Hist. Journ.*, November 15.

The suggested connection between auroræ and zodiacal light is dismissed as unfounded, the latter evidently being some form of reflected sunlight, and having a totally different spectrum. The relation of the aurora to the solar corona seems almost equally shadowy, depending solely on a supposed coincidence of *one* of the lines in the coronal spectrum with a faint band of doubtful position in that of the aurora. We entirely sympathise with the author in his protest against the identification of spectra by the mere coincidence of *single* lines. Such coincidences within the limits of observation with instruments of small dispersion are exceedingly numerous, and the only safe ground of identification is that of likeness of general features, or at least coincidence of many lines.

The latter half of the volume is mainly devoted to the discussion of the auroral spectrum and its supposed coincidences. A reference to the plate and catalogue of auroral lines (p. 104), however, is sufficient to show that it is little use as yet to compare these measures with the accurate determinations of solar and spark lines, only one line out of the nine or ten given being positioned with any approach to accuracy or general agreement of the observers, even to the third figure. It is much to be hoped that Mr. Capron's suggestion of photographing the spectrum may prove practicable, and after his extraordinary success with the lines of vacuum tubes, as evidenced in his recent work on "Photographic Spectra," we can hardly doubt it. Dry plates are now prepared of extraordinary sensitiveness, and there is practically no limit to the time of exposure which may be employed.

We may briefly summarise, however, the results of comparison, so far as it is possible to compare with such defective measures.

Perhaps the first supposed identification of the auroral spectrum was that of Procter, who announced the correspondence of the bright yellow-green line with a band in a vacuum tube, which he supposed to be due to oxygen, but afterwards ascribed to a hydrocarbon impurity. We should not allude to this here, since the correspondence broke down under high dispersion, the auroral line proving slightly more refrangible than that of the tube; but that we wish to give a word of explanation as to the constant recurrence of these carbon lines, which have proved misleading to many experimenters. As is well known, the glass tubes and apparatus employed in such researches are made by the use of a blowpipe fed with coal-gas. The imperfectly burnt products of combustion inevitably pass into the comparatively cool glass tubes, and some of them, such as naphthalene, being of high density, they are condensed on the inner surfaces, and obstinately retained. When, however, they are subjected to the high vacuums of the Sprengel pump, they slowly volatilise, and being good conductors of the electrical discharge, become frequently so brilliant as completely to mask the spectrum of the small residue of other gas in the tube. By heating the tube strongly during exhaustion and "washing out" many times with the pure gas of which the spectrum is desired, these accidental spectra may be got rid of, or at least, so much paled as to betray their character as interlopers. This, however, is an amount of labour hardly to be expected of those who make tubes in a commercial way, and it is to be regretted that in Mr. Capron's painstaking research, he was compelled to employ such tubes instead of preparing them for himself. In a future research we would suggest the employment of tubes thoroughly heated and washed out with air in the first instance, and then worked with a blowpipe fed with pure hydrogen.

Unfortunately throughout, the tubes employed both by Mr. Capron and by Dr. Vogel seem to have been of doubtful purity. That figured on plate xiv. as hydrogen, contains bands of most suspicious resemblance to those of nitrogen, while the oxygen tubes, beside the one or two lines which seemed peculiar to themselves, gave others which were proved by direct comparison, to coincide with those of carbon and hydrogen, though the relative intensities seemed somewhat altered.

Supposed coincidences have been pointed out by Ångström, Vogel, and others, between the auroral spectrum and those of the various gases, such as oxygen, nitrogen, and hydrogen, which are present in the atmosphere. Unfortunately these coincidences do not extend to the one bright line which has been accurately measured, but only to the fainter ones, the positions of which are so doubtful that they might be made to correspond with any spectrum the lines of which were tolerably numerous, so that, intrinsically probable as they may be, we cannot regard them as positively established.

Absolutely no coincidence has been made out between the bright yellow-green line of the aurora and a principal one of any other known spectrum, and the same may be said of the sharp red line which occasionally flashes out in the spectrum, of red auroræ. Mr. Capron, however, points out that the green line coincides with a faint atmospheric absorption band, while the red line seems to occupy the position of the well-known *a* line of the solar spectrum, which Prof. Smyth has shown to be due to dry air.

It would not be fair to conclude our notice of "Auroræ" without a few words of praise to the admirable illustrations, several of which are chromolithographs. Of these perhaps the best in artistic effect is a facsimile of a water-colour drawing of a white aurora seen by the author at Kyle Akin in Skye. But in fact the whole appearance of the book suggests at first glance art rather than science, and we should suppose it is but rarely that a purely scientific treatise has appeared in so ornamental a dress.

OUR BOOK SHELF

A Treatise on Metalliferous Mines and Mining. By D. C. Davies, F.G.S. 8vo. (London: Crosby Lockwood and Co., 1880.)

THE objects of this book, as stated in the preface, are "to describe in a concise and systematic manner the conditions under which metallic ores are found in different countries in the world," and further, "by defining the zones occupied by the various metallic ores to lessen somewhat the amount of unsuccessful search for them." For the first purpose the author notices a large number of mines in various parts of the world, partly from his own observations and partly from accounts published in special journals and in the transactions of scientific societies; and for the second, he deduces from such descriptive matter certain general conclusions, which, in their more important points, are as follows:—

"Gold and silver never occur in strata newer than the carboniferous period."

"Copper ores with trifling exceptions are only found in the lower Cambrian carboniferous and new red sandstone formations."

"The highest horizon of lead ores is in the carboniferous limestone."

The conclusions are apparently derived from the study of phenomena in Wales, and to render them universally applicable all that is necessary is to reconstruct the geology of the rest of the world to suit them, which the author does in a thorough-going fashion. Thus the system requires for Cornwall that the age of the granites should be Laurentian, and the killas and other schistose rocks Cambrian, Silurian, Devonian, &c., in regular succession; and therefore the author concludes that the received view which makes the granite post-carboniferous is a mistake, and corrects his authorities accordingly, even when quoting their observations. Thus in reproducing Dr. Foster's account of the Hay Tor iron ores he disputes their probable carboniferous age, and states that they may belong to an older group, and that possibly of a still older age are the deposits of the West of Ireland, which are found interstratified on the basaltic and porphyritic rocks that skirt the west coast. It appears from a preceding page that by these are meant the iron ores of Antrim, which occur in miocene basalts on the north-east coast between Larne and the Giant's Causeway, and about whose age no question can possibly be raised by any one with the smallest geological knowledge.

Much of the information concerning foreign mines is exceedingly inaccurate, indeed it is difficult to see whence some of it is derived. For example, on p. 240, in a paragraph describing the zinc ores of Silesia, it is stated that the calamine of that country averages 20 to 30 per cent. of metallic zinc, which by selection and dressing is brought up to 70 per cent.; that in 1876 sixty-four mines produced 31,315 tons of zinc ore, and a reference to a paper by Huene in the *Journal* of the German Geological Society is given as an authority. As these statements are contrary to what is generally known upon these subjects, an attempt has been made to verify them; and it appears that (1) the average yield of the Silesian zinc ores in 1876 as smelted was 11·84 per cent.; (2) the production of zinc ores in Silesia in 1876 was 449,374 tons; (3) the paper by Huene, published in 1851, has nothing whatever to do with Silesia, as it describes some zinc mines at Bergisch-Gladbach near Cologne.

The above examples taken quite at random will be sufficient to show the generally untrustworthy character of the book. H. B.

LETTERS TO THE EDITOR

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

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

Why the Air at the Equator is not Hotter in January than in July

THE following, I think, is the explanation of Mr. Fisher's difficulty (NATURE, vol. xx. p. 577), why the January temperature at the equator when the earth is in perihelion is not much higher than in July when in aphelion. The temperature to which Mr. Fisher refers is the ordinary temperature as indicated by the shade thermometer, which of course is simply that of the air. The difficulty is more apparent than real, for if we examine the *indirect* results which follow from the present distribution of land

and water, we shall see that there is no reason whatever why the air at the equator should be hotter in January than in July.

It is well known that, notwithstanding the nearness of the sun in January, the influence of the present distribution of land and water is sufficient to make the mean temperature of the whole earth, or, what is the same, the mean temperature of the air over the surface of the earth higher in July than in January. The reason of this is obvious. Nearly all the land is in the northern hemisphere, while the southern hemisphere is for the most part water. The surface of the northern or land-hemisphere, for reasons to which I need not here refer, becomes heated in summer and cooled in winter to a far greater extent than the surface of the southern or water hemisphere. Consequently when we add the July or midsummer temperature of the northern to the July temperature of the southern hemisphere, we must get a higher number than when we add the January or midwinter temperature of the former to the January temperature of the latter. For example, the mean July temperature of the northern hemisphere, according to Dove ("Distribution of Heat on the Surface of the Globe") is 70°·9, and that of the southern hemisphere 53°·6; add the two together and we have 124°·5, which gives a mean for both hemispheres of 62°·3. The mean January temperature of the northern hemisphere is 48°·9, which, added to 59°·5, the mean January temperature of the southern hemisphere, gives only 108°·4, or a mean of 54°·2. Consequently the air over the surface of the globe is hotter in July by 8° than in January, notwithstanding the effects of eccentricity. It is obvious that, were it not for the counteracting effects of eccentricity, the difference would be much greater. Ten thousand years ago, when eccentricity and the distribution of land and water combined to produce the same effect, the difference must have been far greater than 8°.

But it will be asked, How can this affect the air over the equator, which is not situated more on the one hemisphere than on the other? It is true that those causes have but little *direct* effect on the air at the equator, but *indirectly* they have a very powerful influence. The air is continually flowing in to the equatorial regions from both hemispheres. In fact, the air which we find there is derived entirely from the temperate regions. In July we have the northern trades coming from a hemisphere with a mean temperature as high as 70°·9, and the southern trades coming from a hemisphere with a mean temperature not under 53°, while in January the former trades flow from a hemisphere as low as 50°, and the latter from a hemisphere no higher than 60°. Consequently the air which the equatorial regions received from the trades must have a higher temperature in July than in January. The northern is the dominant hemisphere; it pours in hot air in July and cold air in January, and this effect is not counterbalanced by the air from the opposite hemisphere. The mean temperature of the air passing into the equatorial regions ought therefore to be much higher in July than in January, and this it no doubt would be were it not, let it be observed, for the counteracting effects of eccentricity. The tendency of the present distribution of land and water, when our northern winter occurs in perihelion, is to counteract the effects of eccentricity. But ten thousand years ago, when our winters were in aphelion, that cause would co-operate to intensify the effects of eccentricity. In fact, it would actually more than double the effects then produced by eccentricity. Now if the influence of the present distribution of land and water is so great as not merely to counteract but to reverse the effects of eccentricity to the extent of making the mean temperature of the earth 8° warmer in July than in January, it is not surprising that it should be sufficient to make the equatorial regions at least as warm in the former as in the latter period.

The fact that the equator at present is not hotter when the earth is in perihelion, instead of being an objection to the theory that the glacial period was due to an increase of eccentricity, as Mr. Fisher supposes, is in reality another strong argument in its favour, for it shows that a much less amount of eccentricity would suffice to induce a commencement of glacial conditions in the northern hemisphere than would otherwise be required, were it not for the circumstance to which Mr. Fisher refers. This objection, like many others which have been urged against the theory, arises from looking too exclusively at the *direct* effects of eccentricity.

There is another cause which must also tend to lower the January and raise the July temperature of the equator, viz., the northern trades pass further south in January than in July, and consequently cool the equatorial regions more during the former than the latter season. This general tendency of the trades to lower the temperature of the equatorial regions more in January than in July is of course subject to modifications from the monsoons, the rainy seasons, and other local causes; nevertheless, so long as the present distribution of land and water endures, so long will eccentricity have a counteracting effect upon the temperature of the air at the equator, which but for that would be hotter in July than in January.

Mr. Fisher somewhat misapprehends what he designates my "fundamental proposition." What I stated was "the temperature of a place *other things being equal* is proportional to the heat received from the sun." Those who have read what I have written on this point will remember that what I mean is, that if the temperature of any place depended alone on the direct heat of the sun that temperature would be proportional to the amount received. But then there is no such spot on the face of the globe—there is no place where heat or cold distributed by ocean or aërial currents does not affect the temperature—and I have in "Climate and Time," pp. 41–44, proved that, with the exception of the Arctic regions, there is no part where the temperature is so much affected by those currents as the equator. Were it not for the cooling effect produced by them the equator would be uninhabitable. No knowledge whatever as to the intensity of the sun's heat can be obtained from observations on the temperature of the air at the equator. The comparatively cold air flowing in from the temperate regions has not time to be fully heated by the sun's rays before it rises as an ascending current and returns to the temperate regions from whence it came. More than this these trades prevent us from being able to determine with accuracy the intensity of the sun's heat from the temperature of the ground; for the surface of the ground in equatorial regions is kept at a much lower temperature by the air blowing over it than is due to the intensity of the sun's heat. It thus becomes a very intricate problem to determine how much the surface of the ground is kept below the maximum temperature by the heat absorbed by the moving air.

I may add that although my estimates of the lowering effect resulting from the decrease of the sun's heat arising from increase of distance were computed according to Newton's law, yet I distinctly stated that this law holds only approximately true, but that nevertheless, for reasons given at p. 34 of "Climate and Time," it would be found near enough for my purpose.

James Croll

A Possible Consequence of our Present Weather

I have observed on several occasions that abnormally cold weather in November has been followed by an unusually mild mid-winter and January. These may possibly have been mere accidental coincidences, or they may be connected by a link of causation thus. Our climate, and more especially our winter climate, is largely influenced by the Gulf Stream, and whatever augments this raises our winter temperature, and *vice versâ*.

How, then, is the Gulf Stream likely to be affected by an unusual prevalence of Arctic winds and unusual cold in these latitudes? Such winds, must, to some extent, drive the waters of the Atlantic towards the source of the Gulf Stream, and tend to heap them there, and if there is any truth in the theory which attributes ocean currents to differences of oceanic temperatures, the present unusually cooled waters of the temperate zone will co-operate with the winds and augment this accumulation by their underflow. I do not mean that these combined actions are reversing the Gulf Stream at the present time, but simply that they are exerting a counter action or retarding influence which must result in augmenting the normal magnitude of the reservoir, or tropical accumulation, the outflow of which constitutes the Gulf Stream, and that thus the volume and velocity of the tropical waters which usually flow towards our coast will be augmented when the pressure of the present Arctic winds shall cease, and that our climate will be influenced accordingly. If I am right we may, in spite of present symptoms, or rather on account of them, have an unusually warm Christmas season and January.

This idea is not thrown out as a mere weather prophecy, but as a suggestive hypothesis and an incentive to what appears to me to be a very important and a much neglected branch of meteorological research, viz., systematic observation and record of the variations of the Gulf Stream. The countries whose coast is washed by this beneficent river of ocean are deeply interested in its movements. The Norwegians have already done something towards recording its variations, but so far as I can learn we, who are almost as deeply concerned as they are, have done little or nothing.

It may be that our agricultural troubles of the past three years are in some measure due to its disturbance; if so, it is of national importance that we should study its variations in order to learn whether they are reducible to law, and thus capaple of anticipations sufficiently reliable to induce prudential preparation for their national consequences. W. MATTIEU WILLIAMS

Stonebridge Park, Willesden

[With the extreme desirableness of an immediate and systematic observation, by European nationalities, of the temperature of the Gulf Stream, and of variations in the rate and direction of movement northwards from the tropics of the warm water and of the cold water southwards we very cordially concur. As another illustration of the practical utility of a better knowledge than we now possess of this subject, we may refer to the higher temperature and consequently larger evaporation than usual of the Atlantic in lower latitudes, along with a lower temperature, and consequently lower evaporation than usual farther north, in the beginning of the winter of 1878-79, as being in all likelihood one of the chief causes which brought us the miserable weather of the last twelve months. It is far from being beyond the reach of science to show how the larger evaporation from the more southerly regions of the Atlantic continued to spread itself over Europe further to south than usual, from which resulted the more southerly course pursued by our European storms, with the accompanying plague of east wind and rains over the British Isles, and the commercial distress thus deepened and prolonged. The importance of the inquiry is all the greater when it is considered that the past three years have impressively taught us how, not in India only, as shown by Blanford, but also in our British climate, certain types of weather, such as cold, warm, wet, or dry, when once fairly set in, tend to repeat themselves, and stamp their character on whole seasons or even a succession of seasons. It is by such lines of research that something more than a mere guess of the weather of coming seasons is to be obtained.—ED.]

The Climate of England

WILL you permit me, as a student for twenty years of the phenomena and laws of weather, to express my surprise that in meteorological tables or records, and weather notices in general, so little attention is bestowed upon the direction of the wind? It is true that in the daily forecasts issued from the Meteorological Office, this has been made for some time past a prominent, and, to my mind, the most valuable feature. Still the point has by no means been adequately dwelt upon by writers upon meteorology, the result being the loose and utterly unscientific talk we are accustomed to hear upon the very first principles of the problem of climate.

What is more common than to hear people remark that the climate of England has changed within the last few years? Their main ground for saying so is our having had for four or five seasons winters of exceptional mildness, followed last year by one of as remarkable severity and duration, and to all appearance likely to have following it one of not very different character.

The popular idea of climate has always seemingly been that of something affixed to the soil, a feature as fixed and characteristic as the rivers or mountain chains. Now, strictly speaking, there are for us but two real sources or loci of climate, the pole and the equatorial belts; the cold heavy currents of air from the Arctic regions flowing south, to take the place of the light warm air so rarefied by the sun's heat as to form a comparative vacuum. The aërial set of flux and reflux thus tending to be set up along meridian lines is deflected eastwards by the rotation of the earth on its axis, with the result that in our part of the earth at least the wind is found to blow from some point of west to east for much about 200 days out of the 365. So limited is our sea-girt insular area, that within a few hours, depending on the velocity of the wind, the whole breadth of Great Britain is traversed, so that instead of breathing a climate engendered by local conditions, and to be called our own, we live in an atmosphere reaching us from abroad, and modified by the conditions through which it passes to us (into which I forbear at present to enter in detail). Observation combines with theory to establish the primary fact that what may be called the ruling line or axis of prevailing wind in our island is that from south-west to north-east approximately. Along this line may be said to take place, in the main, the perennial contest of opposing air-currents, on which depends the character of our seasons, the light warm balmy breath of the equatorial current, or so-called Gulf Stream, having to battle with the dry, heavy, chilling atmospheric masses bearing down direct from the Polar regions, or circling over the steppes of Russia, or the uplands of Scandinavia. Drawing a line at right angles to this, or from north-west to south-east, we shall find that so long as the wind keeps well within the south-westerly aspect of this diagonal, frost either sharp or long is with us impossible, and as an immediate response to the vane veering or backing from one side to the other, a rise or fall of the thermometer is to be observed, which may vie with that due to the sun's place in the zodiac. The mercury may be seen to stand as high in January as in June. If we ask why the four or five winters preceding the last severe one were so exceptionally mild, the proximate answer is that during the months when the sun's power continued low, we enjoyed a succession of south-westerly winds which tempered "winter's flaw." Last year, on the contrary, the wind kept early and persistently to the northerly and easterly quarters; and were proper tables available, I believe that an abnormal prevalence of those Polar currents would be shown to have marked the later seasons of this most exceptional year.

The problem is thus shifted a step.

What we have to inquire into is the cause or causes to which is due so exceptional and persistent a flow of wind from one alternative quarter to the other.

To aim at anything like a forecast of winter or summer weather before knowing what the prevalent set of the aërial currents is to be, is to invert the essential conditions of the problem, and to put the cart before the horse. It is for meteorologists, I would urge, to concentrate their attention upon the causes or laws, which determine or disturb the periodical motions of the earth's envelope, especially as it oscillates to and fro across the limited and exceptionally situated group of the British Islands. Simple as such a suggestion may appear to men of science, the notices they have as yet given us will by no means, I believe, show it to be superfluous. It is the conviction that the primary and elementary conditions of the problem are far from having been grasped by the general public that has led me thus far to trespass upon your space.

Gray's Inn, December 2 ALEXANDER TAYLOR

A Correction

A FEW weeks ago I had some correspondence with the late Mr. J. Allan Broun on the subject of my communication to NATURE, vol. xx. p. 54, in the course of which he drew my attention to an error in my value for the barometric oscillation corresponding to 1° F. $\left(q = \frac{\Delta p}{\Delta t}\right)$ at Sibsagar. He said:—

"You had a note on the difference of results for Lucknow and Sibsagar both nearly at the same height; the values of q you made 0·017 and 0·028, the latter for Sibsagar should have been 0·018 or $\frac{\Delta p}{\Delta t} = \frac{0·477}{26·6}$."

I acknowledge the error, and take this opportunity of mentioning it as I fear Mr. Broun's article on the subject, which he told me was shortly to appear in NATURE, and in which he would most probably have drawn attention to my error, has been cut short by his sudden and lamented decease. His last letter to me containing the above correction was dated November 15, just a week before he died.

I may add that while the above error (which was due to my taking Δt to be 16·6 instead of 26·6) disqualifies Sibsagar from demonstrating that the value of q depends on the distance from the coast independently of the altitude, the rule is nevertheless generally evident, and can be shown equally well by taking Goalpara instead of Sibsagar with Lucknow.

At Goalpara h = 386 feet,

$$q = \frac{\Delta p}{\Delta t} = \frac{0·448}{18°·7} = 0·023.$$

E. DOUGLAS ARCHIBALD

Tunbridge Wells, November 29

Monkeys in the West Indies

IN his very interesting paper on "Tails," which appeared in NATURE, vol. xx. p. 510, Prof. Mivart says, "Monkeys are scattered over almost all the warmest parts of the earth save the West Indies, Madagascar, New Guinea, and Australia." As regards the West Indies the statement is not quite correct, and I am sure Prof. Mivart will be glad to receive the following information on the subject. In the islands of St. Christopher and Nevis, which form part of the division of islands commonly called the Lesser Antilles, monkeys are found in large numbers, and a planter friend in the former island, which I have recently visited, assured me that he had lately been obliged to appoint a "monkey-watchman" to protect the cane-fields and the sweet-potato fields of his estate from the destructive raids of bands of monkeys.

In the island of Nevis, which at one time must have formed part of St. Christopher, and which is now only divided from the latter by a very narrow arm of the sea, appropriately called "The Narrows," monkeys—the same as those of St. Christopher—exist in great numbers, and I may add that the tails are "perfectly prehensile," *i.e.*, "naked beneath towards the tip."

Of Trinidad I cannot speak from personal observation, but a scientific friend of mine, Dr. H. A. Alford Nicholls, who lately visited Trinidad, kindly writes to me as follows:—"Prof. Mivart has certainly made a mistake about there being no monkeys in the West Indies. I find, too, that in a work on 'Central America, the West Indies, and South America,' edited by the traveller, Bates, it is stated that there are no monkeys in the Antilles. You know more of the monkeys of St. Kitts and Nevis than I do, but I can tell you something of your Trinidad cousins. There are two kinds of monkeys in Trinidad, and as the fauna is continental, they will doubtless be found on the mainland of South America. One belongs to the Mycetes, and it is called the Red Howler, partly on account of its loud and hideous cries; the other, a diminutive specimen of the Cebidæ, is called the 'Sapajou;' it is a Cebus."

I shall be glad to supply any further information on the subject of monkeys in St. Christopher and Nevis.

Dominica, British West India, November 11 EDMUND WATT

Earthquakes in Iceland

IN NATURE, vol. xxi. p. 89, I see the earthquake which occurred in Iceland on September 24 last ascribed to "volcanic eruptions in the Krísuvík Mountains, a locality where eruptions have not been known within the memory of the present generation." The use of the word "eruption" here is misleading, for though the earthquakes, which frequently occur at Krísuvík, are no doubt caused by volcanic action, nothing of the nature of an *eruption*, in the usual sense of the word, has been known to occur there within the historical period. The boiling springs, mud caldrons, and sulphur deposits, for which Krísuvík is noted, are, on the authority of Prof. Bunsen (Letters to Berzelius), to be ascribed to a pseudo-volcanic action occurring at comparatively slight depths. Though slight earthquake shocks have frequently occurred, during the last eighteen months, while I was at Krísuvík, I have never observed that they had any effect on the boiling springs and other thermal phenomena.

The earthquake of September 24 last, though more violent than any other which I have experienced there, differed from the rest in no other respect. They are generally confined to the neighbourhood of the hot springs and sulphur beds, though the last was felt over a wider area, and seldom do any damage.

Edinburgh, December 1 W. G. SPENCE PATERSON

Diatoms in London Clay

I DO not know if diatoms have been observed in the London clay, or not. If they have not, it may interest many to know that I have discovered triangular, quadrangular, elliptical, and discoidal forms in the London clay of Sheppey. The frustules are frequently perfect, and the markings are plainly discernible as square-sided depressions or elevations; I am not certain which. One of the discoidal forms is an old friend, for I observed it in abundance two years ago; but as I then had no knowledge of diatoms, I passed large quantities by as pyritous concretions.

In my ignorance I stated in a paper on the well referred to (*Proc.* Geol. Assoc., vol. v. p. 357): "It should be mentioned that at and below 293 feet the clay was thickly studded with very minute disks of iron pyrites, each having a boss in the centre, and the edge slightly turned up all round. They were uniformly perfect, as much so as if cast in one mould."

A few days ago I saw *Anticodiscus oreganus*, and was struck by its resemblance to the disks I had seen in the London clay. As I had not preserved any of these, I set to work to get more, if possible, and last night I was fortunate enough to find several distinct species. W. H. SHRUBSOLE

62, High Street, Sheerness-on-Sea, December 2

Colour-Blindness

THE remarks of Mr. Everett at the close of his paper (NATURE, vol. xxi. p. 62) on Prof. Hering's theory, seem to be founded on a misconception. Prof. Hering assumes, not four, but six elements of colour-sensations connected by the equations—

$$B + W = 0\,R + C = 0\,B' + Y = 0.$$

The specification of any colour in his system contains there independent variables, and is of the form

$$D = a\,W + B'\,R + cb,$$

and it will usually take four equations to eliminate WR and B.

It must be noted that Prof. Hering assumes that the red-green and blue-yellow sensations never occur in nature pure, but always mixed with white. If this is granted I do not think that the result of Maxwell's experiments on colour-mixture will be found inconsistent with his theory. JOHN TENNANT

19, The Boltons, S.W., November 28

Intellect in Brutes

I OFFER the following illustrations of reasoning powers in animals, should you care to insert them.

1. Some years since, while hunting in Northern Michigan, I tried, with the aid of a professional trapper, to entrap a fox who made nightly visits to a spot where the entrails of a deer had been thrown.

Although we tried every expedient that suggested itself to us, we were unsuccessful, and, what seemed very singular, we always found the empty trap sprung.

My companion insisted that the animal dug beneath it, and putting his paw beneath the jaw, pushed down the pan with safety to himself; but though the appearances seemed to confirm it, I could hardly credit his explanation. This year in another locality of the same region, an old and experienced trapper assured me of its correctness, and said in confirmation, that he had several times caught them, after they had made two or three successful attempts to spring the trap, by the simple expedient of setting it upside down, when, of course, the act of undermining and touching the pan would bring the paw within the grasp of the jaws.

2. A Dandie Dinmont terrier, after the death of his mistress, was playing with some children in a room into which was brought a photograph (large) of her, that he had never previously seen. It was placed upon the floor leaning against the wall. In the words of my informant, who witnessed it, the dog, when he suddenly caught sight of the picture, "crouched and trembled all over, his whole body quivering. Then he crept along the floor till he reached it, and, seating himself before it, began to bark loudly, as if he would say, 'Why don't you speak to me?'" The picture was moved to other parts of the room, and he followed, seating himself before it and repeating his barking.

3. The dog whose demoralisation by the salute of a monkey was published in NATURE, vol. xviii. p. 77, recently had another encounter with one, and behaved in so sneaking a manner as showed that he had not forgotten his first impression.

Boston, November 22 C F. CREHORE

Electric Lighting

IN NATURE, vol. xx. p. 641, you say, "For the first time perhaps in the history of electric lighting two rival magneto-electric machines are illuminating the same hall." I can state an earlier instance, though not an exact parallel. At the annual fair of the American Institute, held in New York during September, October, and November, 1878, the main hall was illuminated by the Wallace-Farmer machine and light, and the machinery hall—directly communicating with it, by the Brush apparatus. The two halls form practically one.

ALEX. S. GIBSON

Norwalk, Conn., U.S.A., November 14

JEAN BAPTISTE ALPHONSE CHEVALLIER

THE death is recorded on December 1 of Prof. A. Chevallier, who deserves notice here as one of the Nestors of French pharmaceutical chemistry. He was born at Langues, in Lorraine, July 19, 1793. After completing a course of scientific study, he opened a pharmacy in Paris, where he soon attracted attention by his talent for investigation, as well as by his ability in scientific literary work. In 1825 he assumed the editorship of the *Journal de Chimie médicale*, and continued this labour until some years prior to his death, having as associates Payen, Pelouze, Robinet, Orfila, Péligot, Dumas, and other leading chemists of the day. Soon after entering upon his career as investigator, his merits were recognised by the government, and he gave up his business connections to accept the Chair of Chemistry at the École supérieure de Pharmacie, a position which he occupied up to the time of his death.

Among Chevallier's earlier researches should be mentioned his investigations on the absorptive capacities of living plants for various inorganic solutions, and especially his exhaustive studies in connection with Payne, on the hop and the potato, which attracted general attraction. In physiological chemistry notice should be taken of his detection of various poisonous metals, such as lead and copper, in normal organisms. The knowledge of French mineral waters is also greatly indebted to his numerous and exhaustive analyses, and the presence of arsenic in many springs was first signalled by him. The greater portion of Chevallier's life was devoted to the chemical phases of public hygiene, and in this connection he published a number of valuable papers on the detection and prevention of adulteration in a large variety of articles of food, methods of preserving food, disinfectants, &c. Of his devotion to the cause of scientific inquiry an interesting anecdote is related from the earlier part of his career. A case of poisoning was to be tried at Paris in which acetate of morphine had been used, and Chevallier, who had sold the salt to the murderer, was summoned as a witness. Anxious to have the full nature of this hitherto untried poison well established, and being limited as to time, he immediately undertook a thorough investigation of its toxic effects on his own system, and succeeded so well that at the trial he was able to give a detailed description of the symptoms attending the use of the drug in question.

As a scientific writer Chevallier was widely and deservedly known. His first work in 1824, in connection with Payen, "Traité des réactifs chimiques," reached a third edition in five years. In 1826-29 he published, with Richard and Guillemain, an extensive "Dictionnaire des Drogues simples et composées," in five volumes. In 1850 appeared his admirable "Dictionnaire des Altérations et Falsifications des Substances alimentaires, médicamenteuses, et commerciales," which reached a third edition in 1858, and was translated into other languages. Other important works were "Recherches sur les Moyens appliquées à la Conservation des Substances alimentaires" (1858), "Du Café, son Histoire, son Usage, etc." (1862); "Traité des Désinfectants sous le Rapport de l'Hygiène publique" (1862).

T. H. N.

THE SEWAGE OF LONDON

GENERAL SCOTT, in his recent paper at the Society of Arts, entitled "Suggestions for Dealing with the Sewage of London," deserves credit for having drawn attention to a subject which in itself must have especial interest for all residents in the metropolis, but which, from the manner in which he has dealt with it, possesses further attractions for those who have made the scientific aspects of the sewage question their study, in that he has really attacked this much-debated problem in an entirely new direction, and has in so far entered upon fresh ground. We do not remember that any previous investigator has set himself the task of examining into the composition and character of the suspended matters of water carried sewage coupled with the possibility of the mechanical separation by simple subsidence (1) of the heavier mineral particles or the detritus, and (2) of the lighter flocculent particles, which latter, consisting as they do mainly of the fecal matters, possess a far higher manurial value than the heavier substances washed from the roads and pavements.

The sludge deposited from sewage by one or the other systems of precipitation has received hitherto the chief share of attention from scientific men, and even when the possibility of recovering the solid matters in sewage by some system of straining or rude filtration, or the retention of such solids in tanks, in which the sewage is brought to temporary quiescence, has been considered, it seems on all occasions to have been the practice to regard the entire bulk of such deposits as an inseparable compound of very low value from the manure point of view. It is of course the manurial value of the ingredients contained in suspension and in solution in sewage which has been so frequently inquired into by chemists; and, beginning with the report of Dr. Hoffman and Mr. Witt in 1857, down to that of Messrs. Rawlinson and Read in 1876, a vast mass of valuable information concerning the nature, composition, and value of the manurial elements of town sewage has been accumulated. It has remained for General Scott to point out that—

1. A very large proportion of the solid suspended matters may be removed from sewage by simple subsidence.

2. That such matters may roughly be separated, the more valuable from the valueless, by the method in which such subsidence is accomplished.

3. That after such preliminary treatment, any chemical process for the clarification and partial precipitation of the dissolved impurities of sewage may be carried out far more readily, and under conditions rendering their success in an economical point of view one of greatly increased probability.

4. General Scott has indicated various simple methods for dealing with the silt and detritus removed from the sewage at a relatively small expense; of deodorising and fitting the sludge obtained by subsidence for the manufacture of a manure; and lastly, a mode of further purifying the London sewage by a system of chemical treatment whereby it may be rendered suitable for discharge into a river of large volume.

Assuming the dissolved impurities to be incapable of recovery unless the sewage water can be utilised for irrigation, the first object of General Scott's paper was to show how large an amount of harm was done to rivers and the dwellers on their banks solely by the solid matters contained in sewage. By means of extracts from the reports of the various Royal Commissions who have examined into this question, and the information furnished to the Metropolitan Board of Works by their own advisers, Messrs. Bidder, Hawksley, and Bazalgette, he proved that the deposits in the river, the mud banks, the foul emanations from which were most unhealthy, and the dangers to navigation were all due to the discharge of the solid ingredients of raw sewage into rivers and into the Thames.

General Scott next entered very minutely into the composition of the suspended matters of sewage. An estimate of the total weight of solid matters due to a mixed population of 3,500,000 persons, with a proportionate allowance for the fertilisers existing in the excreta of animals, together with the *débris* of the animal and vegetable substances which might find their way into the sewers, would manifestly represent the sum total of the organic matters in London sewage.

Concerning the gross annual amount of organic matters different estimates appear to vary very slightly, and in assuming them in the case of London at 50,000 tons per annum, there would seem to be but a small margin for error; the quantities of detritus, however, have been very differently stated by the various authorities. From the most reliable analyses of the London sewage, taken at all periods of the day and night, and in many different parts of the metropolis, there appears to be a tolerable unanimity in assigning the ratio of the organic to the mineral ingredient of the suspended matters to be as 1 is to 2. After a period of settlement it is found that the proportion is, by the subsidence of the heavier mineral particles, exactly reversed, as the larger portion of these valueless components of sewage impurities rapidly subside, entangling with them about ⅕th of the organic matters in suspension. General Scott proposes, therefore, a double system of tanks. The first set would consist of a series of shallow catch pits, in which the sewage will only be brought to a state of partial repose, and in which it will part with about four-fifths of the solid mineral matters and one-fifth of the organic matter. In the second set of tanks, in which more time will be given for the settlement of the matters in suspension, the sewage will be deprived of nearly all the remaining suspended impurities, namely, one-fifth of the mineral, and four-fifths of the organic matters. If we assume the gross weight of the organic matters at 50,000 tons per annum, the mineral ingredients will, according to the analyses quoted by General Scott, equal 100,000 tons, and the total of 150,000 tons thus obtained, is, in reality, a very low estimate of the amount of the suspended matters in London sewage. These matters, General Scott is of opinion, he could roughly separate in his tanks thus:—In the detritus tanks he would obtain 80,000 tons of mineral matters, together with 10,000 tons of organic matters; in the second set of tanks he would expect to find about 20,000 tons of mineral matters mixed with about 40,000 tons of organic matters. The exact percentage composition of this latter sludge would, he believes, after studying and comparing many analyses and valuations, be somewhat as follows:—

Organic matter (without nitrogen)	66·50
Nitrogen	3·50
Phosphoric acid 2·80 = tribasic calcic phosphate...	6·07
Potash	1·25
Sand and inert mineral matter	22·68
	100·00

In the debate which took place after the paper, Dr. Frankland, while admitting General Scott's process to be "worthy of trial," took exception to this estimate, and maintained that his experience was "that after the separation of detritus from London sewage, the maximum percentage of organic matter was 63, whilst the minimum was 21, the average being 39½, and these high percentages were obtained under exceptionally favourable circumstances, because, in the collection of these samples of sewage, little or none of the so-called detritus was mixed with it at all." He further stated that "he did not think it would be safe to calculate on more than 33 per cent. of organic matter in the dried sludge." This question of the possibility or otherwise of effecting a separation more or less perfect, of the mineral from the organic elements of the sludge lies at the root of General Scott's proposals, and while giving all due weight to Dr. Frankland's high authority, we are compelled to admit that General Scott's figures, many of them based on the analyses of Dr. Frankland himself, seem to point in the opposite direction to that pointed out by Dr. Frankland, as concerns the relative proportion of the mineral and the organic matters after settlement.

The question to be decided is, admitting the composition of the sewage solid to be in the first instance 2 mineral to 1 organic, can we reduce this proportion to 2 organic to 1 mineral, by bringing the sewage to a state of quiescence in tanks? This could be tried on a sufficiently large scale to settle the point at issue in a very short time, and as it is a question which to a great extent depends upon the result of actual experiment on a large scale, it is certainly one for the officers of the Metropolitan Board of Works to decide.

Passing over the theoretical values of the deposits, based upon their contents in nitrogen, phosphoric acid, and potash, which General Scott has dealt with very carefully, we come to the question of deodorising the sludge and its preparation as a manure. For the former purpose the employment of slaked lime is advocated, used in the small quantity of only ·66, or less than 1 per cent. of the total weight of the sludge. This slaked lime, made into milk of lime by the addition of water, is to be thoroughly incorporated with the sewage deposit, and a sufficient amount of crude superphosphate is then to be added, in order nearly, but not quite, to neutralise the lime. A crystalline precipitate of phosphate of lime is thus formed in the sludge, which greatly aids in the drying of the compound, or, to put it more correctly, facilitates the extraction of the water. Some of those who took part in the debate doubted whether General Scott, in his estimate of 20*s.* per ton on the dried material, which included the cost of chemical treatment, had made a sufficient allowance for the great labour and difficulty which would have to be incurred in drying the sludge for use as a manure. Dr. Voelcker, who pointed out that "he had gone very carefully into the figures in the paper, and was very glad to find that General Scott had avoided those exaggerations which frequently disfigured calculations of this kind," quoted some observations he had made tending to show that sewage sludge parted with water with extreme difficulty, though he admitted that after treatment with lime and phosphoric acid such sludge would dry with greater rapidity. In the various forms of filter presses now largely used for drying clay slip and expressing precipitates, very great improvements have recently been effected, and it has been stated on good authority that it becomes possible by their use to reduce the moisture in such materials as low as 50 per cent. There still remains, however, a large proportion of water to expel, and, as Dr. Voelcker stated, this can only be accomplished by means of artificial heat.

The question of the cost of drying sludge is one which possesses many features of interest, and the entire subject would be one well worthy of the special consideration of the Society of Arts at their annual conference on the treatment of sewage. We should like to have devoted more time to the calculations of General Scott of the theoretical value of the three chief fertilisers present in sludge, viz., nitrogen, phosphoric acid, and potash, as also to the expense of preparing soluble phosphoric acid, concerning which latter point Dr. Voelcker threw out some valuable suggestions during the discussion, but we must now conclude. We entirely agree with General Scott in his denunciation of the folly and imprudence of continuing to cast raw sewage into the Thames; he has certainly pointed out a way of greatly abating the present evil, and as the plan he advocates could be tried upon a sufficient scale at an almost nominal expense, we feel justified in urging with Dr. Frankland that this should be done, and we cordially echo his concluding observation, "that the Board of Works have no right to look for a profit in getting rid of the objectionable matter. If they can succeed in doing it without a loss or at a cost not greater than that involved in dredging it out of the river again, it ought to be done; because if sewage mud is deposited in the river there must be an obstruction to navigation, besides the putrefaction of organic matters which, when deposited on the banks of a tidal estuary, become very offensive, especially in warm weather."

So far as one can judge from the facts adduced by General Scott, his scheme promises to be more efficient for the ends aimed at than any hitherto proposed, and certainly it seems to us that the great scientific principles which are applicable to the subject have been kept well in view. And from our standpoint this must be the test of the efficiency of any scheme for the disposal of sewage. We fear that hitherto those with whom the decision rests as to what scheme shall be adopted for the disposal of the sewage of London have looked upon the question too much as one between rival "schemes," and considered far too much the supposed interests of rival "bodies," and too little the clear teachings of science and the welfare of the public. It is evident that for London, at least, the whole subject of the disposal of sewage will have very soon to be reconsidered, and we trust that the authorities concerned will take into their council reputable chemists and physicists, who we are sure, can have no interests more at heart than to see the unmistakeable teachings of science practically applied to the salvation of society.

THE NEW WEALDEN DINOSAUR

At the last meeting of the Geological Society, Mr. J. Whitaker Hulke, F.R.S., brought forward some new facts concerning the remarkable Dinosaur *Ornithopsis*, which cannot fail to interest both geologists and naturalists.

In the original collection of Wealden fossils made by Dr. Mantell, and acquired for the British Museum, were two fragmentary bones, the nature of which was somewhat doubtful. Dr. Mantell regarded and figured one of these as a tympanic bone of *Iguanodon*, at the same time pointing out that it presented some resemblance to a vertebra. Prof. R. Owen adopted Mantell's views, and figured it as the tympanic bone of *Iguanodon*, or, perhaps, of *Cetiosaurus* or *Streptospondylus*.

In 1869 Prof. H. G. Seeley pointed out that the fossil in question was undoubtedly a portion of a vertebra, and one of a new and very remarkable type. It exhibited points of comparison with the vertebræ of birds, in the lightness of its construction, and in the existence of great cavities penetrating into the centrum. Hence Prof. Seeley suggested for it the generic name of *Ornithopsis*.

In 1870 Mr. Hulke, who was at that time unaware of Prof. Seeley's determination of the vertebral character of the British Museum specimens, gave a description of the neural arch of a vertebra which he had discovered in the Wealden of the Isle of Wight. From the beautiful character of the groined entrance to the neural canal, Mr. Hulke was led to suggest the name of *Eucamerotus* as a provisional one for the new Dinosaurian genus which the specimen evidently represents.

He especially pointed out as of great interest the enormous size of these vertebræ, and the fact that they are built up of thin plates of very compact osseous tissue, with immense spaces of cancellous tissue between them. At a later date Mr. Hulke recognised the identity of his *Eucamerotus* with the *Ornithopsis* of Prof. Seeley.

In 1876 Prof. Owen again took up the study of the forms in the British Museum. He adopted Prof. Seeley's and Mr. Hulke's views as to the vertebral character of the fossils—but he rejected Prof. Seeley's generic name on the ground that the resemblance between these vertebræ and those of birds is merely superficial, and that the name of *Ornithopsis* is therefore misleading. Prof. Owen described two new forms presenting this peculiar structure in the vertebral column, and to these he gave the names of *Bothriospondylus* and *Chondrostosaurus;* he insisted that the large cavities seen in the fossil vertebræ were probably originally filled with cartilaginous substance, as is the case in the sharks and rays, and argued, therefore, that any comparison with the vertebræ of birds was a misleading one. Mr. Hulke and Prof. Seeley, however, while admitting that the structure does not necessarily imply the powers of flight in the forms possessing it, yet insist that in all probability the cavities in the vertebræ were true air-cells, and therefore that the structure is "bird-like;" on these grounds they maintain that the name of *Ornithopsis* ought not to be superseded.

In 1877 Prof. Marsh recognised among the numerous Dinosaurian remains obtained from Colorado a number of gigantic forms with vertebræ presenting the same peculiarities as are found in *Ornithopsis;* to these forms he gave the names *Atlantosaurus*, *Morosaurus*, *Apatosaurus*, *Allosaurus*, and *Diplocus*. Prof. Cope had simultaneously described three other forms—*Camarasaurus*, *Amphicœlias*, and *Epanterias*, all presenting the same peculiarities as are found in the English form *Ornithopsis*. One of the American forms, *Atlantosaurus* had a femur seven feet in length. When the two distinguished American palæontologists visited this country in 1878, they both recognised the specimens of *Ornithopsis* in Mr. Hulke's collection as presenting numerous points of resemblance with the new forms which they had described.

Now in the communication which he has recently made to the Geological Society, Mr. Hulke has described vertebræ from several parts of the spine of *Ornithopsis*. This he is enabled to do by the courtesy of the Rev. W. Fox, of Brixton in the Isle of Wight, who has long been such an indefatigable collector of the vertebrate fossils of the Wealden, and has permitted Mr. Hulke to make use of his materials. Mr. Hulke shows that while the dorsal vertebræ were closely bound together by processes, so that this part of the spine must have possessed great rigidity, as is the case with birds, the cervical vertebræ indicate the existence of the greatest mobility. But the point on which Mr. Hulke principally insists, from its bearing on the discussion which has taken place between himself and Prof. Seeley, on the one hand, and Prof. Owen on the other, is that the cavities and cancellous tissue are confined to the dorsal vertebræ, and do not occur in the other portions of the spinal column; this he insists is inexplicable, if, as Prof. Owen insists, the cavities in question had no functional character, but were filled up with cartilaginous tissue, while it finds a ready explanation in the supposition of Prof. Seeley and himself that they are truly pneumatic cavities. Mr. Hulke also points out that there are reasons for believing that some at least of the vertebræ referred to the genus *Cetiosaurus* belong to the new group of forms to which so much attention has been directed during the last few years.

There can be no doubt that there existed during mesozoic times, both in this country and on the American continent, a group of reptiles of gigantic dimensions, which presented such peculiarities of structure, especially in their vertebral column, that they must be placed in a distant sub-order of the *Dinosauria*. For this, perhaps the name of *Sauropoda*, suggested by Prof. Marsh, may be adopted.

The existence of this bird-like character of pneumatic bones in reptiles of such gigantic dimensions as these peculiar Dinosaurs undoubtedly were is certainly very startling and unexpected. At the same time we believe that neither Prof. Seeley nor Mr. Hulke favours the idea that the forms in question were capable of flight. Mr. Hulke promises shortly to add another to his valuable contributions to our knowledge of these forms by describing the limb-bones of *Ornithopsis* and its allies, and discussing the habits which a study of their structure seems to indicate. All geologists and naturalists will look forward eagerly for the promised memoir.

CASSELL'S NATURAL HISTORY[1]

The third volume of this well-illustrated and popular account of the animal kingdom contains descriptions of the Ruminantia by the late lamented A. H. Garrod,

[1] Edited by P. Martin Duncan, M.B. (Lond.), F.R.S., F.G.S. Vol. iii. London: Cassell, Petter, and Galpin, 1879.)

M.A.; of the Rodentia by W. S. Dallas; of the Edentata and Marsupialia by the Editor, and of the first two Orders of Birds by R. Bowdler Sharpe.

The ruminating animals are divided into the Bovidæ, the Cervidæ, the Tragulidæ, and the Tylopodæ. A little more attention to typographical details would have assisted in making this division more clearly perceptible. Thus the first three chapters are headed quite correctly, "Artiodactyla—Ruminantia: Bovidæ," while Chapter IV. is headed "The Cervidæ," and Chapter V. has no chief heading at all, although it treats of part of the Cervidæ, the Tragulidæ, and the Tylopodæ. Such a want of uniformity is apt to be a stumbling-block to the student, whose perplexity is no little increased when he finds the same confusion not only in the headings of the chapters, but also in the text itself. Thus, in the chapters on the Edentata the author seems only to have awoke up to the necessity of giving any details of the order as an order, when he had just finished all he had to write about the species contained in the order; and as a consequence, not only is the cart put before the horse, but the account of the order is far too short, and almost nothing is said as to the many anatomical peculiarities characterising it. So much for criticism, which we make in the interests of the work itself, which, if completed as begun, will doubtless form not only a work of useful reference to the general reader, but also will be most useful as an encyclopædia of zoology. To constitute it a complete natural history, of course the other kingdoms of nature will have to be also treated of.

For the antler-less deer (Tragulidæ) Mr. Garrod coined the useful word "deerlets." In respect of their toe-bones they seem to stand intermediate between the swine and the true ruminants. Each foot in the common pig possesses four toes, that corresponding to our thumb in the fore-limb and to our great toe in the hind-limb being absent. The bones of all the toes that are present are quite separate from one another just as in man, but those of the outer and inner digits in each limb are smaller than those which bear the larger hoofs. In the true ruminants, as is well known, these larger toes are partially fused together, the bones of the two central digits forming the "cannon bone," while the bones of the other toe are reduced to mere splints, or disappear. In the deerlets these bones are not blended at all in the fore-limbs of the water-deerlet of West Africa; in which, as in all the other species, the digits two and five are perfect from end to end. The want of antlers in either sex is another distinguishing peculiarity. We would gladly have had more details given us of this very interesting group, the scientific names of the species of which are in no one instance given.

The Lophiomys.

The chapters on the rodents are very well and carefully written, and the classification adopted is that proposed by Mr. Alston. The orderly sequence of the families in this section of the work might be commended as an example, and the scientific names of the species following their English names, in italics, is an immense improvement on the plan generally adopted throughout this work, and as a proof that the reader will find in this section new as well as interesting information, we quote the following account of perhaps the most remarkable rodent known:—

"The importance of an animal in the zoological system by no means depends either upon its size or on its abundance in the world; its rank in the classification is decided solely by peculiarities of organisation which distinguish it more or less from its fellows; and in many cases the creatures which are regarded with the most interest by the naturalist are those which seem most to withdraw themselves from general observation. A single genus, perhaps containing only one or two species, may, by a singular combination of characters, be so completely isolated from all the recognised allied groups that it cannot be placed in any of them, and accordingly a distinct family, possibly even an order, has to be established for its reception. Sometimes subsequent discoveries add to the number of species forming the group thus set up, and in this way the prescience of its founder is confirmed. Sometimes the group remains in its original condition, leaving us, according to circumstances, to regard the anomalous creatures of which it is composed either as a special development of their general type, or as the residue of a group which may have presented a greater variety of forms at some past period of the earth's history.

"The latter is perhaps the case with the curious little rodent which alone forms the present family, of which its original describer, M. Alphonse Milne-Edwards, writes as follows:—'In its general aspect it somewhat resembles certain opossums, and like these it is pedimanous (having the hind feet hand-like); but these are the only analogies it presents to the marsupials, and in its dental system, as also in the rest of its organisation, we easily see that it belongs to the order Rodentia. It differs, however, from all the members of this group by characters of considerable importance; I may even say that, by some peculiarities of structure it departs from all other mammals, and that we find in it anatomical arrangements of which we have hitherto had examples only in the class of reptiles.' After an exhaustive discussion of the characters of this curious little animal, M. Milne-Edwards comes to the conclusion that it is most nearly related to the members of the following family, and especially to the hamsters, although he found it impossible to unite it with them. In this course he has been followed by other writers.

"The general construction of the skull is the same as in the Muridæ, but from the temporal ridges thin plates are developed, which bend downwards, and articulate with similar plates springing from the malar bones, and thus completely arch over the temporal fossæ after a fashion only met with in certain reptiles, and especially in the Hawksbill Turtle (*Chelone caretta*). The whole upper surface of the skull is covered with minute but perfectly definite granules, arranged with much regularity, and these, which occur in no other mammal, give the skull a very peculiar aspect, such as may be seen in some fishes. As in the Muridæ, there are three molars on each side in each jaw, and these are rooted and strongly tubercular; the foremost in each series having three and the others each two ridges. Without entering in detail into the peculiarities described at great length by M. Milne-Edwards, we may say that in its general structure, and especially in that of the skeleton, the animal is murine, but with a very important distinction, namely, that the collar-bones, which are well developed in the rats and their allies, are here reduced, as in the hares and rabbits, so as to form only two small bony styles freely suspended among the muscles, and that the first toe in the hind feet, although not very long, is so attached as to be opposite to the rest, thus converting the organ into a prehensile hand which the animal uses freely in climbing. The cæcum is small.

Hoffmann's Sloth (from life).

"In its external characters this animal is as remarkable as in its anatomical structure. In general appearance, as stated by its describer, it has much resemblance to a small opossum, but the bushy tail and the peculiar arrangement of the hair on the body are met with in no marsupials. The head is small; the general form stout; the limbs short, and the hind ones not much longer than their fellows; and the ears are of moderate size and sparingly clothed with hair. The prevailing colour is blackish-brown, but a triangular spot on the forehead, a streak under each eye, and the tip of the tail, are white; and the long hairs which clothe the body and tail are dark only in the middle, the base and tip being white, as are also a great quantity of finer and shorter hairs which form a sort of under fur. But the chief peculiarity of the coat is to be found in the arrangement of the hairs of the body. The long hairs of the middle of the back and tail, some of which are nearly three inches in length, are capable of being raised into a nearly upright position, forming a sort of crest which gives the animal a very peculiar aspect, and this crest is separated from the pendulous hair of the flanks by a sort of furrow clothed with very peculiar hair of a greyish-tawny colour. These hairs are unlike any others known to occur among mammals. The apical part is of the ordinary construction; but the following portion down to the base is 'very rugose, and presents a spongy aspect, due to the interlacing, and, so to speak, felting of a multitude of epidermic filaments emanating from radiate cells, which constitute a perfect network of irregular meshes. Within the sort of sheath thus formed longitudinal filaments which break up into bundles of fibrils are to be seen.'

"Very little is known as to the habitat of this animal, which M. Milne-Edwards has named *Lophiomys imhausi*, the former name referring to the crested character of the back, the second commemorating the person who first brought the creature to the notice of naturalists. M. Imhaus, stopping for a few hours at Aden, on his way home from Réunion, saw a living specimen of this rodent in the possession of a Negro, from whom he bought it, but could learn nothing as to its origin. He inferred, however, that it had not been brought very far, and that its native country was either Southern Arabia, or some region in Abyssinia, or Nubia, on the other side of the Red Sea. This specimen was brought to France, and lived for about a year and a half in the Garden of Acclimatization in the Bois de Boulogne, where it fed upon maize, vegetables, and bread, slept during the day, and climbed with ease upon chairs and other convenient objects by the aid of its hinder hands. It never took its food in the fore-paws to carry it to the mouth as so many rodents do. When irritated it elevated the crest right down to the end of the tail, and defended itself by biting vigorously."

The chapter on the fossil Rodentia contains a large number of facts packed into a small compass; reference will be found in it to very many of the recent discoveries of rodent remains in the miocene deposits in America, and a detailed account is given of that remarkable fossil form called *Mesotherium cristatum*, by M. Serres, and for which Mr. Alston has formed a section of the rodents called Hebetidentata from their incisor teeth, which, instead of having the chisel-like edge so characteristic of the incisor teeth of all rodents, are continuously enamelled and are four in number in the lower jaw, and two in the upper. The skull and teeth of this strange form are figured; as Mr. Alston says, "It appears to have been a survivor, to pliocene times, of a much earlier type, which represented an era at which the Rodents were not yet clearly marked off from their allies. In fact, Mesotherium seems to continue *into* the order Glires, that line of affinity which Prof. Flower has pointed out as extending from the typical Ungulates through Hyracodon, Homalodontotherium, Nesodon, and Toxodon."

The following is an account of Hoffmann's sloth (*Cholœpus Hoffmanni*):—

"This is a sloth with two clawed fingers on the fore, and with three claws on the hinder extremities. Living specimens are occasionally brought to Europe, especially from Porto Rico, so that its general appearance may now and then be studied at the Zoological Gardens, in the Regent's Park. If it be looked at there in the day-time, it certainly merits the name of sloth, for it resembles a bundle of long, light, brown hair, fixed on the top of a bar of wood close to an upright branch, or huddled up in a corner on the ground; but in the morning, and also late in the evening, the creature begins to move slowly, and to look out for the food put for its use on the floor of the den. All the Hoffmann's sloths have pale brown hair, whiter at the tips, and a white face, showing a brown band across the nose, extending to a ring round each eye. They have also a long and full crest of hair on the neck, and the hair on the limbs is darker than that of the rest of the animal. Dr. Peters, who discovered this sloth, examined the skeleton, and found only six vertebræ in the neck, and in this it differs from the *Cholœpus* just noticed.

"When its food, consisting of carrots and lettuce, and bread-and-milk, is put down in the morning it is soon in movement, and enjoys its milk hanging down from a bar with its hind legs, and resting its back on the floor of the cage. It seizes the food between the claws and the long straight palm of the fore-foot, and passes it into its mouth, chewing actively with the molar teeth, especially with the first, which are sharp. It cares little for the spectators, and when it has finished, slowly mounts up into a corner of its little den and settles down to sleep. In the evening it becomes lively, for it is, and, indeed, all sloths are, nocturnal in habit. The hairless snout, of a light red tint, the absence of 'smellers,' the little eyes with a few hairs around them, and the broad forehead, give the animal a curious appearance. The hair is brushed back on the forehead, and comes around the very small ears on to the cheeks, and is whitey-brown, and this same tint is seen over the whole of the back in long slender hairs. But the under hair is light red or red-brown. The long and slender hand, with its two claws, contrasts with the rather bulky upper part of the limbs, and the flesh-coloured palms are very remarkable.

"The whole of the sloths lead very monotonous lives; their food is ever within their reach, and it is abundant, and they do not appear to have to compete much or at all in the struggle for existence with other animals. Their enemies are snakes and the carnivora, but it is evident that they are much more readily preserved by their habits from the latter than from the former. Leading such an uneventful existence, there is no great call upon their nervous energies or intelligence, and these are at a low pitch. The brain consequently is very simple in regard to convolutions, which are few in number and shallow."

The portion of this volume devoted to the birds is what might have been expected from so well-known an ornithologist as Mr. Sharpe. In the preparation of the chapters on the anatomy of a bird, he acknowledges his obligations to his colleague in the British Museum, Mr. Jeffery Bell, and an excellently well written chapter it is, though it ends a little abruptly; and the periods of incubation in the case of some of the best known birds might usefully have been added.

In the present volume, the two first orders, that of the birds of prey and of the picarian birds, are treated of, and the rest of the orders will probably form volume iv., the publication of which, we trust, will not be long delayed. While aware of the vast multitude of the feathered throng which Mr. Sharpe has to pass under review, might we suggest to him that it is very important that when he gives a paragraph to a sub-family, he might so arrange it as to let the reader discover without difficulty what species quoted really belonged to it? Thus, the arrangement on p. 310 is very perplexing. The sub-family of the cockatoos is of the same value, so far as classification goes, as that of the Amazon parrots or of the Conures, and yet there is no uniformity, so far as typographical details go, to indicate this. If there be a genus Androglossa, it is not alluded to, and for want of quoting, at least one species of the genus Nasiterna in the preceding paragraph, the "it" that was found at Mafoor by von Rosenberg must remain an unknown bird to the reader. There are said to be about thirty species of Amazon parrots known; which, then, is "the Amazon parrot" figured? The text is appealed to for an answer in vain. Not two lines are devoted to the Macaws. The same is very much the case all through: thus, the honey-guide is figured after Keuleman's sketch; eleven species are known, but neither is the name given of the species figured, nor is the name given of the species whose habits are described. The common goat-sucker, the whip-poor-will, and the lyre-tailed nightjar, are figured, and yet no scientific names for them are to be found. No doubt both author and editor will agree with us that the value of this work would be greatly added to if the good example set in this matter by Mr. Dallas were followed. The illustrations are in general very good, but is there not one egg too many in the nest of the edible-nest swiftlet? The general get-up of the volume—type, paper, and binding—are all that could be wished, and despite the few things in it which we think might be amended, we most cordially recommend it and its predecessors as very excellent volumes on the natural history of the mammals and birds.

PROF. HUXLEY ON TECHNICAL EDUCATION

AT the lecture by Prof. Silvanus Thompson, on "Apprenticeships," at the Society of Arts last week, Prof. Huxley was in the Chair, and in inviting discussion on the paper, said he would commence it by making a few remarks himself. He had listened to Prof. Thompson's paper with gratification, not only on account of the good sense it embodied, but also for a more selfish reason, inasmuch as it entirely accorded with the views which he, coming to the matter from a different side, had himself expressed. Unfortunately he had no personal acquaintance with the ordinary kinds of work in what were called handicrafts, but he ventured some two years ago in that very room to point his remarks with respect to technical education by the knowledge he possessed of medical education. He then expressed a hope that something real and practical would soon be done by the City Guilds, which had done him the honour of consulting him on this subject of technical education, and the advice he gave them was in precise accordance with the principles which Prof. Thompson had laid down that night. Whatever might be the merits or demerits of the old system of apprenticeship, it was as thoroughly doomed in the different kinds of ordinary handicrafts as it had been long doomed in physic. The only alternatives appeared to him to be of two kinds. In the first place, we ought to bring within the reach of the young people who were employed in our great manufactures the means of carrying on their education in the particular branches of business with which they were respectively occupied beyond the time during which the necessities of practical life obliged them to be at work in the workshop—that is to say, for a period corresponding virtually with what used to be their apprenticeship. One of his suggestions, therefore, was that there should be established in the neighbourhood of the great centres of industry schools to which young boys who are learning certain handicrafts could resort in order to receive instruction which would qualify them to work skilfully and intelligently at their trade. He likewise suggested that the guilds should employ part of their large funds in the establishment of a central institution, which should do for the teaching-power of the country that which such institutions as the École des Arts et Métiers in France, and the Polytechnicum at Zurich, did in their respective countries. In England there was not only a total absence of schools to which apprentices could resort, but there were no teachers competent to teach in such schools, even if they were established. He thought that the suggestions he made to the guilds were of a sound and practical nature, and calculated to advance the interests of technical education in this country. He understood Prof. Thompson to object to the existing elementary training in our Board schools on the ground of its technical nature and of its occupying the minds of the student entirely with book learning and matters which had no sort of bearing on his future life. No one endeavoured more earnestly than he, when he occupied a seat at the School Board, to remedy the evil of the exclusively book character of our ordinary school instruction. He did not entertain the slightest doubt that an extension of the Kindergarten system, including the use of tools and the knowledge of elementary machines, was a matter of great importance, but he could not think that the evil of not giving hand-work in the elementary schools was after all very great. Although it was a great thing to make skilled workmen, yet it was much more important to make intelligent men. The four or five years during which children ordinarily remained at school were not too much to devote to even an exclusive study of reading, writing, and arithmetic, and to the acquirement of some intelligent knowledge of geography, the elements of history, and the rudiments of physical science. On this point he might observe that no pupil was admitted to the Écoles d'Apprentis in Paris until he was thirteen years old, or unless he presented his certificate of elementary education. If we attained one half or a quarter of the good results reached in the Écoles d'Apprentis, the improvement in the condition of the average British workman would be exceedingly great.

In proposing a vote of thanks to Prof. Thompson for his paper, Prof. Huxley expressed his belief that, as far as London was concerned, it would be a scandal and a robbery if a single shilling were asked for out of the general revenues of the country for technical education. The City of London Guilds possessed enormous wealth, which had been left to them for the benefit of the trades they represent. If the people did not insist on the wealth being applied to its proper purpose, they deserved to be taxed down to their shoes. It would be well if those who had charge of these matters in the city of London would understand that they were morally bound to do this work for the country, and he hoped if they continued to neglect the obligation they would be legally compelled to do it.

NOTES

No more than justice has been done to Sir Joseph Whitworth by granting him a prolongation for five years for his process of manufacturing fluid-compressed steel. The powerful evidence brought before the Committee of the Privy Council as to the utility of this steel could not be resisted. Mr. James Wright, the Engineer-in-Chief of the Navy, stated that the invention "has met a want long felt for the principal parts of marine engines which have been subject to failures;" from his experience of it he has perfect trust in it. Mr. Hotchkiss, the patentee of the revolving cannon used by the French Government, stated that he never had occasion to reject a single *barrel* of the steel. The evidence from Mr. J. Davidson, of Woolwich, Mr. Purdey, the well-known gun-maker, and others, showed that by getting rid of the air-cells the steel answered perfectly, and is a better metal than had ever been produced by any previous process. Their Lordships were satisfied that it would in all probability be highly useful "in carrying out the highest achievements of engineering skill."

THE long-expected experiments by the *Thunderer* Gun Committee commenced on Tuesday at the proof butts on the Government marshes, Woolwich. In connection with these experiments, Sir William Palliser organised, and last week carried out, a successful series of experiments with a doubly-loaded gun, in order to ascertain whether double-loading was or was not the cause of the bursting of the *Thunderer's* gun. Five double charges were fired, each successive charge being increased in length. No sign of flaw or damage could be perceived. A similar result attended experiments with an air-space between the powder charge and the base of the projectile. But when shall we have a gunner like Froude to abolish experiments on the scale of 12 inches to a foot? The navy now build a paraffin boat for a few shillings, instead of a real one costing a quarter of a million to experiment with. What will the experiments, including the bursting of the gun, cost? If smaller experiments cannot be devised, no one has a right to say that Palliser's experiments on a smaller scale teach us nothing.

WE are glad to see that decisive action has been taken on the side of the United States for the acquisition of the ground in the neighbourhood of Niagara Falls as an International Park, and so preserve visitors from the innumerable annoyances to which they are at present subject. At a meeting of the Board of Commissioners of the New York State Survey, on November 20, Director Gardner, of the Survey, presented conclusions arrived at by the board at its meeting in Niagara last September, illustrated with maps, diagrams, &c. The plan proposed is to take a strip along the American bank, varying from 100 to 600 feet in width, extending two miles from the new suspension bridge to the head of the rapids, and plant it with trees, to shut out from view the ugly bazaars, manufactories, booths, and hotels which destroy the natural scenery of the banks. The plan also involves the purchase of Goat and Bath Islands, which, the Commission has reason to believe, can be bought. The proposed park will extend to and include Canal Street, in the village, over which the State now has jurisdiction. Director Gardner places the total amount required to secure all the property needed at 800,000 dols. The Commissioners thought the estimate too low. A report recommending that the State shall purchase the property will be prepared by Messrs. Dorsheimer, Stout, and Barnard. It is the unanimous opinion of the Commission that New York should proceed to reclaim her side of Niagara without reference to what Canada may do. One map, shown by Director Gardner, indicated that the recession of the Falls since 1842, when a trigonometrical survey was made, has been something over 100 feet.

FRENCH meteorologists have observed a curious analogy between the present season and the severe winter 1788-1789. This winter was observed and described by Cotte, one of the most celebrated French meteorologists. The frosty weather set in on November 25, and ended on January 13. On December 25 intervened a partial thaw. The end of January and February were relatively genial, and the frosty weather again set in on March 4, and kept on up to the end of the month. Frost was so intense that wine was congealed in cellars. The thickness of ice on the Seine was 18 inches, and the breaking of the ice happened only on January 20. Note was carefully taken of the minima observed in a large number of Continental cities. It was observed that the minimum of temperature happened in Germany on December 18, in France on the 31st, and in Russia only on January 5. During frosty weather the wind was almost always blowing from north-east with clear sky. Sometimes it was blowing from south, but then snow was falling, sometimes with great abundance.

THE quantity of snow which fell in Paris during the day of December 4 and the ensuing night, according to a calculation made by a member of the Municipal Council, amounts to 245,000,000 cubic feet for the interior of the fortifications. It has been estimated that the expense for removing by handwork and carting this immense quantity of snow, would be about 800,000 francs.

THE dates of the freezing of the Neva have been carefully observed from 1703. It has never frozen sooner than in 1805, on October 16, nor later than in 1740, when it froze on December 28. This year the date is November 15; the mean date is November 13.

SOME curious statistics of gas-lighting in Paris have been published recently. The greatest duration of public lighting is 14h. 30m., and smallest 5h. 25m. The cost of gas for public and private establishments is 2,000,000*l.*, about *one pound* per head for each inhabitant of Paris. The total consumption of gas is 6,500,000,000 cubic feet. In 1880 the Paris Municipality intends to enlarge its lighting expenses by 16,000*l.*, and 8,000*l.* for establishing new gas-lamps. No provision appears to be made for electricity.

THE excavations at Olympia under the auspices of the German Government have been resumed this winter with a force of 100 workmen. A statue of Nemesis, and heads of Titus, of a kneeling infant, and of Paionios' Nike have already been unearthed this season. The total number of works of art thus far excavated is sixty-seven, consisting of forty-one figures and twenty-six heads.

WE regret to have to record the death of Madame Louis Figuier, the wife of the well-known author of so many popular works in science. Madame Figuier has written a number of plays, and has been a fellow-worker with her husband in the publication of his "Théâtre Scientifique," which has appeared quite recently anonymously.

DR. H. TRIMEN, who leaves England to assume his appointment in Ceylon in January, is succeeded in the editorship of the *Journal of Botany* by Mr. James Britten, F.L.S., of the Botanical Department of the British Museum.

A METEOROLOGICAL station has been opened at Prato, thus connecting Fiesole and Florence with Pescia and Lucca.

TELEGRAPHIC communication between Paris and other cities of France and the Continent has been almost interrupted by snow. It is only in Germany that the telegraphic service has continued almost unimpeded, owing to the establishment of subterranean communications.

MESSRS. SAMPSON LOW AND CO. are about to publish Dr. August Weismann's "Studies in the Theory of Descent," with a prefatory notice by Charles Darwin, F.R.S., translated and edited, with notes, by Raphael Meldola. Part I.—On the Seasonal Dimorphism of Butterflies (with two coloured plates). Part II.—On the Origin of the Markings of Caterpillars; On Phyletic Parallelism in Metamorphic Species (with six coloured plates). Part III.—On the Transformation of the Mexican Axolotl into Amblystoma; On the Mechanical Conception of Nature. The German text, we are informed, has been carefully revised and brought down to date by the author, under whose supervision the chromo-lithographic plates have been accurately re-drawn and engraved.

WE understand that Mr. Anderson's long-promised work on Lightning Conductors will now be issued in a few days. Messrs. Spon, of Charing Cross, are the publishers.

THE well-known Boulak Museum at Cairo has been undergoing repairs, and the fine collection was deposited in a neighbouring warehouse under what seemed proper guardianship. But, the *Times* correspondent writes, robbers the other day broke in through the roof, and they must have been robbers of a certain rank of intellect, for some 80 or 100 scarabees of great value pecuniarily, and impossible to replace, as they related to the early dynasties, were abstracted, although they were things of no apparent worth to an ignorant person.

A CORRESPONDENT of the *North China Herald* understands that the director of the magnetic and meteorological observatory connected with the Roman Catholic mission establishment at Sikawei, near Shanghai, has good reason to suppose, after a careful study of the typhoon of July 31, that the Chinese typhoons, like the cyclones of the Bay of Bengal, do not have their centre eight points to the right from the direction of the wind (the face being turned against the latter), as is generally supposed, but from nine to ten points. It is certainly of the utmost importance to navigators that this conclusion of Père Dechevrens should be carefully investigated, to which end the cooperation of ship-masters is invited. They should forward observations of the barometer and thermometer, force and direction of the wind, mentioning the latitude, longitude, and height above the sea-level of the spot where their observations have been taken, the description of instruments used, whether the thermometer is attached to the barometer, and what corrections, if any, are to be applied, with general description of weather, &c.

We have received the seventh edition (November, 1879) of Prof. E. Morren's "Correspondance Botanique." There is no alteration this year in the plan or scope of this useful botanical directory for the whole world; but the necessary corrections and additions seem very carefully made up to the date of issue. The only noteworthy additions to the list of names for each country are in the case of France, which requires two extra pages, and Italy, which takes one page more than last year.

The Associated *Soirée* of the Literary, Scientific, and Art Societies of Liverpool was held in St. George's Hall yesterday. The programme was of a varied character, both literature, science, and art, being well represented upon it. The idea of thus uniting the various classes of societies in a large town is a happy one, and deserves imitation.

We notice from the November number of the *University College of Wales Magazine* that numerous important additions have been made to the museum of that institution, which now contains collections of very varied character.

Science Gossip for December publishes a useful list of naturalists who are willing gratuitously to assist learners of natural history and others, personally when practicable, otherwise through the post.

Prof. Newberry has reprinted his article on the "Geological Survey of the Fortieth Parallel" (New York, Appleton) from the *Popular Science Monthly*. We have at various times referred to the volumes of this magnificent work; Prof. Newberry's paper gives a good *résumé* of the whole.

The *Colonies and India* calls attention to the fact that a small quantity of flax grown in West Australia, which recently fell into the hands of an English manufacturing firm, was found to be of such excellent quality that a large demand has suddenly sprung up in the colony for both indigenous and cultivated flax.

The additions to the Zoological Society's Gardens during the past week include three Pin-tailed Whydah Birds (*Vidua principalis*) from Africa, presented by Capt. T. H. Bowyer Bower; two Common Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Capt. Burke; a Mississippi Alligator (*Alligator mississippiensis*) from the Mississippi River, presented by Mr. W. G. Marshall; a Slow-worm (*Anguis fragilis*), European, presented by Mr. W. A. H. Bernard Smith; two Red River Hogs (*Potamochœrus penicillata*) from West Africa, two Elliot's Guinea Fowls (*Numida ellioti*) from East Africa, an Elephantine Tortoise (*Testudo elephantina*) from the Aldabra Island, deposited; two Prong-horn Antelopes (*Antilocapra americana*) from North America, a Slow Loris (*Nycticebus tardigradus*) from Malacca, a Laughing Falcon (*Herpetotheres cachinnans*) from Brazil, a Bar-tailed Godwit (*Limosa lapponica*), a Common Curlew (*Numenius arquatus*), two Pomatorhine Skuas (*Stercorarius pomatorhinus*), European, purchased.

OUR ASTRONOMICAL COLUMN

Orbits of Binary Stars.—In addition to elements of O. Σ. 235, which apppear in the recently-published "Handbook of Double Stars," Dr. Doberck has lately investigated orbits for the binaries 4 Aquarii and μ^2 Herculis, stars for which no similar computation had been previously made. He assigns a period of 129·8 years for the former, the passage of the periastre at 1881·80, and for the latter a period of 54·25 years, the periastre at 1877·13. The elements give the following angles and distances:—

4 Aquarii.					μ^2 Herculis.				
1880·5	Pos.	188·2°	Dist.	0·32″	1879·5	Pos.	241·1°	Dist.	1·05″
1885·5	,,	242·0	,,	0·22	1880·5	,,	247·1	,,	1·04
1890·5	,,	295·9	,,	0·32	1881·5	,,	253·4	,,	1·01
					1882·5	,,	260·1	,,	0·97

The extent of Dr. Doberck's investigations relative to the orbits of the revolving double-stars will be seen from the following nearly complete list of objects, for which we are indebted to him for the best systems of elements yet in our possession:—Σ 3121, μ^2 Hercules, O.Σ. 298, α Centauri, γ Coronæ Borealis, ξ Scorpii, Σ 3062, ω Leonis, *p* Eridani, Σ 1768, ξ Bootis, 4 Aquarii, τ Ophiuchi, η Cassiopeæ, λ Ophiuchi, 44 Bootis, μ^2 Bootis, 36 Andromedæ, γ Leonis, σ Coronæ Borealis, α Geminorum, ζ Aquarii, O.Σ. 235. It must be borne in mind, in order to appreciate the amount of labour involved in these researches, that in the majority of cases the orbits are not the results of rough or graphical approximations, but have been worked out with a degree of refinement, which exhausts the data actually at Dr. Doberck's command. He has made this subject as much his own as Prof. Julius Schmidt has in his case that of the variable stars.

Errors of the Lunar Tables.—Prof. Winnecke publishes observations of the moon made by Dr. Schur at the provisional observatory of the University of Strassburg in the year 1878, and the corrections required by Hansen's tables, and by the same tables as improved by Prof. Newcomb, who showed the large and increasing deviation of the tables would almost wholly disappear if, for the empirical term, an empirical alteration of the other term due to the action of Venus is substituted, and suitable alterations made in the elements of mean motion. The advantage derived by the introduction of Newcomb's corrections is seen to be very considerable, the signs alternating in the course of the year, and the corrections being generally small, while with Hansen unaltered there is a larger and uniformly negative correction throughout.

From the same observations there is deduced a correction to the mean semi-diameter adopted in Hansen's tables amounting to −1″·29. Soon after the appearance of these tables, Dr. Oudemanns, by a careful discussion of occultations and direct heliometric measures, inferred a correction of −1″·09. If the mean of these values be adopted, we shall have for the moon's mean semi-diameter, 15′ 32″·16. Dr. Oudemanns' paper will be found in vol. xxvi. of the *Monthly Notices* of the Royal Astronomical Society.

Re-Discussion of Ancient Solar Eclipses.—The publication of recent investigations on the motion of the moon, appearing to render a new discussion of the ancient eclipses of the sun desirable, the work has been commenced under the auspices of the Smithsonian Institution, by Mr. D. P. Todd, of the American *Nautical Almanac* Office. The computations so far relate to the eclipses of Thales, Larissa, Ennius, Agathocles, and Stiklastad, and to the two eclipses of the thirteenth century, which have formed the subject of an important memoir by Celoria, of the observatory at Milan. It is proposed to extend the original scope of the research to include a large number of ecliptic dates, and great facilities are expected from the use of Newcomb's Tables of Eclipses, which have recently appeared. We shall allude further to these tables in a future column. It will be seen that this interesting research is in excellent hands.

The Solar Parallax.—Mr. Downing, of the Royal Observatory, Greenwich, has made a determination of the sun's mean parallax from observations of Mars in declination at the observatories of Leyden and Melbourne, during the very favourable opposition in 1877, the same comparison-stars having been used at both stations. The observations were made between July and October, but Mr. Downing has only compared them on those days when planet and stars were observed at Leyden and

Melbourne on the same day or on the following day, so that the change in error of the places interpolated with second differences from the *Nautical Almanac*, has merely to be carried back for 9½ hours or carried forward for 14½ hours. The resulting mean solar parallax is 8″·96, and assuming that the probable error of a single observation of declination is 0″·5, the probable error of the result is ± 0″·051. The value obtained by Prof. Newcomb from similar observations in the year 1862 was 8″·855, nearly identical with that which Leverrier held to be pretty definitive, and which was given by the planetary theories, or 8″·86. In most of the national ephemerides, Newcomb's mean value, obtained in his paper on the sun's distance in the Washington Observations for 1865, or 8″·848, has been adopted; the *Connaissance des Temps* substitutes Leverrier's.

METEOROLOGICAL NOTES

MR. E. KNIPPING, Tokio, has written a brief account of three typhoons which occurred in the China and Japan Seas in September, 1878. In twelve charts and one diagram he sets down the paths of the three storms and the weather of each day from the 15th to 21st, when the third and most violent of the typhoons occurred. The heaviest squalls and gusts of wind were met with in the front part of the typhoon, or with north-east and south-east winds, whereas they are hardly mentioned in the ship's logs with south-west winds in the rear of the storm. The path of the typhoon was to north-west from 15th to 19th, to north on 19th and 20th, when it recurved to the north-east, following a course midway between Japan and the continent. Its rate of progress was 10 miles an hour on the average, rising to 25, and falling to 2⅓ miles an hour. The diagram, which summarises the author's views regarding the behaviour of the winds, seems to raise questions which call for further inquiry. Thus the south-east wind shows, near the centre of the hypothetical typhoon, an in-curving tendency, which becomes less and less on receding from the centre, till, towards the outskirts of the storm, it is represented as blowing outwards. On the other hand, the north-east wind, immediately contiguous, very decidedly in-curves near the outskirts of the storm, but on approaching the centre the incurvation becomes less and less till it disappears. The statement is made that at a distance of 900 miles from the centre, with a north-east wind, the centre of the typhoon bears right ahead, but with a south-east wind the centre bears south. For a satisfactory examination of the points here raised, and other points, such as the remarkable changes in the form of the typhoon while off the coast of Shanghai, fuller data are required, so that the positions of the centre at different times be more accurately ascertained. The publication of details of the data in an appendix to the work is equally necessary.

PROF. NIPHER'S *Missouri Weather Service Report* for October last is to hand, and is of more than usual interest. The returns show the weather of that State to have been unprecedently warm for the season, the mean temperature of St. Louis, viz., 63°·1, being the highest for any October of the past forty years. At the same time the rainfall was only 0·57 inch, being, with the single exception of 1872, when the rainfall was 0·29 inch, the driest October in forty years. The rainfall was unusually small over no inconsiderable portion of the State, extending to north-west of St. Louis, and in the extreme north-east it amounted only to about a ¼ inch, whereas, on the other hand, within a limited district immediately to southward round Cuba, and over a pretty extensive region in the west, lying to north and south of Kansas City, it exceeded 4 inches. The service is being ably and vigorously worked, eighteen new stations being added in November, so that there are now seventy-three stations, the results of whose observations are quickly sent broadcast over the State and beyond it, reaching Europe even in the third week of the following month. We observe with much satisfaction that the efficiency of this weather service is to be greatly enlarged by the active co-operation of the directors of the principal railroads, who have intimated their readiness to make meteorological observations a regular part of the duties of their station agents at points selected by Prof. Nipher himself.

IN connection with the meteorological work proper of the Missouri Weather Service, Prof. Nipher has been carrying out a magnetic survey of the State during the summers of 1878 and 1879, the expense of the survey having hitherto been met by private subscriptions. The results of this survey are given on a valuable map which accompanies the October Report, showing the lines of equal magnetic variation, and attention is directed to the tendency of the needle to set at right angles to those river-valleys which do not run north and south. A report on the climatology of Missouri is in course of preparation by Prof. Nipher, at the request of the State Board of Agriculture. It is with some surprise we learn that the expense of organising and carrying on this service has been wholly borne by two of the directors and Prof. Nipher. But this state of things the Americans are too sharp-sighted to allow to go on, it being in the interests of the State to provide that a service which is so energetically and effectually working out the climatologies of its various agricultural centres does not run the risk of being starved out for want of the few dollars required to meet its working expenses.

CAPT. TOYNBEE, in the *Journal* of the Meteorological Society for October, gives an interesting comparison of the temperature of the Atlantic during the Decembers of 1877 and 1878 from observations made on the temperature of the sea every four hours of these months by Capt. Watson, of the Cunard steamer *Algeria*. The result shows that for the outward and homeward passages to America the part of the Atlantic traversed by the *Algeria* was 3°·2 warmer in December, 1878, than in December, 1877. A comparison is also made of the mean temperature of the British Isles, and from observations at about forty stations it is shown that the December of 1878 was 8°·0 colder than that of 1877, "in spite of the fact that the sea to the westward was more than 3°·0 warmer." The higher temperature of the sea in December, 1878, would appear not to have extended far to northward, seeing that on the west of Scotland the sea was half a degree colder than in 1877, and in Farö 1°·7 colder, whilst on the north-west of Iceland the sea during December, 1878, was 0°·2 warmer. The interest attached to such an inquiry centres in the point that 8°·0 greater cold over the British Isles during 1878 as compared with 1877 may have been brought about in consequence of the fact that the Atlantic to west-south-westward was more than 3°·0 warmer. It is, for example, possible that this abnormal distribution of temperature in the Atlantic was more or less immediately connected with the more southerly course taken by our European storms since the end of October, 1878, from which have inevitably resulted the unusual prevalence of easterly and northerly winds and the cold weather we have had since. An inquiry more practically important could scarcely be suggested to meteorologists than an investigation of the point suggested many years ago by Sabine as to there being a possible connection between the temperature of the tropical and subtropical waters of the Atlantic during the autumn months and the severity or mildness of our European winters; and certainly no more suitable period could be selected for the inquiry than the last two years, a twelvemonth's warm, fine weather having set in during October, 1877, and a period of cold weather, exceptionally protracted and severe, having commenced in the end of October, 1878.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society, on Monday evening, Mr. Wilfrid S. Blunt read a paper entitled "A Visit to Nejd," in which he gave an interesting account of a journey made last winter in company with his wife, Lady Anne Blunt, from Damascus southwards to Jôf and the Jebel Shammar in Central Arabia. The results of Mr. Blunt's expedition may be thus briefly summed up. The oases of Kâf and 'Ittery have now been visited and the Wady Sirhan explored by Europeans for the first time. By taking barometrical observations along its entire length, Mr. Blunt ascertained that the Wady Sirhan from Ezrak to Jôf lies on nearly a uniform level of 1,800 feet above the sea, from which he thinks that it was formerly an inland sea, and is miscalled a Wady or valley. Along the whole distance he roughly surveyed the pilgrim road, marking the position of the wells and the reservoirs made by Zobeyde. Mr. Blunt has also constructed a map of the Jebel Shammar district. The most interesting outcome of his journey, probably, is the collection of a series of facts relating to the physical condition of the great sand desert of Nefud, and in some material respects his observations are at variance with those of Mr. Palgrave. Mr. Blunt appears to be the first to call attention to the deep horse-shoe hollows, called by the Arabs *fulj*, with which the whole surface of the plain is pitted.

IN the present critical state of affairs between China and Japan in regard to the suzerainty of the Loochoo Islands, much interest attaches to an official document issued in the latter country on the subject. All the Loochoo Islands, the Japanese maintain, are connected by certain geomantic signs in the earth with the Japanese province of Satsuma. The forty-eight characters of the Japanese alphabet are in use there, having been communicated to the islanders by Minamotonotametono. As regards language, they use a mixture of Chinese words and the Japanese alphabet in their literature. They call their own kingdom Okina, or otherwise, Okinawa. As regards religion, they worship Yi Shih, the Great Spirit of Japan, besides other divinities. In many of their domestic customs, too, the Japanese maintain that their practice indubitably indicates their origin.

THE new number of *Les Annales de l'Extrême Orient* contains some ethnographical notes on Thibet by the Abbé Desgodins, illustrated by a map of that country and the neighbouring regions.

THE just published part of *Le Globe* contains a paper by Dr. E. Dufresne, entitled "Une station d'hiver pour les phthisiques dans les Hautes-Alpes," and a third article by M. Venuikof on geographical discoveries in Asiatic Russia.

THE *Bulletin* of the Antwerp Geographical Society contains the text of the "Résolutions et Vœux," presented by the section of the late Commercial Geography Congress at Brussels, and adopted by the general meeting.

AT the last sitting of the Paris Society of Geography a letter from M. Sibiriakoff, one of the promoters of Nordenskjöld's North Asiatic Expedition, was read. This generous gentleman proposes to the Society to send a handsome subscription, in case a French expedition is sent to these parts. But it does not appear likely this suggestion will be taken into consideration.

M. HERTZ, the founder of *L'Explorateur*, the first popular journal of geography established in Paris, died a few days ago at the age of fifty. He was a member of the Council of the Geographical Society and one of the promoters of the Commercial Geographical Society.

U.S. NATIONAL ACADEMY

THE National Academy of Sciences held its semi-annual meeting at Columbia College, New York, October 28th–30th. Prof. W. B. Rogers presided. The meeting was welcomed by Prof. F. A. P. Barnard (President of Columbia College), as being the first use that has been made of the new building recently constructed and not yet quite finished, on the western front of the college grounds; thus appropriately inaugurating it in the interests of science. Prof. Rogers opened the meeting with a few brief but eloquent remarks, descanting on the far-reaching character of the researches which are now most prominently before the scientific world. As instances he cited the proofs brought by Prof. Whitney of the discovery of human remains in the pliocene; the evidence adduced by Mr. Lockyer, showing that in the sun many of the elements may prove to be compounds; the marvellous expositions of "radiant matter" in Mr. Crookes's experiments; and the striking discoveries in the uses of electricity and the telephone. Prof. Rogers is not ready to accept all the new theories which accompany these novel conceptions, but he feels assured that we are on the road toward new truths. The present age, like that which preceded the Newtonian era, has brought together a vast and somewhat chaotic mass of observations, out of which great principles shall be determined. In this work it is to be expected that some of the members of the Academy will bear an active part.

Dr. Henry Draper read a paper on the photography of star spectra, which we gave at p. 83.

Prof. C. A. Young contributed some "Spectroscopic Notes." He showed the want of true achromatism in the ordinary achromatic object-glass. By special arrangement of apparatus and the use of high dispersive powers, he has divided several spectral lines hitherto regarded as basic. The abundance of double lines in the spectrum has a meaning that needs to be investigated; as a curious fact, it is comparable to the excessive number of double stars that the telescope reveals. Prof. Young is prepared to indulge in a doubt as to whether the dark lines are really produced by absorption.

Dr. J. J. Woodward, Surgeon, U.S.A., read an elaborate paper on original researches reported in the second medical volume of the "Medical and Surgical History of the War of the Rebellion." This is a work published by the U.S. Government in several large quarto volumes. In preparing the work, Dr. Woodward consulted 124 different authors. His studies were aided by the use of the very large number of specimens in the pathological collection of the U.S. Army Museum. For various representations, *e.g.*, showing the cicatrices of diphtheritic ulcers, photography and the heliotype were employed. The special researches applied chiefly to diseases of the internal organs, such as dysentery and intestinal catarrhs. The minute changes indicating the beginnings of disease were closely studied. Dr. Woodward's conclusions tend to confirm the more recent and advanced views of pathology.

Dr. J. C. Dalton presented some observations on the structure of the human brain. He divided all brain matter, including the part which extends into the spinal column, into two kinds, the white and the gray. He proceeded to show that the gray kind was in three deposits, which are connected with one another—the spinal cord, the cerebral ganglia, and the extension into the outer sheath of the brain. The connection between these portions was shown to be continuous. The true shape of the corpus striatum and its connection with, as a part of, a circular organ called the surcingle, was demonstrated; and it was also shown that the lobes of the brain presented the appearance of being lapped together and doubled over around the crus cerebri. In the discussion that followed, Dr. Woodward stated that the brain had been so prepared by a peculiar process, that a single one was sawed into 1,000 slices for microscopical examination.

Prof. A. Guyot presented some remarks on a new map of the Catskill Mountains, and on the topographical relations of that mountain group to the adjacent regions of the Appalachian system. The excellent work that has been done by Prof. Guyot in the survey of the Catskill region was described some months ago in a paper read before the New York Academy of Sciences: copies are now furnished of the original map that was then exhibited. The object of the present paper was to call attention to the geological problems exhibited by the Catskill plateau. The author did not regard the carving of the mountains as glacial work, though the evidence of glacial scratches was not wanting. The process which had taken place, he thought, was an elevation of the whole district. But at the time of that rise the Adirondack formation was already in position, and by it the Catskill plateau was squeezed as it rose. The mountains which now occupy the place of that plateau were left by erosion, their valleys being carved out by the rivers. Prof. James Hall, in the discussion which followed, expressed himself as delighted with the adhesion of so good an observer as Prof. Guyot to this theory of the formation of mountains by erosion, and not by their separate upheaval. Prof. Rogers described an instance where one of the Shenandoah Mountains could scarcely have been formed by a separate upheaval, for all its strata were horizontal from bottom to top; but the surrounding region was full of the evidences of disturbance.

Prof. James Hall exhibited some new and remarkable forms of crinoids from the Lower Helderberg formation. These specimens were obtained partly in New York State, and partly in Tennessee. They were from three to four inches in diameter, and of varying shapes, no two alike, though mostly spheroidal; some were hemispherical or much flattened; others were turbinated. It was at first suspected that these were expansions of the bulbous root of crinoids, but subsequent observations indicated that these are the summits of the animal. They are made up of polygonal plates, but the arrangement is not distinctly radial, and its stellate character is greatly obscured. The specimens, which are now quite numerous, seem to be overgrowths, and present great difficulties in classification.—Prof. Hall read also a paper upon another Silurian fossil, *Lycopodites vanuxem*. This has been regarded as a plant, allied to the ferns: a more thorough study of the subject has convinced Prof. Hall that this fossil was an animal form. It is found in quantities that cover many acres with a thickness of five to fifteen feet. The attention of the Academy was also called to the question as to the classification of *Stomatophora*, a coral found upon masses of favosite, and in the same horizon as the curious crinoids. In the discussion which followed, Prof. Newberry called attention to the sponge-like appearance of the crinoid specimens, suggestive of a missing link between crinoids and sponges.

Prof. Asaph Hall read a brief paper on this year's observations on the satellites of Mars. The discrepancies of position of Deimos are very small. It is found that Phobos comes to its greatest elongation 44 minutes before the place as computed : its period as now ascertained is 7h. 39m. 13·996 sec.

A paper by Prof. Joseph Le Conte on the old river-beds of California, was read in the absence of its author, and attracted much attention. These river-beds are now in process of being washed out by hydraulic mining, in the search for gold ; and it is in them that some of the earliest traces of prehistoric man are alleged to have been discovered. Prof. Le Conte does not regard the hydraulic method of attack as promising to yield many fossils in good preservation ; it is more likely to destroy all traces. The mode of formation of the old river-beds, which are found in Middle California, is peculiar. Their rivers had been completely displaced and have formed new channels, sometimes parallel, and sometimes even at right angles to the old ones. The new channels are cut perpendicularly through 2,000 to 3,000 feet of slate rock. The old channels are filled with boulders and pebbles; capped with a conglomerate layer, described as "trifaceous," the product of a volcanic overflow, with few pebbles. Under ordinary circumstances the tendency of rivers to clear their own channels is effective, though sometimes operating at long intervals. If the load of detritus is too heavy, it is deposited ; but eventually there comes a time when the river is no longer overloaded, and then it proceeds to tear up and remove its previous deposits. Thus at the present time the Colorado River is underloaded, and is cutting its channel, while the Platte is overloaded and filling up; the Yuba River has filled a depth of 15 feet within the past 20 years. But in the old river-beds under consideration, the deposit has been capped and protected by a volcanic overflow. We find evidences of this lava flood over a vast district, but not extending to the British possessions. Prof. Le Conte is inclined to fix the period of the lava flow as at the boundary between the tertiary and quaternary. Whitney and other geologists have referred the gravel of these river-beds to the pliocene; Prof. Le Conte thinks that the fossils indicate the approach of a change to the quaternary, and that the passage from the pliocene to the glacial epoch was gradual. To review the whole procedure, he begins with the elevation of the Sierras, when a general drainage system was constituted without much tendency to erosion. Glaciers formed and were melted, and thus were provided the boulders and gravel. Then came the lava flow, which destroyed the old drainage system, and compelled the rivers to seek new channels. The further elevation of the Sierras had renewed the glacial operations, which in some instances had wholly swept away the lava and replaced it by a different class of deposits. The paper elicited a very lively discussion, in which all the geologists present took part. Prof. O. C. Marsh is inclined to give full weight to the views of Prof. Whitney and Clarence King, who have been long in the field and have studied the subject very thoroughly. Prof. Marsh said that he himself has picked out fossil remains from these river-beds, which were unquestionably pliocene, and of animals living in a tropical climate. The volcanic outbreak certainly took place in the pliocene, and before the glacial epoch ; of this he had assured himself by observing the position of layers of basalt. We find the remains of man in this position—in the pliocene, along with remains of sloths and other tropical animals. We concede that these animals were there in that era. Why must we suppose that the remains of man were brought thither by some accident? It seems more reasonable to believe that man was there in that warm climate, in which he could live, than that he came in with the cold and the glacial era.

"Our Memory for Colour and Luminosity," was the subject of an essay by Prof. O. N. Rood. He proposed to give a few results from a series of experiments recently begun and not yet completed. It is generally supposed that while we have a distinct memory of different colours, such, for instance, as those which are called "primary," we do not remember with definiteness, particular shades of colour or specific mixtures of white and black. Nearly all optical instruments in which there is a provision for comparing either colours or amounts of luminosity, are constructed with great care so as to bring as nearly as possible into contact the colours or shades to be compared. The prevailing notion seems to be that we do not retain for ten seconds an exact memory of a given shade or tint. Prof. Rood exhibited the apparatus by means of which he tested the correctness of this notion. Two disks were so arranged that either one could overlap the other in any required proportion. The disks were of different colours, which blended into a given tint when the disks were rapidly revolved—a tint having a known percentage of each of its components. Let us suppose that this tint was obtained by thus blending 43 parts of yellow with 57 parts of red. Prof. Rood wished to ascertain how near to that proportion he would get when he reproduced that tint from memory. So he took a glance at it while the disks were revolving. An assistant then disarranged the disks, and afterwards proceeded to rearrange them, making the blended tint more or less yellow as directed by Prof. Rood, until the colour attained corresponded to the latter's recollection of the original tint. The original having 43 per cent. of yellow, the reproduced colour had—on an average of many trials—42·6 per cent. of yellow. This was when only a minute elapsed between looking at the tint and reproducing it. The largest variations from the mean were not over ½ of one per cent., a difference of tint so slight as to be just barely perceptible when it is shown by direct contrast and the superposition of the differing shades. When an hour was allowed to elapse before the colour was reproduced from memory, the tint obtained averaged 45 2 of yellow, showing an error of 2·2 per cent. error. Reproductions 24 hours afterwards gave 47·5 ; *i.e.* 4½ per cent. Equally near results followed in testing the memory for other mixtures of colours, such as yellow with green, and blue with green. The amount of error in several of these instances was exhibited to the Academy by means of the apparatus, and was scarcely distinguishable. This power of memory for colours might, however, be peculiar to this experimenter : to test that point, a similar set of observations were made upon his assistant's memory, with as good results. There was a single and curious exception. During one of the experiments a cord in the apparatus snapped ; this incident so distracted the assistant's memory of a given tint that his reproduction of it was utterly at fault ; but immediately afterwards he regained his usual average of correctness. The reproduction of grays, that is, mixtures of white and black, is attended, as might be supposed, with a somewhat larger average of error ; but the experiments on this point are not yet complete. From what has thus been shown it is evident that the memory of definite tints is fairly accurate, so that it can be depended upon within certain limits. Hence the juxtaposition of tints to be compared in spectroscopes and other optical instruments is not always necessary. The instruments themselves can be made far less complicated and costly where this feature of cons ruction is not required. Observers can be trained to an accurate memory of tints and even of differences of luminosity. Prof. Rood showed also some apparatus for obtaining a quantitative analysis of the effect of contrast upon adjacent colours. It was shown, for instance, that the colour of a small disk on a large ground was overwhelmed by its background to the extent of 12 per cent. In the discussion on this paper, Prof. Trowbridge, of Columbia College, stated that his students in drawing, preparatory to a course of engineering, were required first to make a draught from a model, and then, the next day, to reproduce the draught from memory. Several of these drawings, with the duplicates from memory, were exhibited ; they gave conclusive proof that the memory of form under such circumstances may be cultivated to a high pitch of accuracy.

Prof. S. P. Langley gave a brief account of a portion of his researches on the radiation of the solar atmosphere. These have demonstrated the decline of heat-radiating power from the centre to the edge in a certain series ; and also a decline of light-radiating power in a totally different series, the light near the centre having a blue tinge while that of the outside edge is chocolate red. The apparatus used in these researches was exhibited. About thirty years ago Secchi ventured the assertion that there was a marked difference of temperature between the northern and southern hemispheres of the sun. Prof. Langley afterwards disproved this by experiment, and placed the facts before the French Academy. Somewhat recently two Frenchmen, Messrs. Cruls and Lacaille, announced to the Academy, (through the Emperor of Brazil, who is a corresponding member) that they had verified the original observations of Secchi. They stated that the heat of the northern hemisphere of the sun was to that of its southern, as 100 to 75. Prof. Langley has since carefully repeated his experiments, and is satisfied that there is not a demonstrable difference in the heat of the two hemispheres. In the course of 400 observations he has found only fractional differences of less than one per cent., and since there is no systematic relation between these, they are to be ascribed to such errors as we may reasonably expect.

A second paper from Dr. Joseph Le Conte was read, on the glycogenic function of the liver, being a continuation of a paper on the subject read at a previous meeting and since published. The theory which is advanced in these papers and supported by certain experiments, is as follows:—Food passing into the liver is there changed into materials fitted for the blood, the albumenoids into nitrogenous and saccharine substances, the amyloids into glycogen or "liver sugar." In preparing sugar for the blood, the liver exercises its chief function by supplying easily combustible fuel. The combustion of this fuel takes place in the capillaries, whither oxygen is also carried by the blood. With regard to the place of combustion being in the capillaries, in contact with tissue, there is no longer a question; the novelty claimed by Dr. Le Conte is in respect to the preparation by the liver of the fuel for this combustion. He does not concede that the tissues are themselves burned in the process. He regards the liver as a sort of storehouse, and asserts that the fuel it provides one day may not be consumed till the next day in the capillaries. Many arguments were brought to bear in support of these views. The paper elicited a brilliant discussion in the meeting, for although the main point, the alleged function of the liver, was cheerfully conceded, a question was raised as to the use of the word "combustion" in describing vital processes; such use of the term being ably opposed by Dr. J. Lawrence Smith, who regards oxygen as serving an alimentary rather than a destructive purpose in the animal economy, while Dr. G. F. Barker argued that a true combustion was performed where the oxygen united with carbo-hydrates and the process was accompanied by evolution of heat.

A paper delivered by Dr. George F. Barker had for its title "On Arago's Experiment." It bore reference to the theory which asserts that a wire becomes a magnet during the passage of electricity. This was called in question about fifteen years ago by Prof. Franklin Bache, of Philadelphia (brother of the late Alexander Dallas Bache of the U.S. Coast Survey). He found that when the magnetic field was cut in two by means of a disk of cardboard, a wire that had previously supported a quantity of iron filings, suddenly dropped them. He inferred that the support of the filings had not been due to the wire being a magnet during the passage of the current, since the current was still passing when they dropped. Their previous support, before the interference of the cardboard, was therefore to be attributed either to their magnetic adhesion to one another, or to the direct influence of currents circulating in the magnetic field which were cut in twain by the cardboard. Dr. Barker has been experimenting with a very powerful magneto-electric machine of the Wallace pattern. It was capable of heating a quarter of an inch gas pipe, three feet long, to bright cherry redness in a minute. Its current was used with a copper wire in Dr. Barker's experiments: the question at issue being whether this copper wire became a magnet during the passage through it of the electric current. A five inch iron spike was held under and close to the wire; the gravity of the spike was lessened, but not sufficiently to support it, even when it was brought within the 1000th of an inch of the wire. But as soon as the spike actually touched the wire, it stuck fast, was wholly supported, and arranged itself transversely to the wire. When the spike was withdrawn from the wire by only the 1000th of an inch, it fell, being no longer sufficiently attracted. Dr. Barker regards this as showing that the attraction in the wire is greater than that in the field. The wire was then passed perpendicularly through a hole in a glass plate on whose upper surface iron filings were sprinkled; these, when the current was passed through the wire, arranged themselves on the plate in concentric circles around the wire, thus indicating that such was the direction of the currents in the magnetic field. When the spike was placed near the wire and parallel to it, but suspended by the upper end, the lower end moved in the direction of the field-currents, throwing the spike out of perpendicular. These observations were regarded by Dr. Barker as evidence that the wire becomes a magnet in the experiment of Arago.

Prof. J. S. Newberry delivered a paper on the vegetation of the Atlantic coast of North America in the cretaceous period. He began by briefly sketching the position of the cretaceous in the United States (and specially the lower cretaceous), along the eastern base of the Appalachian chain. A large collection of fossil leaves from this horizon, obtained in the green sands of New Jersey, was exhibited; it included many leaves from trees of the salix family, in great variety; and leaves and twigs of conifers; the specimens were of remarkable beauty and clearness of detail. These fossils indicate that the dawn of the cretaceous period in this country was attended by a temperate climate. It seems probable that the plants of that period spread from America to Europe before the tertiary age, and were destroyed by the glacial epoch, after which, an Asiatic flora, spreading westward, filled the void. In a discussion upon this paper, Prof. Marsh stated his belief that these fossil leaves were older than the lowest cretaceous marls of New Jersey, in which we find crocodilian and other remains indicative of a warm climate. A similar question had arisen about fossils from Dakotah; animal remains at first regarded as cretaceous, but now known to be Jurassic. Local proximity of formations differing widely in age, is not uncommon at the West. Within fifteen or twenty feet of a place where he picked out remains of dinosaurs, crocodiles and the like, he had found at fifty feet lower depth, the ichthyosaurus. Dr. Newberry said that the clays referred to in New Jersey underrun the marl beds, and are a shore deposit, probably a freshwater one. Prof. Marsh hoped that these localities would be very thoroughly explored. Up to the present date we know of no cretaceous mammal; this is the most serious break in our palæontological record. Prof. Rogers mentioned that certain fossils obtained in Virginia sandstones had been classed as Wealden, but he was inclined to consider them as on the border line between cretaceous and Jurassic. He regarded the position of the New Jersey fossils as yet open to question. Prof. Newberry sketched on the blackboard a sectional view of the strata in the New Jersey locality. Prof. Marsh suggested that these conifers and willows may have grown in elevated positions, on mountain sides, where they would have a temperate climate though it was tropical at the base of the mountains; and that these forests might have been dislodged by flood or avalanche, and carried down into the swamps at the base. It was long supposed in Europe that there was no angiospermic flora below the miocene, and when Prof. Marsh picked up there the leaves of an angiosperm in the cretaceous, the specimen was regarded as a great curiosity. In this country such fossils were abundant; but as to the Jurassic flora we know too little to speak with any certainty. Prof. Rogers stated that an investigation of Virginia and Maryland clays, now in progress, would probably solve this question; and Prof. Newberry expressed a similar hope in regard to certain researches on the shores of Buzzard's Bay, Mass.

A second paper by Prof. Newberry was descriptive of some interesting deposits of gold and silver ores in Utah and Colorado. Specimens were shown of sulphate of baryta with ruby silver. The Horn silver mine of Utah had $20,000,000 of ore in sight; the footwall was limestone; the sandstones are full of the impressions of plants, the plants themselves being replaced by horn silver. Such impregnation by a metal is rare, but there are parallel instances with copper, in New Jersey, in porous sandstone. Near the Horn silver mine is one of a conglomerate rock containing a rich argentiferous galena, going down at least 200 feet, and yielding $50 to $60 to the ton. A similar class of deposits has been found in Colorado, in the district of the Silver Cliff mine, a region of trachytic rock like that of the Horn silver district. It would appear that when the trachyte had been heated so as to be softened, while in the shape of balls of various sizes, the ores had coated them and filled their crevices. The ground is covered with this rusty-looking rubbish. At depths of 150 feet in it, silicified wood is sometimes found, and occasionally free gold, or "wire" gold. A man named Bassick, a sailor who had been round the world, and was quite penniless, picked up one of the rusty trachyte lumps and succeeded in having it assayed; the yield was $50 to the ton. He was thus led to the discovery of what is now known as the Bassick mine, which he eventually sold for $1,000,000. Silver Cliff is distant about six miles; it is a hill of shattered rock—breccia which has been cemented together; the mining operations there have gone 250 feet below the surface, into a zone of oxidized ore; the rock of the hill itself is worth $50 to $60 per ton, and its quantity is simply enormous. From other mines specimens were exhibited containing large quantities of arsenic, the ore being also accompanied by veins of orpiment and realgar. Specimens from Leadville mines showed the progress of change from carbonate to galena ores. The limestone surface had been eroded, and then porphyry was poured over it; the fissure veins were formed in this contact. The famous Leadville deposits are not so rich as had been supposed; specimens picked out for assay were very choice; in general the ore contains iron and a great deal of silica. There are two gold mines in Leadville, one of which is ferruginous quartz. The town itself is vile. Its climate is repulsive. It is at an elevation of 10,500 feet, and water is scarce, so that the whole place is covered with at least 5 inches of dust. There is no sewerage, and this dust is the filth of the town; the air is full of it, and it must be inhaled with every breath of the dwellers there. But every man in Leadville believes himself potentially rich, and has a mine or a claim for sale. Speculation in claims, and mere gambling in fractional ownerships, is the principal business. Prof. Newberry had seen the law papers in the examination of a mining property where no less than 14 claims overlapped one another. There is really valuable mining property in abundance, not yet developed, in Colorado and Utah; but the properties that are put on the market for sale in New York are generally worth little or nothing, and will tend to discredit investment in all Western mines.

Prof. J. Lawrence Smith gave an informal account of some recent researches for new elements. A few years ago he found a field of research in the cerium and yttrium minerals, and was well satisfied that he had obtained a new substance, which he named mosandrum, in the cerium group. Since then he has been studying the components of samarskite, and has found, he believes, two new elements, one of which he calls columbium, and the other he proposes to name in honour of his friend and the instructor of his youth, Prof. William B. Rogers. But having much other business requiring his attention, Prof. Smith has done little in that line of research, since then, except to purify some mosandrum. Not wishing to delay the progress of discovery, he turned over a mass of the earthy material to Messrs. Lafontaine and Lecoq Boisbaudran, who have since announced several discoveries. The new elements are not yet separated; the supposition of their existence is based upon observations on their absorption spectra. Prof. Smith has great doubts whether this method is trustworthy. He found that a given solution showed a different spectrum the second day from that of the day before. The addition of nitric acid in greater or less strength was found to alter a spectrum to an extent fully as great as would be considered indicative of the presence of a new metal. But in nitric acid itself there is nothing to provide these new spectra. Hence a doubt is thrown over all discoveries that rest exclusively upon absorption lines. There are probably 8 or 10 new earths in the yttria group. Of the newly announced metals, Prof. Smith thought philippium was more likely to prove real than most of the others. In the discussion that followed, Dr. Barker pointed out that the colour of a solution affected its spectrum. He regarded the discoveries based solely on absorption spectra as not to be trusted until supplemented by chemical tests.

The other papers read at the meeting were as follows: "On the Mean Pressure of the Atmosphere over the United States at Different Seasons of the Year," by Prof. Elias Loomis; "Questions as to a very Direct and Simple Method of Ascertaining the Ellipticity of the Terrestrial Spheroid," and "The Completion of the Theory of Parallel Straight Lines," by Prof. Stephen Alexander.

The meeting closed with a brief address by its presiding officer, Prof. Rogers. In the course of his remarks he expressed a wish that hereafter some measures should be taken for a more general and widespread invitation to the public to be present at the meetings of the Academy. This suggestion will probably be adopted.

WM. C. WYCKOFF

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following Statutes, which the University of Cambridge Commissioners contemplate making for the University, having been communicated to the Council of the Senate, the Vice-Chancellor hereby gives public notice thereof in the University.

"The University shall have power to adopt as an affiliated College in any place within the United Kingdom or in any part of the British Dominion any institution founded for the education of adult students, with such conditions as to the provision of lectures, and as to the rules and arrangements for the students, as may be determined from time to time by Grace of the Senate. Students of the institution who shall have continued members of it for such length of time, not less than two years, and shall have attended such lectures, and passed such examinations, as may be required from time to time by Grace of the Senate shall, if admitted as members of the University, be deemed to have kept already three of the terms required for any degree."

"Students in Science, who having already taken a degree in Arts, Law, Medicine, or Surgery, have given proofs of distinction in Science by some original contribution to the advancement of Science, and having done all that is required by the statutes and Ordinances of the University, may be admitted to the title of Doctor designate in Science, and shall afterwards be created Doctors at the time prescribed by the University."

"The management and regulation of the Botanic Garden, together with the appointment and removal of the Curators, Superintendents, Officers, and servants employed therein, shall henceforth be vested in a Syndicate consisting of the five Governors and Visitors appointed by Dr. Walker, that is to say, the Chancellor, or in his absence the Vice-Chancellor of the University, the Master of Trinity College, the Provost of King's College, the Master of St. John's College, and the Regius Professor of Physic, together with such other persons as may be appointed from time to time by Grace of the Senate."

The Syndicate appointed on May 31, 1877, to consider how to encourage students to read for honours in more than one tripos, in consequence of urgent representations on the part of head masters of public schools, have made a sixth and final report, leaving the Board of Natural Science Studies to propose the necessary and more than formal changes required in the regulations. With this exception, the Syndicate consider the duties committed to them to have been completely discharged.

Lord Rayleigh, we are glad to learn, has consented to become a candidate for the Chair of Experimental Physics at Cambridge; the election takes place to-morrow.

Mr. E. B. Tawney, F.G.S., Assistant to the Woodwardian Professor, who has made most valuable donations to the Woodwardian Museum, has had the degree of Master of Arts conferred upon him. Every geologist and palæontologist who knows Mr. Tawney will be glad to see this recognition of his merits.

THE number of matriculated students attending the University of Edinburgh this season is 2,510, the number of students in medicine being 1,138, in law 363, and in divinity 74. There is an increase, as compared with last year, in all the faculties, that in medicine being 96, and the total increase 178.

THE Court of Assistants of the Cordwainers' Company being impressed with the importance of the City Guilds employing part of their funds in the establishment of a central institution for the promotion of technical education, have, in addition to a grant of 250*l*. per annum already made, voted a donation of 500*l*. towards the building fund, on condition that the total sum agreed to be subscribed for that purpose be in their opinion adequate to the satisfactory fulfilment of the object contemplated.

SCIENTIFIC SERIALS

Gazetta Chimica Italiana, fasc. viii. and ix.—On cimene of cuminic alcohol, by SS. Paterno and Spica.—Decomposition of chlorhydrates of ethylamine by means of heat, by SS. Fileti and Piccini.—Gasometric analysis and methods, by SS. Amalo and Figuera.—Artificial improvement of leaves of indigenous tobacco by means of the sap of exotic leaves, by S. De Negri.—On phenoltolylates, by Dr. Mazzara.—On meta-amido-cinnamic acid, by the same.—Synthesis of phenyl-cumarine, by Dr. Ozliaboro.—On sulph-acids of cumene and on a new cumophenol, by Dr. Spica.—On insecticide powders from the flowers of *Chrysanthemum cinerixfolium*, Trev., by Prof. Dal Sie.—Artificial production of the oligiste of Vesuvian lava, by S. Coppola.—Researches on the products of oxidation of alcoholic derivatives of natural and synthetic thymol, by SS. Paterno and Canzoneri.—On a new organic acid, lithobilic acid, found in oriental bezoar, with lithofellic acid, by Dr. Roster.—On a new method of preparing phenolglycolic acid and on pyrogallotriglycolic acid, by Dr. Giacosa.—Resistance of seeds (especially clover) to prolonged action of gaseous and liquid agents, by S. Giglioli.—On lapacic acid, by S. Paterno.

Journal of the Franklin Institute, November.—We note here the following:—A general differential equation in the theory of the deformation of surfaces, by Mr. Craig.—Future water supply of Philadelphia, by Mr. Bukinbine.—A new illustration of persistence of vision, by Prof. Tobin.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 27.—"On the Structure of Serous Glands in Rest and Activity." By J. N. Langley, M.A., Fellow of Trinity College, Cambridge. Communicated by Prof. Michael Foster, M.D., F.R.S.

The Parotid Gland of the Rabbit.—The alveoli of the gland can be observed in the living state without serious interference with the blood circulation. When the gland has been quiescent for several hours, the alveolar-cells are granular throughout, and the outlines of the cells are only faintly marked as clear lines without granules. When the gland secretes, the granules disappear from the outer borders of the alveolar-cells, that is, from that portion of the cells nearest the basement membrane. After prolonged secretion, very few granules are left in the cells; those that do remain in any cell form a thin layer at its inner portion, that is, at the portion bounding the lumen, and stretch outwards, also as a thin layer, along the cell-sides a variable distance from the lumen.

In an alveolus during secretion, the cells separate from one another slightly near the lumen; thus the lumen stretches out for a short distance between the cells; it becomes larger, at the same time, by the diminution which takes place in the size of the cells.

The above described changes occur whether the secretion is induced by giving food to the animal, or by giving it pilocarpin, or by stimulating the sympathetic nerve running to the gland. The two zones of the fresh state are not preserved by alcohol and other reagents.

Osmic acid shows some considerable differences between the resting and the active gland, the chief amongst which is the more equal staining of the substance of each alveolar-cell in the active state.

The Parotid Gland in the Rat, Cat, and Dog behave in rest and activity like the parotid of the rabbit in a corresponding condition. The living condition in these cases, however, has not been observed in the glands with intact blood-circulation.

In one case where the sympathetic nerve of a dog was stimulated, a saliva was obtained from the parotid, of unusual character. The saliva clotted readily, and contained 8·3 per cent. of solids, of which 7·8 per cent. were organic substances. Jacobson's nerve was uncut. The much more rapidly flowing saliva following subsequent injection of pilocarpin had a slightly lower percentage of salt than the slowly secreted sympathetic saliva. In several cases in other glands I have also seen a diminution in percentage of salts, notwithstanding an increased rate of secretion of fluid.

The Sub-maxillary Gland of the Rabbit undergoes changes in activity similar in the main to those which occur in the parotid. The changes are, however, less marked; the granular condition of the gland has a less direct relation to the state of hunger of the animal.

The sub-maxillary gland has one very characteristic feature, the transition- and some of the ductule-cells contain, in life, granules more distinct and larger than those contained in the alveolar-cells. How far these disappear during secretion is uncertain.

As in the parotid so in the sub-maxillary, reagents do not preserve the normal appearances. The secreting gland treated with osmic acid shows alveolar-cells much more evenly stained throughout than does the resting-gland.

The deep black staining of the transition-cells with osmic acid described by Nussbaum does not take place if the gland be treated with osmic acid only; the deep coloration is the result of a subsequent treatment with alcohol. With osmic acid alone, the ducts stain darker than any other part of the gland.

I must uphold my previous objection to Nussbaum's view that ferment is formed in the transition-cells and not elsewhere. Briefly my objections were that the ductule-cells, in their method and depth of colouring behave like the transition-cells, and that the black coloration of the transition-cells with osmic acid does not occur if the gland is previously treated with absolute alcohol, in which the ferment is said by Nussbaum to be insoluble.

I can in the main confirm Bermann's description of a "tubular gland" in the sub-maxillary of the rabbit.

The Infra-orbital and Lachrymal Glands of the Rabbit show an outer clear and an inner granular zone in activity even more distinctly than the parotid. In both these glands osmic acid preserves more nearly the living appearances. The two zones if present normally, are also present after treatment with osmic acid.

In the *Mucous Glands* during secretion the changes in life are less readily followed, but they are probably similar to those mentioned above. In rest the alveolar-cells form granules like the alveolar-cells of a serous gland; but in the former case the granules are of nearly the same refractive power as the surrounding substance and so not conspicuous. In activity the granules are used up, and disappear first from the peripheral parts of the cells.

"Report on Phyto-Palæontological Investigations on the Fossil Flora of Sheppey." By Dr. Constantin Baron Ettingshausen, Professor in the University of Graz, Austria. Communicated by Prof. Huxley, Sec. R.S.

Physical Society, November 22.—Prof. W. G. Adams in the chair.—New Members, Prof. Reilly and Prof. Heath, of Cooper's Hill Engineering College.—Prof. Guthrie exhibited a new photometer in its crude form and demonstrated its action to the meeting. It consists of two fixed plane mirrors inclined to each other at an angle. The rays from the two sources of light to be compared, are allowed to fall on these mirrors, those from one source, say that on the right hand, falling on the right hand mirror, and those from the left hand source on the left hand mirror. These rays are again reflected from the mirrors at right angles to their former paths and thrown upon a semi-transparent screen where their relative intensities can be compared by the eye of the observer between the mirrors and each source of light; a revolving shutter is interposed. These shutters are formed of brass disks and they are both mounted on the same axis which can be turned by hand or otherwise. They would completely screen the light from the mirrors were it not that each is provided with four radial apertures or slots through which the rays can pass. The slots on the side at which the brighter source of light is placed are narrower than those on which the weaker source is placed. The latter slots are made adjustable in size by sliding blinds and a scale is added to measure the degree to which they are closed. On revolving the shutters the reflection of the rays to be compared are seen side by side and (owing to persistence of images on the retina) continuously on the screen placed in front, and they are brought to equality of brightness by closing or opening the blinds of the adjustable shutter. When this is so the ratio of the respective orifices of the shutter as given by the scale is the inverse ratio of the luminous intensities compared. Prof. Adams remarked that the speed of rotation should be such as to produce a uniform field of light on the screen, a result which hand-turning was not very conducive to. Prof. Foster observed that the use of this new photometer might be less fatiguing to the eye than those photometers which presented a steady beam to the eye undiluted with intervals of darkness during which the light is cut off, as on the instrument before the meeting.—Prof. Reinhold then read a paper by Prof. Rücker of the Yorkshire College, Leeds, on a suggestion as to the constitution of chlorine offered by the dynamical theory of gases. If a gas of density δ consists of molecules each of which possesses *no* degrees of freedom, and if also the inter-molecular forces are negligable, the specific heats at constant pressure (Cp) and at constant volume (Cv) are connected by the two well-known equations,

$$(1) \quad (Cp - Cv) \quad \delta = \cdot 0694$$

$$(2) \quad \frac{Cp}{Cv} \dots 1 + \frac{2}{m+e}$$

where e is a quantity which depends upon the potential energy of a molecule; hence if Cp is given by experiment Cv can be calculated from the first equation, and then $m + e$ is known from the second. Regnault determined the specific heats at constant pressure of 35 gases, and from the experiments of E. Wendemann and of Wullier it appears that his values are correct within 6 per cent., and that $m + e$ can be calculated very approximately from the above equations if Cp is given. One of the chief difficulties of the thermo-dynamic theory of gases has been to attribute to m and e values which would at once lead to the observed ratios of Cp and Cv and satisfy any rational supposition as to the interior mechanism of a molecule. Kundt and Warhng proved that for mercury $\frac{Cp}{Cv} = 1\cdot 666$, which is consistent only with the supposition that the atoms of mercury are smooth rigid spheres; and Boltzman and Bosanquet have pointed out that for a smooth rigid surface of revolution $\frac{Cp}{Cv} = 1\cdot 4$, a number agreeing closely with the experimental value for air, O, N, H, CO and NO. The molecules of these gases may therefore be constituted of two spheres rigidly united, or, as Prof. Rücker suggests, bound together by forces which prevent their separation of their surfaces while leaving them otherwise free to move. The principal object of Prof. Rücker's paper was to point out an interesting fact connected with the application of this theory to chlorine.

The maximum number of degrees of freedom which a molecule composed of n smooth rigid spheres could possess would be $3n$, but the forces in play between the spheres might reduce this number. Thus the value of $m + e$ could not exceed but might be less than $3n + e$. When the molecule consists of two atoms $e = o$ but for complexer molecules we should, *cæteris paribus*, extract its value to increase with the number of molecules. From two tables of results calculated by him, Prof. Rücker, however, finds that for a number of simple and complex gases and vapours the value of $m + e$ is for each substance less than $3n$ (or the maximum possible value of m), while for the majority of chlorine compounds examined the reverse statement holds good, that is, the value of $m + e$ is generally greater than $3n$. This difference may be explained by supposing that for chlorine e is abnormally large, and that the spheres are not necessarily in contact; or that n has been taken too small, that the symbol Cl_2 is incorrect, and that the chlorine atom contains a larger number of sub-atoms than has been supposed, a supposition which accords with the recent researches of Prof. Victor Meyer on the vapour density of chlorine. Prof. Rücker also finds that the ratio of the specific heats of bromine and one of its compounds studied (C_2H_5Br), agree with those of chlorine and the corresponding chlorine compounds. Dr. Shettle, of Reading, then read a paper on the influence of heat upon certain forms of induction coils considered more especially in relation to the inductive power which the blood exercises on the various structures of the body. The author found that when a copper and a zinc wire were insulated from each other by parchment paper and paraffined silk, and wound in close proximity to each other, an (induced) current was indicated on a galvanometer whose terminals were connected to the neighbouring ends of the zinc and copper wires respectively, the other ends being left free. When the latter were connected across the deflection was *nil*. On raising the temperature of the two wires by causing hot water to flow inside the coil into which they were wound the deflection was largely increased. These experiments lead Dr. Shettle to imagine there is a similar action in the animal body. The heart is made up of nerves and muscular fibres winding spirally, and some of these wind round each other so as to form a spiral cord round which the blood capillaries also wind. Dr. Shettle compares these nerve and muscle bundles to the coils of zinc and copper wire in his experiments, and infers that electric currents may be induced in them as in the wires. The flow of the warm magnetic blood would also tend to produce currents in them. Dr. Shettle further drew attention to the fact that animals live and move in a magnetic field, and that electricity must be generated in them by their movements internal and external.—Mr. Emmott exhibited Crossley's form of microphone, which consists of four short rods of carbon jointed loosely into four blocks of carbon so as to form a square. It is used as a transmitter for telephones, and Mr. Crossley regularly transmits the services of a church with it to several hearers. Its speaking, singing, and whistling powers were successfully demonstrated to the meeting.

Paris

Academy of Sciences, December 1.—M. Daubrée in the chair.—The following papers were read:—Observations on M. Trecul's last note relative to chlorophyll, by M. Chevreul. He asks whether chlorophyll is a constituent part of the organ, or is only accessory and without organic activity.—On some properties of glucoses, by M. Peligot. By action of alkalies on glucose, he obtains a crystalline substance (which he calls *saccharine*), having the composition of ordinary sugar, or saccharine, not yet sugar. In presence of yeast it does not ferment; its taste is not that of sugar, but almost *nil*, with a slight after-bitterness. The common view, that saccharine matters should be regarded as polyatomic alcohols, is not (M. Peligot thinks) confirmed by production of this new substance. In the action of lime on glucose, a true saponification occurs.—Note on the crystalline form and optical properties of saccharine, by M. Des Cloizeaux. The optical phenomena do not enable one to conclude with certainty whether saccharine belongs to the rhombic or the clinorhombic system.—Questions relative to phylloxera addressed to M. Thenard, by M. Fremy.—Reply to these questions by M. Thenard. This relates to the use of sulphide of carbon, and its effects on vines.—Demonstration, by means of elliptic functions, of a theorem in the theory of the libration of the moon, by M. Gyldén.—Note on the measurement of quantities of electricity, by M. Hirn. He calls attention to M. Villari's demonstration that the action of the spark of Leyden batteries on the magnetic needle is proportional to the quantities accumulated, and seeks to show that this law is in harmony with those he himself has indicated as to the effect of continuous currents; (he expresses a wish that M. Villari's important memoir might be published *in extenso* in French).—Periodic movements of the ground revealed by spirit levels, by M. Plantamour.—This gives results of a year's observations at Secheron from October 1878. The east side went down with decreasing temperature until June, (there being a pretty exact parallelism between the curves); then the east rose until the beginning of September, in a much greater proportion than the exterior temperature. From 32·8mm. the greatest depression to the east, on January 15, to the maximum of elevation 19·5 mm. on September 8 gives 52·3mm. as the total amplitude of oscillation during the year, (or 28·08s). There was generally besides a daily movement, with amplitude on September 5, of 3″·2. The minimum is usually between 6 and 7·45 a.m. the maximum twelve hours later. In the meridian direction, the movements of the ground are much less; the total amplitude for the year was only 4″·89. They show an unexplained anomaly relative to the movements east and west. The daily movements in the meridian are very rare, irregular, and small. It seems, then, that at Secheron there are periodic movements of rise and sinking of the ground, and that, generally, they are determined by the exterior temperature. Perhaps the configuration and nature of the ground have also some influence.—Establishment of scientific and hospital stations in Equatorial Africa, by M. de Lesseps. It has been decided by the French Committee of the African Association to establish such stations between Zanzibar and the Gaboon; the Chambers have voted 100,000 fr. for the purpose.—Astronomical junction of Algeria with Spain; international operation under General Ibañez and M. Perrier, by the latter.—Note rectificative of M. Viallanes's opinion regarding phylloxeric spots in the environs of Dijon.—M. Lamarre described an electric phenomenon lately observed by him during a fall of snow at Cherbourg. Luminous *aigrettes* appeared at the points of his umbrella.—Determination of curves and surfaces of two surfaces which have double or stationary contacts with each other, by M. Zeuthen.—On series relative to the theory of numbers, by M. Lipschitz.—On a dynamometric brake regulated automatically, by M. Carpentier.—Separation of phosphoric acid from sesquioxide of iron and alumina, by M. Derome.—On the constitution of stag's horn, by M. Bleunard. It is an inferior homologue of coagulated egg-albumen. It is more hydrated than albumen.—Determination of chlorine in different grains and forage plants, by M. Nolte. Chlorides form part of all vegetable food.—Rhythmic contraction of muscles under the influence of salicylic acid, by M. Livon. A rhythmic tetanic period with contractions decreasing in intensity, precedes exhaustion.—On the mode of distribution of phosphates in muscles and tendons, by M. Jolly.—Influence of different colours on the development and respiration of infusoria, by M. Fatigati. The respiration is more active in violet than in white light, and less active in green than in white.

CONTENTS

THURSDAY, DECEMBER 18, 1879

BOSTON AND HARVARD

To the common remark that nowhere in the United States does an Englishman feel himself so much at home as in Boston; a student of science may add that nowhere else does he meet with so much to remind him of the intellectual activity and enthusiasm for science that mark the great centres of life in the old country. Boston can boast of one or two of the oldest and most active scientific societies in America, which for generations have gathered together and sustained an able succession of workers. In the neighbouring venerable Harvard it enjoys a perennial fountain whence it may draw for ever fresh stores of inspiration and encouragement. This influence of the University is everywhere apparent. Among those who take a lead in promoting science by discovery and exposition among the Boston citizens, Harvard men occupy always a foremost place. A stranger, however, with leisure and opportunity to note some of the more salient features in the scientific life of Massachusets soon comes to realise the pervading influence of one man. He sees it in the ordinary cultivated society of Boston, he meets with it at every turn in Harvard, he finds it uniting as a common bond of sympathy the younger scientific men of the state. The name of Louis Agassiz has become a household word in the community, and, among the scientific workers, sounds as a rallying cry to unite them for common sympathy and support. Great as were Agassiz's solid contributions to the literature of science, they form a monument to his genius not perhaps more honourable or enduring than the impetus which his example and ceaseless enthusiasm gave to the progress of science in his adopted country. To have written the immortal "Recherches sur les Poissons fossiles" and to have founded so vigorous a school of science at Harvard combine to give him a high place in the temple of fame.

It is delightful to hear in general conversation in Boston spontaneous recognitions of Agassiz's eminent services. Many stories are current of his indomitable courage in carrying out schemes for the advancement of his favourite studies, of his consummate address, which enabled him to win over into active assistance men who were disposed to be indifferent if not hostile. One interesting anecdote is told of a dinner party at which he was present, when Mr. Ticknor gave an account of an early meeting of the British Association. At the Geological Section there had been a paper on fossil fishes, and, said Mr. Ticknor, one speaker who evidently knew the subject profoundly, proceeded to show the audience the characters of the types of ancient fishes, and remarked that he had no doubt a specimen would yet be discovered exhibiting a certain structure, which he illustrated by a drawing on the board. Murchison, who was in the chair, thereupon pulled out from a drawer a specimen which had just come up from Scotland and had not yet been exhibited. It completely bore out the prognostication. Agassiz had been listening to the tale with undisguised interest, and when Mr. Ticknor turned round and pointing to him said, "There is the man," he started up flushed with excitement and exclaimed, "It was the proudest moment of my life." Such anecdotes affectionately preserved show how he lives in the memory of the community he strove so earnestly to benefit. The little misunderstandings which are always sure to arise in the pathway of a man absorbed in one great aim are now forgiven and forgotten. Men remember that it was not for himself but for the cause of science that he solicited and strove.

Among the younger men of science the influence of the teaching and example of Agassiz has been profound. It is not that they have adopted his views or even that they have chosen his branch of science. On the contrary many of them have espoused evolutionary doctrines against which he protested, and have taken to sciences remote in subject from his. But he infused into them a genuine love and enthusiasm for scientific progress. By this common sentiment they are united in a bond of sympathy which cannot but be very helpful to their own studies and to the advancement of science. One of the most interesting tokens of this community of feeling is the establishment of a club or society which has no name, no office-bearers, and no laws, but which has for its object the reunion of its members for social intercourse at stated intervals. It began its existence in a meeting of two or three of Agassiz's students, and now it has drawn into its circle most of the scientific zeal and ability of the younger men of the district. Nor is it wholly confined to the younger generation. At one of the simple but most excellent and jocund dinners of the club the writer of this notice found the genial and universally beloved veteran in botany, Dr. Asa Gray, as well as that long-tried explorer of the deep sea, Count Pourtales.

Nor among the benefits bequeathed to Harvard by Agassiz can we forbear an allusion to his son. With enthusiasm not inferior to that of his father and with an ample fortune for the furtherance of his views, the present distinguished keeper of the Museum of Comparative Zoology is gathering together at Harvard the most extensive and valuable collection of recent invertebrate zoology in the world. So far as exhibition space will admit, a large and varied series of specimens is displayed. Some departments are marvellously rich. The dredgings by Prof. A. Agassiz and Count Pourtales have supplied a large suite of living corals, some of them undistinguishable from Tertiary Mediterranean species. In one of the rooms is an altogether unique collection of crinoids from the Carboniferous Limestone of Burlington. A European accustomed to the usually fragmentary condition of palæozoic echinodermata can hardly at first believe that these exquisite specimens of many species and genera, with every plate and joint in position, come from so ancient a formation. As at Yale, cellars are crowded with treasures awaiting examination and display. The work-rooms attached to the Museum are likewise full of material in all stages of investigation, and bearing witness to the amount and value of the original research carried on here by Prof. Agassiz, Count Pourtales, and their assistants. The only regret a visitor can justly express is that the plan of the building has not secured a larger amount of internal light. The windows at the sides form the only entrance for light, and they are not large or numerous enough for the size of the rooms. Would it not be possible, in the contemplated additions to the Museum, so to modify the plan as to secure, at least for the exhibition galleries and floors, some amount of light from the roof?

H

Within the walls of the Museum Prof. J. D. Whitney has accommodation for geological work. He is engaged in the completion of the memoirs of his great Californian survey. He has recently issued the first part of an exhaustive monograph of the auriferous gravels of California, which is published in the *Memoirs of the Museum of Comparative Zoology*. One of the most generally interesting and important features in this essay is the cautious and masterly way in which the author states the evidence for the existence of human remains in the gravels beneath sheets of basalt, and at a depth of 130 feet from the surface. It is impossible to resist the cogency with which he marshals the facts and maintains the genuineness and high antiquity of the Calaveras skull. The second portion of the memoir, devoted to a discussion of the origin of the auriferous gravels and of the glacial phenomena of the Pacific coast and of North America generally, is awaited with much interest. Prof. Whitney, in the course of his prolonged researches in the west, made a large and important collection of rocks. These are now being carefully investigated by his associate, Dr. M. E. Wadsworth—a young petrographer, who in recently taking the degree of Doctor of Philosophy at Harvard, presented, as his thesis, a remarkable essay on rock classification, largely based on these collections. The Professor, with the devotion to geology which has characterised his long and distinguished career, carries on this work at his own expense. The results will be published in full in the *Memoirs of the Museum of Comparative Zoology*.

There is much more than the name of Cambridge to remind one of its namesake at home. Its quiet air of studious retirement, its quaint buildings and tree-shaded walks have much of the mother-country about them. One or two features of the place, however, are characteristically American. Thus in the great library at Gore Hall, most of the work of receiving and distributing books is done by young women, and done, too, with a noiseless decorum and celerity worthy of all praise. A magnificent Memorial Hall to those graduates of Harvard who fell in the late Civil War bears witness in its crowded lists of names that culture and courage may go hand in hand. The simple eloquence of these lists, where every class and division of the faculties is represented, brings home to the mind in a startling way the terrible realities of a war. May the occasion never arise for another range of tablets either there or here!

While Harvard is necessarily the great centre of scientific research, much admirable work is done in Boston in the way of practically expounding science. The Institute of Technology has for its primary object the education of the community in these branches of scientific knowledge conducive to progress in the arts and industries of life. In pursuance of this aim the methods of tuition are so practical and thorough that the results must be felt far beyond the industrial circles. Established mainly through the enlightened zeal of the present venerable President of the National Academy, Prof. W. B. Rogers, it began a few years ago to languish, but its founder has recently come back to its rescue, throwing himself into its affairs with all his old heartiness and kindliness until, freshened and stimulated by his influence, it is once more shooting up into lusty vigour. But besides this establishment, wholly devoted to scientific instruction, the Boston School Board has made the practical teaching of science an important part of education in the public schools. At an early age the pupils are led to take an interest in physiology by references to the experience of their own bodies, and thus the laws of health are firmly lodged in their minds. From simple beginnings they are conducted through successive years of progress and are well grounded in physics, chemistry, botany, and zoology, until before they leave, if they choose to go so far, they are found at work in laboratories repeating experiments, making analyses, or dissecting plants or animals. The thoroughness of the whole system, and the length to which such State-paid education goes (for it must be remembered that all this training is free), would make most members of our School Boards stand aghast, were any utopian to propose its introduction in this country.

A student of science from this side of the Atlantic besides finding himself at home among lovers of science in New England is astonished and gratified to find that if he has himself done anything to advance our knowledge of nature, his work is as well known there as at home. The welcome he receives is all the heartier from men who have long known him by name and have come already to regard him as in some measure a personal friend and fellow-worker. A brotherhood of this kind, so cosmopolitan, so genuine, and so kindly, carries with it an enduring helpfulness. One comes away from a participation in it strengthened and cheered, with wide enlargement of ideas and sympathies that seem to fill the mind with aspirations and to brace the whole frame for endless exertions to achieve them. Undoubtedly, in spite of all that demagogues may declaim, there is in American society of the more cultured kind a deep undercurrent of affection for the old country. It shows itself in many ways and sometimes crops up unconsciously and almost to the confusion of the native-born American as if he would rather be thought indifferent in the matter. The writer is tempted to conclude with an illustrative story told him by a Harvard friend to whom the incident occurred. Some years ago, just at the time that the famous pamphlet, "The Battle of Dorking," was making a stir in the States as well as here, this friend was in Kentucky with an acquaintance of his who, like so vast a number of his countrymen, had been engaged in the Civil War, and had lost heavily in friends and fortune. This man knew well what were the horrors of war, yet after he had finished reading the pamphlet, and was appealed to by his companion as to what he would do if the picture drawn in its pages were a reality instead of a fiction, he paused and after a little reflection replied, "Well, I think I'd have to go for the old country." There are many thousands of Americans who would have no objections to thrash England themselves, but who would not sit quietly and see the castigation bestowed by any other people.

A. G.

PLANTÉ'S "RESEARCHES IN ELECTRICITY"

Recherches sur l'Électricité. Par Gaston Planté. (Paris, 1879.)

M. GASTON PLANTÉ has published, under the above title, the elegant and important electrical researches which he has pursued with so much success during twenty years, and with many of which the readers of NATURE have been made familiar from time to time.

The basis of these experimental researches is the *secondary battery*, originally devised by Ritter, but which in M. Planté's hands has become developed into what is practically a new and important source of electricity. M. Planté, by employing for his secondary cells large plates of lead immersed in dilute sulphuric acid, charged by a small Bunsen's or Grove's battery, and by arranging the secondary cells in such a manner that they can be charged in multiple arc, and discharged in series, obtains during the ten minutes or so during which the discharge continues currents not only of as great electromotive force as would be obtained from a Grove's battery of a much larger number of cells, but also of much greater "quantity;" the internal resistance of these secondary cells being excessively small.

In studying the construction and operation of these secondary batteries, M. Planté has brought to light a large number of interesting facts. He finds that such batteries improve with use, the two lead electrodes gradually becoming spongy, thereby holding in loose combination larger quantities of the oxygen and hydrogen gases, respectively, than new plates of lead. He observes several highly suggestive analogies between this electro-chemical accumulation of the energy of the current, and the electrostatic accumulation of the Leyden jar. This analogy extends even to the existence of a residual charge. It appears that the electromotive force of such a cell well charged may be as high as 2·7187 volts, while the internal resistance may be as low as 0·05 ohm, and that the actual quantity of the primary current which may be realised after being thus accumulated amounts to 88 per cent. These data are given amongst the stores of information in the first section of M. Planté's work. The second section treats of the practical uses which have been made by M. Trouvé and others of the currents from secondary batteries, and which embrace a wide range of applications, chief amongst which is the application to surgical cautery by means of wires raised to a white heat, for which operation a powerful current of short duration only is required. Another suggestion, to employ such batteries as accumulators of the current supplying electric lights, has already been seized upon by more than one inventor, amongst others by Mr. Edison.

The third section of the work before us deals with sundry phenomena produced by the discharge of the powerful currents of large secondary batteries. To obtain these effects M. Planté has used batteries of from 200 to 800 secondary elements. Luminous liquid globules and delicate flame-like aureoles are produced at the surface of liquids when the current is led into them under certain conditions: even a globule of fused mica has been produced by the current, and wandered about in a manner suggestive of the alleged behaviour of the "balls of fire" sometimes accompanying violent thunderstorms. The discharge may even be employed to write upon glass which is etched away under the negative pole of the secondary battery. The many analogies presented by these experiments with some of the less understood of natural phenomena, globular lightning, auroræ, and wreathed lightning discharges, &c., are treated in detail in the fourth section. M. Planté considers the "Fire of Saint Elmo" to be a phenomenon of discharge of negative electricity, whilst he compares the globular lightning to the phenomena observed in the discharges at the positive pole of his batteries. One of the most curious of his speculations is that concerning the spiral nebulæ, which he compares with the spiral forms produced at the negative pole when dilute acid is electrolysed by a moderately strong current between copper electrodes in the presence of a powerful electromagnet. These "electrodynamic" spirals consist of streams of particles of oxide of copper whirled off from the end of the electrode and which, conducting the current, undergo a rotatory displacement under the influence of the neighbouring magnet. These spirals, which therefore indicate the lines of flow of the current, resemble the spirals obtained by the present writer in iron filings under the joint influence of a magnet and a current traversing it longitudinally, and which differed from those of M. Planté in indicating lines of magnetic induction, not lines of current flow. So strongly does the analogy of form weigh with M. Planté that he asks (p. 243) whether the nucleus of a spiral nebula is not truly an "electric focus," and "whether the spiral form is not probably determined by the presence in the neighbourhood of strongly magnetised heavenly bodies!" Another astronomical analogy is discovered by the author between the sun-spots and certain "crateriform perforations" which are produced in moistened paper beneath the positive pole of the secondary battery.

The fifth, and last part of the work, explains the construction and operation of the author's "rheostatic machine," which is a series of mica condensers which are charged in multiple arc from a battery of 600 or 800 secondary elements, and discharged in series in very rapid succession. This instrument is capable of producing almost continuously the effects of intense discharges of statical electricity, and promises to prove of great utility as an instrument of research.

We have preferred to give the reader a brief *résumé* of the contents of this delightful narrative of researches, rather than to criticise in detail the many salient points which it presents. Experimental researches of the present day are seldom conducted with such patient and ingenious endeavour as those now published in M. Planté's volume. The student of electrical theory will find in them but little that he did not know before. The phenomenal not the theoretical aspect of the question is ever uppermost; and in default of theory there is a tendency to ride *the analogies* too hard. But none can help admiring the beauty and originality of the experiments here recorded, nor doubt the very high value of the results obtained. There will, too, be many readers who will long that all treatises on experimental science were written in so clear, concise, and elegant a style as that of the author.

SILVANUS P. THOMPSON

NATURAL HISTORY OF THE ANCIENTS

Gleanings from the Natural History of the Ancients. By the Rev. W. Houghton, M.A., F.L.S. Illustrated. (London: Cassell, Petter, and Galpin, 1880.)

THIS interesting volume consists of a series of short lectures treating of most of the animals known to the early inhabitants of Egypt, Palestine, Assyria, Greece, and Rome, from the oldest historic period down to about the middle of the third century of the Christian era. Referring to his sources of information the author expresses his acknowledgments to the Biblical and Assyrian records and the classical writers of Greece and Rome. Alluding to Aristotle's work, "The History of Animals," he quotes Lewes's well-known remarks thereon, which, while he will not fully endorse, he yet on the whole agrees with.

The author warns the reader not to expect an exhaustive treatise on the subject; the avowed object, as the title indicates, being but gleanings picked up almost at random from a spacious field; indeed, a volume quite as large might be written on only those domestic animals known to the ancients. If not a complete history, these "Gleanings" are, however, very pleasant reading, deeply interesting to the intelligent student, and making him wish for more. In some cases a little more information would be useful, and we would venture to suggest to the author that in another edition he might with advantage add more details about the very early history of some of the best known of the animals which he has selected for notice. Thus the Egyptians were the only people amongst the ancients who habitually domesticated the common cat; with them it was a great favourite, and we would certainly have liked a little more of what the author could have told us about the cat as it is found in an Egyptian home; had it a pet name there? and is it not strange that the children of Israel do not seem to have come across it during their lengthened sojourn in that strange land? In another edition the references should be quoted at greater length; thus the general reader could scarcely be expected to know that the translation of Prof. Gubernati's interesting work on "Zoological Mythology" is referred to as "Guber. Zool. Myth."

The Egyptian dog is acknowledged by the author not to come up to the standard of modern European views of canine beauty; but he is not so severe on them as Mr. Mahaffy, in whose eyes the house-dogs appear to have been worthless curs, and the hunting-dogs more like those lanky creatures kept by some of the Irish peasantry for an occasional Sunday coursing match (Mahaffy, "Prolegomena of Ancient History"). The author states that the Egyptian monuments anterior to the date of Amosis (about B.C. 1500), of the eighteenth dynasty, give no representation of horses, but considers it would not be safe to conclude from negative evidence that the horse was not introduced into Egypt anterior to that date. Leaving the date of the papyrus Sallier to be settled by experts, but presuming it from Mr. Goodwin's Essay ("Cambridge Essays," 1858) to relate to events about the time of the Exodus, we find such allusions as "The horses of my lord are well," and "His ploughshare, which is of metal, corrodes, the horses die through the labour of ploughing;" the latter is very remarkable for being part of the complaint of an agricultural tenant; these would show that at this date—possibly the date of the years of famine—horses, were then employed in field work.

The common pig formed part of the farmyard stock of the Egyptians, and the author thinks that they were kept as probably useful in treading in the corn after it was sown, and he quotes Herodotus and Ælian as describing the process; neither author says anything about the pigs being muzzled when performing this useful part, but they are shown as such on a Theban sculpture referred to.

The section about the pigeons might be greatly expanded; there is next to nothing told us about the pigeon as known to the Egyptians and Hebrews, and though there is a woodcut from an Assyrian sculpture showing hare and birds, yet there is not a word in the text as to the hare being known to the Hebrews and Assyrians.

The second part of the volume on wild animals is nearly equally interesting as the first. In it we read of the lion, hyena, stag, wild bulls, boar, vulture, pelican, ostrich, and many other birds, as well as of several species of fish, known in the olden times.

OUR BOOK SHELF

Bulletin des Sciences Mathématiques et Astronomiques. Deuxième serie, tome iii., avril 1879. (Paris.)

THIS number opens with abstracts of works by H. Lemonnier ("Mémoire sur l'Élimination," Paris, 1879); E. Schering ("Analytische Théorie der Determinanten," Göttingen, 1877); and an interesting note by S. Kantor ("Quelques Théorèmes nouveaux sur l'Hypocycloïde à trois Rebroussements"). Our present object is, however, to take notice of two long articles by M. G. Darboux, (α) "Sur un nouvel Appareil à Ligne droite de M. Hart" (7 pp.) (β) "Recherches sur un Système articulé" (42 pp.).

(α) is founded on a five-bar linkwork, described by Mr. Hart in the eighth volume of the *Proceedings* of the London Mathematical Society (p. 288), which M. Darboux looks upon as a construction of great interest. The writer explains Mr. Hart's method and slightly generalises it, getting the following results: (1) an ellipse and Pascal's limaçon can also be described by the linkwork; (2) a movement of a straight line which always remains horizontal whilst its several points describe vertical straight lines. By means of a duplication of the apparatus, "on pourra poser une table sur ces droites, et l'on aura ainsi la disposition la plus simple connue, permettant de réaliser un mouvement parallèle dont les applications sont évidemment très-variées."

(β) is a discussion of Mr. Kempe's "recherches très-interessantes" "On Conjugate Fourpiece Linkages" in the ninth volume of the *Proceedings* of the same Society (pp. 133-147). M. Darboux remarks that Mr. Kempe has considered one interesting case only, that, viz., "où les équations sont des identités et où par conséquent la déformation de la figure est possible." He praises the ingenuity of the method employed, and says that Mr. Kempe has arrived at a large number of solutions of a problem which, *à priori*, would be thought to have none. He then proceeds to attack the question in a more general manner, connecting the problem with the use of Mr. Hart's apparatus, referred to in his paper (α). "La marche qui j'ai adoptée repose d'une part sur l'emploi des *grandeurs géométriques* dans le plan et sur leur expression bien connue au moyen d'une variable complexe, et d'autre part sur les recherches que j'ai publiées récemment[1] et d'après lesquelles la théorie du quadrilatère articulé est identique à celle d'une cubique plane, que j'appellerai *cubique associée au quadrilatère.*"

Denoting the outer quadrilateral of Mr. Kempe's figure by $MNPQ$, and the inner by $M'N'P'Q'$, M. Darboux calls them respectively the quadrilaterals T, U, and the associated cubics he calls the cubics T, U, and taking $t, t', t'', t''', u, u', u'', u'''$ as the co-ordinates of a point in space with reference to the two cubics, he finds the conditions that a certain group (4) of equations between these co-ordinates shall be satisfied by an infinite number of values of the t's and u's. He regards these equations, when the movement of the figure is possible, as establish-

[1] P. 109 of the *Bulletin* for March, 1879.

ing a correspondence between the t points of the cubic T associated with the quadrilateral T, and the similarly determined u point, and proceeds to examine all the cases in which this correspondence is uniform, *i.e.*, when to a point of each curve corresponds a single point of the other curve. He then shows that all other cases may be reduced to this case of uniform correspondence. His conclusion, after a discussion of these equations of condition, is that *there are no other solutions besides those deduced from the uniform correspondence* cases. He establishes coincidences with most of the cases discussed in Mr. Kempe's paper, and arrives at one new case, viz., when Mr. Kempe's triangles reduce to straight lines coinciding with the sides respectively of T and U.

Our object has been to draw attention to what we look upon as a valuable pendant to the last-named gentleman's Researches in Linkworks.

Lecture Notes on Physics. By C. Bird, B.A., F.R.A.S. (London: Simpkin, Marshall, and Co., 1880.)

THE author says in his preface that the book "may be supposed to represent the notes, somewhat expanded, which the teacher would desire the class to take down and learn." If so, the "notes" before us would certainly merit a good deal of attention from the teacher's red-ink pen. Of its 178 pages, 68 are taken up with examination papers of the Science and Art Department. The various branches of physics are very unequally treated. Occasional blunders are frequent. Thus on p. 27 we are told that "Writing m for the refractive index, the critical angle for any medium is $\frac{1}{m}$." On p. 2 Laplace's correction of the velocity of sound for the adiabatic conditions is stated to be the ratio of the two specific heats of air, when it should be the square root of that ratio. On the very next page we are told that the amplitude of a sound-wave varies inversely as the *square* of the distance from the source, and that *therefore* the intensity falls off in the same ratio; whereas in fact the intensity is proportional to the square of the amplitude. Under the heading "Electrometers" we observe that the only instruments named are the quadrant pith-ball electroscope, the torsion balance (which is not even described), and the unit-jar! But one could hardly expect accuracy of an author who allows himself to talk about "force" being "converted into heat."

Diagrams of Zoology. Sheet I. and II., with handbooks thereto. By Dr. Andrew Wilson. (Edinburgh and London: W. and A. K. Johnston.)

THESE sheets are meant to serve as important adjuncts in the way of illustrating a series of lectures on the classes to be met with in the animal kingdom. They have been drawn and coloured under the direct superintendence of Dr. A. Wilson, and are accompanied by a handbook to each sheet which contains full descriptions of each figure. They will no doubt be found most useful for the purposes of science classes in our public schools, and in them illustrations of recently described forms will be found. For example, under the kingdom of the protozoa, we find no less than five figures representing that low form of animal life called by Hæckel *Protomyxa aurantiacea*, one of the Monera.

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.*]

The Exploration of Socotra

WOULD you allow me, on behalf of the Committee of the British Association for the Advancement of Science for the Exploration of Socotra, to state in your columns that we are anxious to find a competent naturalist to proceed to Socotra early next year, the gentleman whose services we had hoped to secure being unfortunately unable to undertake the task. The expedition will be but a short one, as it would be useless to remain in the island after April.

It would be desirable that the explorer should have some acquaintance with Arabic and some local knowledge of the surrounding districts.

P. L. SCLATER

11, Hanover Square, W.

Monkeys in the West Indies

IN reply to the inquiries of Mr. Watt (NATURE, vol. xxi. p. 132), I send you the following extract from the *Proceedings* of this Society for February 13, 1866.

"Mr. Sclater called the attention of the meeting to three monkeys recently received from the Island of St. Kitts, West Indies. Mr. Edward Greey, Fellow of the Society, having reported the existence of monkeys in a wild state in considerable numbers upon this island, had been urged by Mr. Sclater to attempt to obtain some specimens, in order that it might be ascertained to what species they were referable, as it had always been believed that there were no native Quadrumana in the Lesser Antilles. Through the assistance of Mr. John Carden, of St. Kitts, Mr. Greey had succeeded in obtaining a specimen of this monkey, and two others from the same island had at the same time been presented to the Society by Mr. H. B. Cameron, Superintendent of the R.W.I.M.S.P. Company, at St. Thomas's. The animals were undoubtedly referable to the common green monkey (*Cercopithecus callitrichus*, Geoffr.) of Western Africa, and must have been introduced years ago, as they were stated to be now very abundant in the woods of St. Kitts, and to cause great damage to the sugar-plantations."

As regards Trinidad, where true American monkeys (*Cebidæ*) are certainly found, it should be recollected that, zoologically speaking, Trinidad is not one of the Antilles, but a little bit of Venezuela, broken off at no very remote period.

Prof. Mivart and Mr. Bates are, therefore, correct in saying there are no *indigenous* monkeys in the Antilles.

P. L. SCLATER

Zoological Society of London, 11, Hanover Square, W.

Is Mount Unzen a Volcano?

IN a recent visit to the Simabara Peninsula, about twenty miles east of Nagasaki as the crow flies, an opportunity was afforded me of ascending "Unzen," a mountain which rises about 4,700 feet above the sea (by aneroid). If tradition is to be believed "Unzen" is an active volcano, the subterranean fires of which have been slumbering since the close of last century, when a disastrous earthquake, accompanied by a volcanic eruption, destroyed 53,000 of the inhabitants of the district. But I failed to find any trace of a recent volcano, which, wherever it may be, is certainly not situated in the higher peaks of the mountain, where popular belief has located it. From the sea-level up to the highest summit a porphyry is the ever-prevailing rock, which varies somewhat in different parts of the peninsula. True it is that from many points of view Unzen has somewhat the form of a truncated cone, but there the resemblance ends.

There are, however, three hot sulphur springs, which may help to explain the popular error on the subject. One of them is situated in the fishing village of Wohama, at the foot of the mountain, and close to the water; a strong odour of sulphuretted hydrogen scents the air, and the thermometer placed in the water rose to 112° F. Rather more than 2,000 feet above the sea are the hot springs of Kojeego and Unzen. In the former place the water bubbles up into a pool some ten or fifteen yards across, with a temperature of 182°, while at Unzen the hot springs are on a far more extensive scale, numerous springs bubbling away furiously over an area of several acres, which is completely destitute of vegetation. The ground is often so hot that with a thick pair of boots one cannot stand long on the same spot. The thermometer rose as high as 202°, which would be only about 6° below the boiling-point of water at that elevation, and a dense cloud of white smoke ascended into the air which was strongly impregnated with the same sulphureous odour. The chemical and thermal influences of these hot sulphur springs have produced a singular effect on the porphyry of the immediate locality; while the rock has a tendency to lamination, its disintegrated felspathic constituents whiten the whole surface, and the neighbouring hill-slopes overlooking the springs are as white as any chalk-cliffs from the same cause. This phenomenon is only to be found in the immediate vicinity of the hot springs.

It is with the hope that these few notes may be the means of eliciting further particulars, especially as regards the history of this so-called volcano of Unzen, that I venture to send them to NATURE. H. B. GUPPY, Surgeon H.M.S. *Hornet*

H.M.S. *Hornet*, Nagasaki, October 13

Astronomical Subject-Index

I AM preparing for publication, by the Royal Dublin Society, a review of the progress of astronomy during the present year, consisting of a classified index catalogue of books, memoirs, and notes on astronomical subjects published since the beginning of the year, and, secondly, of a short account of the contents of the more important papers in the various branches of astronomy.

Any person who has felt the want of such a "subject index" could assist materially in the undertaking by sending me, as soon as possible, the titles of such papers as seem likely to be overlooked on account of having been published in less widely-diffused periodicals or transactions. In particular I would be glad to hear of papers published quite recently in transactions or proceedings of learned societies, as these often are not distributed until some time after their publication.

J. L. E. DREYER

The Observatory, Dunsink, Co. Dublin, December 11

Distinguishing Lights for Lighthouses

A propos of your article on Sir William Thomson's letter in the *Times*, and the dangers to ships from bad systems of distinguishing the lights of different lighthouses, I send you the accompanying graphic account by my brother, Mr. J. P. Thompson, of a narrow escape from shipwreck which occurred to him during the autumn of the present year, and which illustrates the urgent need for reform in the adopted system.

SILVANUS P. THOMPSON

"All went well till off Ushant, when the wind began to rise, and by Saturday afternoon the Channel was heaved up by what was logged as a 'moderate gale' from the south-west. This kept freshening every hour, and at 7 P.M., when the lamps were being lit, the captain said we should have a very 'dirty night,' and he accordingly donned his oilskins and 'sou'-wester.' The atmosphere began rapidly to cloud, and at 9 o'clock you couldn't see more than a ship's length or two ahead. As we were in a crowded track of vessels, the watch look-out was doubled. . . . At 11 I was on deck again, and found all looking out eagerly for either the St. Agnes (Scilly) or the Wolf Light, the latter being near the Cornish coast. Of these lights the St. Agnes shows a white light at each revolution of a minute, whilst the Wolf is the same, but with a flash of red between. The sea was very phosphorescent, and this dazzled the eye when looking for lights. I was set as a look-out on the starboard quarter, and many times had to go aft for the captain to see how she lay by the compass abaft (she was being steered at the wheel in an iron wheel-house on the bridge.) . . . About midnight we sighted a light, and on timing it, found it to be a white light of a minute's revolution; we looked in vain for a red flash between the whites, as we knew we ought to be near the Wolf. But in the fog not a 'smell of red' could be discerned, although by the rate at which we passed it we must have been very near it. Supposing, then, that there was no red flash, this must be the Scilly light, and the captain accordingly steered more easterly, so as to fetch the Wolf. He nevertheless hardly thought we had got so far to the west as the Scilly, so he ordered a sharp look-out to be kept for breakers or land. At 3.30 I turned in again, but at 4 A.M. I suddenly heard the look-out cry out 'Land! breakers ahead!' and then I heard the captain run to the telegraph, and heard the bell ring in the engine-room, and the captain's sonorous voice calling 'All hands! square away the yards! 'bout ship!' I jumped up, and ran on deck, and there right ahead the fog had just lifted to show us we were almost ashore, heading straight on Penzance; so near, indeed, were we that I could have easily counted the houses. Happily the ship, answering her helm well, came round beautifully, and at the same time the fog closed again, hiding the shore and the dreaded rocks. So after all it *was* the Wolf light we had sighted, *but the fog had prevented us from seeing the red flash*. It was a narrow escape, though; and then we had to beat back in the teeth of the gale, and it took us six hours to beat back to the Land's End."

The First "Sin"

IT occurred to me lately, whilst reading in the September number of the *Contemporary Review*, an article by Lenormand called "The First Sin," that it may be possible to turn another page of that very interesting history of ideas, the reading of which appears to be one of the great tasks allotted to this century. Although it seems unlikely that the idea suggested to me by the article has not also occurred to others, I cannot discover that anything has been said about it, for the author seems strangely enough to lead one to the door, as it were, and leave one there without opening it; I should therefore like, if you will permit me, to lay it before your readers, and hear what they have to say about it.

My idea is this: that the tradition of a tree of life, and also of a tree of the knowledge of good and evil, both connected with a sin and a catastrophe, probably originated in man's first acquaintance with the effects of intoxication.

Lenormand himself connects that tradition with the worship of Bacchus (and also with the theft of fire in a piece of a tree by Prometheus, and with that of the apples of the Garden of the Hesperides). It seems strange, therefore, that he goes no farther, more especially as he himself points out that the representations of the tree on the monuments of different nations are always referable to those from the fruit or foliage or crushed branches of which an intoxicating liquor is derived; from the Soma tree, that is, and the palm and the vine.

There is no need to burden your pages with proofs and quotations, as any one interested in the subject can procure the magazine now at half price; I will merely add to my suggestion that, as the primitive notion of life must have been characterised by warmth and motion, and the first effects of the fruit of the tree would also be, probably, warmth and excitement, exhilaration and the temporary exaltation of some of the faculties, it would easily come to be looked upon as a "tree of life;" and that, the after-effects being bad and degrading, it would thereby become a tree of the knowledge of evil as well as good, and also the cause of a fall into a lower state of being.

May I add a suggestion concerning the serpent always connected with the tree, as on the early Babylonian cylinder figured on p. 91 of George Smith's "Chaldean Account of Genesis"? It appears to have represented the principle of evil very early, probably long before it was connected with the tree, and to have been at first the sea, which in a storm was the chaos out of which everything was formed, and which, as it seemed to swallow up sun, moon, and stars, and to bring forth the storm-clouds—those monsters with which the sun-god fought with his arrows the lightnings—came also, not unnaturally to represent the destructive principle. But how did it become a serpent? May it not have been the singular resemblance that the edge of the sea—as seen from a moderate height in a calm—bears to a huge serpent—now blue, now white, according to the amount of foam—winding and writhing about the earth, and eating out its rocks and shores, that caused its destructive attributes to be transferred to the serpent? A common name may have been the means. The resemblance is especially striking when the eye looks along the shore, as in the bend of a bay.

Another suggestion. Some years ago, when reading the description of the locality of the Battle of Beth Horon in Dean Stanley's work on Palestine, it seemed to me to point to the origin of the tradition of the sun and moon standing still at the command of Joshua, and I do not think it has been noticed. In any valley lying north and south, if one goes up the western hills as the sun sets to the valley, when one reaches the summit the effect of a new day and a fresh supply of sunlight is very striking. This sensation must have been strongly felt by the warriors of Israel, when, after pursuing their enemies up the pass, the still sunlighted valley beyond broke upon their sight; and I cannot but think that, figuratively expressed, as it would be, and with much exaggeration, in the triumphal song sure to have been made and sung after the victory, it may well have originated the tradition of a standing still of the sun; the moon would follow suit. The songs are said to be the oldest parts of the Bible, and "Jasher" or "The Upright" may have been the singer or recorder of the lost song of triumph. J.

The "Encyclopædia Britannica"—The Nile

THE volume of the Nile is made a thousand times greater than the truth in the new "Encyclopædia," vol. vii. p. 706, art. Egypt, by an error copied from the last edition. The same mistake occurs in Rawlinson's "Herodotus," vol. ii. p. 7, Note GW.; in the Geographical Society's *Journal*, vol. xix.; in Fullarton's *Gazetteer*, and probably elsewhere, and some fables have been founded on it.

I observed the error myself some years ago, after being perplexed by it in some rainfall estimates, and mentioned it to the late Sir Gardner Wilkinson, who intended to have it corrected; but there has been no fresh edition of the "Herodotus," and it has escaped revision in the "Encyclopædia." As it illustrates a special danger, easily overlooked, in copying French figures, it deserves perhaps a few lines in NATURE to put it right.

In English notation we mark decimals with a point, and use commas to divide periods; but the French generally use commas to mark off decimals. The authority for the volume of the Nile is Linant's measurement, given by Clot Bey in the "Aperçu général sur l'Egypte," tome i., pp. 40, 41, and the figures are given as follows, in cubic metres of water discharged into the Mediterranean at full flood in twenty-four hours:—

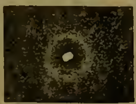
English authorities	705,514,667,440
Linant	705 514 667,440

The last three figures are decimals, and the quantity is in millions, not in thousand millions. ALBERT J. MOTT

December 14

Lunar Rings

ACCORDING to your suggestion I have followed up my experiments with lunar light on bromo-gelatine plates, and at midnight on November 28, for the third time at full moon period I



obtained on one plate three well-defined rings round the photographic image of the moon with 1 minute, 1½ minute, and 2 minutes' exposure.

The 1 minute exposure is fainter than the above woodcut, the 1½ minute the same in density, and the 2 minutes' exposure is denser and more defined; while six consecutive nightly observations previous to the 28th failed to give any vinculum or indication of refraction of light.

One of the six taken on the night of November 24 with *two hours'* continuous exposure gave a bright clean well-defined line 2½ inches long, gapped here and there by passing clouds, but not the slightest indication of blurr or dispersion was shown on the brightest parts of the line.

Whether the cause which produces these rings at full moon phase *only*, depends upon the greater effulgence of lunar reflection at that particular time; whether it is cosmical or atmospheric in its nature, or optical or chemical, there can be no doubt that there is refraction of the lunar light; the existence of a dark space between two luminous (or more correctly speaking actinised regions) as manifested by the above annular *periodical* impressions is a clear indication of the dispersion of light, but how, why, or where the decomposition takes place is not so obvious.

Sunderland, December 5 GEORGE BERWICK

Stag's Horns

IT is well known to be the universal belief in the Highlands that stags eat the horns they shed, and every gillie will tell you that no one ever picked up a horn. Can any of your readers inform me what really becomes of them?

There must be abundant opportunities of observing the whole process in places like Windsor Park, where red deer are kept in a domesticated state. G. W. H.

ON A NEW COPYING PROCESS

A VERY elegant process has recently been introduced into this country for copying and multiplying letters and documents. It is known by various names, according to the etymological skill of the makers. One calls it a "hektograph," another less pardonably calls it the "centograph," while yet another, to bridge the gap between ancient Greek and modern English, styles it the "printograph." But whether it is introduced by these names, or the polygraph, the compo-lithograph, or the velocograph, the principle is the same; though the details are slightly varied in each case. A slab of gelatinous material in a shallow tin tray forms the type. The letter is written with a special ink on any kind of paper, and when dry is placed face downwards upon the jelly, and allowed to remain a minute or more. On removal it is found that the greater part of the ink has been left behind on the jelly. It is only necessary to place pieces of paper on the latter, and on their removal they are found to be perfect fac similes of the original copy. The number of copies obtainable varies with the ink, the most potent being aniline violet, such as Poirrier's. With this a hundred copies may be produced. Others, such as Bleu de Lyon, Bismarck brown, or Roseine,[1] yield forty to fifty. It was with a view to determine the principles which govern this beautiful process, that I made an examination of the subject. The slab consists of gelatin and glycerine, with carbolic or salicylic acid to prevent fungoid growth, and in the "chromograph" a quantity of barium sulphate is added, which gives the slab a white, enamel-like appearance.

If a hot, strong solution of gelatin in water be prepared,[2] and then a certain quantity of glycerine stirred in, the whole mass will become solid in cooling. This might at first sight appear to be a solution of gelatin in water *and* glycerine; but such is not the case, the gelatin being quite insoluble in glycerine. When the aqueous solution solidifies, the gelatin still retains the water, but the large quantity of glycerine being dispersed through the mass, makes the whole into what is practically *a very fine gelatin sponge containing glycerine in its pores.*

The moisture-loving nature of the glycerine prevents the "sponge" from getting dry, while the insolubility of the gelatin in the glycerine prevents its becoming liquid. When the copy is placed on the jelly, the glycerine comes out to meet the ink, for which it has an intense liking. All the suitable inks are freely soluble in glycerine. Some, too, contain acetic acid either in the free state or in combination with bases as in rosaniline acetate. The acetic acid exerts a solvent action on the gelatin, so that it will be found that after taking off some impressions with an acetic acid ink, as the "multiplex," the jelly will be etched wherever the ink has come into contact with it. As long as any of the ink remains on the jelly, the glycerine will come out of the pores to keep it moist, but when the whole of the ink has been removed the flow of glycerine ceases, and the parts become quite dry. If the ink is not entirely removed by taking a sufficient number of impressions, and the jelly left, after a lapse of twenty-four hours the remaining ink will be absorbed by the jelly. It is necessary, therefore, that the copies should be taken off as soon as possible, so as to avoid the defect caused by the spreading of the ink.

Most of the makers suggest, that directly the slab is done with, the type should be washed off. The hektograph and most others require that the water should be warm, but the finely divided barium sulphate in the chromograph, renders the surface less tenacious, and the impression may be removed with cold water.

Where practicable, it is better in all cases to leave the slab for twenty-four hours, when the old impression will be quite absorbed, and not interfere with a new one.

This gelatin copying process has been received with so

[1] A very potent and easily prepared ink which will yield a hundred copies, may be made by dissolving rosaniline in a cold-saturated solution of oxalic acid. It must be allowed to dry spontaneously.

[2] 4 oz. gelatin dissolved in 6 oz. water, and 20 oz. glycerine, sp. gr. 1·26, previously warmed, stirred in. Any air bubbles in the gelatin are removed before the addition of the glycerine. A cheaper compound which answers equally well, but is rather darker, consists of Scotch glue 6 oz., water 8 oz., glycerine 20 oz. These quantities make a slab 10 × 13 × ¼.

much favour by the public, that it shows there is a great want for some rapid means of getting a limited number of copies of letters, &c.; and seeing that any number of colours may be used in the original drawing, Mr. Norman Lockyer has suggested that it would be of much use in laboratories, for the multiplication of original sketches of biological specimens, and even for spectra charts, and so save much of the time spent in making duplicate copies. The gelatin slab cannot be said to be perfect, as it is liable to be affected by atmospheric changes; but, bearing in mind the fact that the whole is simply a sponge filled with a compound capable of liquefying eertain inks, it is reasonable to hope and expect that chromography is only the pioneer of a process, which shall possess all its advantages and none of its defects. R. H. RIDOUT

THE ANIMAL HEAT OF FISHES

THE belief that fishes are *cold-blooded*, that is, that they take on the temperature of the water which surrounds them, with no power to resist it, and that they develop little or no animal heat themselves, is still held by many even scientific observers. This belief is based partly upon the well-authenticated fact that fishes have been frozen and thawed again into life; partly upon the statements of many travellers who have found them living in water of a very high temperature (Humboldt and Bonpland recording the highest, 210° F.); and further, that a thermometer inserted into the rectum of some living fish freshly drawn from the water has been repeatedly found to indicate temperature corresponding very closely to that of the water itself.

During the past summer, and in connection with the operations of the U.S. Fish Commission at Provincetown, Mass., Surgeon J. H. Kidder, of the U.S. Navy, was detailed to make some systematic observations upon the subject of fish-temperatures with a view to setting the question upon a secure basis of actual experiment. Thermometers were made expressly for the purpose by Mr. John Taglialne, of New York, of unusual delicacy, registering about 10° F. each, and recording fifths of a degree. These were used in connection with Negretti and Zambra's deep-sea thermometers, and all the instruments were deduced to a single standard by frequent comparisons, so as to insure *relative* accuracy. The fish were taken with a line, and their temperatures observed at once, care being taken that no considerable change in temperature occurred during the time consumed in bringing the fish to the surface. The observed temperatures were then compared with that of the water as recorded by a Negretti-Zambra thermometer sunk to about the depth from which the fishes were taken. The first observations, made by inserting the thermometer into the rectum of the fish, agreed with the generally-received opinion, showing but little higher temperature than that of the surrounding water.

The mode of experiment was then somewhat modified. Considering the fact that the intestinal canal of a fish is in close contact with the thin and scarcely vascular walls of the abdomen, which is surrounded by the water in which the animal swims; and, further, that the arterial blood comes from the gills, where it has been spread out as thinly as possible and brought into the closest contact with the surrounding water—a process well calculated to cool it quickly to the same temperature—it follows that neither the interior of the rectum nor the arterial blood would appear to have the same value as representing the body-temperature in fishes that those parts possess in mammals and birds. It is rather in the venous circulation and the branchial artery that we should seek for the heat which must certainly be developed in the chemical processes of nutrition and waste, and in connection with active muscular movements. In the remaining experiments of the series—about ninety in number—the fish was therefore opened at once, and the bulb of the thermometer inserted into the cavity of the heart, or branchial artery, with the results indicated in the following table, which shows the averages:—

Fish.	Temp. of surrounding water.	Rectum.	Venous blood.	Remarks.
Cod	° 39–42	° + 0·98	° + 4·63	
Haddock	,,	+ 1·30	+ 5·30	Spawning.
Pollock	42	+ 2·40	+ 4·50	
Hake	,,	+ 2·40	+ 9·80	Spawning.
Bluefish	70–73 *	+ 0·25	− 1·55	
,,	,,	+ 0·50	+ 1·70	
Young mackerel † ...	65 *	+ 4·10 ‡	+ 5·25 §	
Do. do. (*Scorulus dekayii*) ‖	60 *	—	+ 2·30 §	
Sculpin	60 *	+ 0·80	+ 3·20	
Eel Pout ¶	—	+ 3·00	+ 6·00	
Flounder	42	—	+ 3·00	
Dogfish	42	+ 4·40	+ 12·00	Oviducts contained mature young.
Do. young from oviduct	42	—	+ 20·60	

It appears from these experiments that fishes do develop a measurable quantity of animal heat, which is more apparent during the spawning season, and much greater in elasmobranchs (as is to be expected from their more perfect digestive and assimilative apparatus) than in other fishes. It also appears that the measure of this animal heat is to be sought in the venous blood, and not in the intestinal canal or arterial blood.

The limits of this preliminary note will not permit us to go into an enumeration of the difficulties of observation or the measures taken to guard against the errors likely to attend them. Nor is the number of observations (ninety-five in all) sufficient to warrant the offering of these figures as a final statement of the *degree* of animal heat presented by the several fishes observed. All that can be said to be proved so far is the fact that fishes do manifest animal heat, and in considerable quantities, sufficient to warm again, to the extent of from 3° to 12°, blood that has been cooled in each circuit to the temperature of the surrounding water. Details will be given in the forthcoming report of the United States Fish Commission.

In the single instance of a lower temperature than that of the water, observed in five blue-fish, all taken on the same day, it may be that the individuals experimented on, being taken at the surface, had just come up from a much greater depth and colder stratum of water. There seems to be no conceivable provision by which a fish can maintain a temperature below that of the surrounding water, cooling by evaporation being out of the question. The young dogfish from its mother's oviduct showed a temperature 8° higher than that of the mother herself, for the obvious reason that its blood, not coming into contact with the water by its gills (the umbilical sac was still attached), was not cooled otherwise than mediately, through the blood of the mother.

NEW MODES OF SHOWING DIFFERENT CHARACTERISTICS OVER SMALL ARCS IN AZIMUTH FROM THE SAME LIGHT-HOUSE APPARATUS

WHERE a light on a rock or island has to illuminate constantly the whole horizon, the ordinary dioptric fixed apparatus is all that is required. But when, as at

* Surface-swimmers. † "Sinkers." ‡ Stomach, through œsophagus.
§ Temperature taken in blood flowing from heart, the organ being too small to admit the thermometer.
‖ This rare species, not seen in Massachusetts Bay for thirty years, appeared, young, at Provincetown last summer in considerable numbers.
¶ *Zoarces anguillaris.*
The sign "+" indicates excess, and "−" deficiency, as compared with temperature of water.

many places, there is a shoal at some distance from the lighthouse, or where a reef of rocks projects seawards from the shore, it sometimes becomes necessary to adopt means for keeping vessels clear of such dangers at night, as, for example, near Souter Point, where Mr. Douglass and Mr. J. T. Chance employed successfully the electric light for guarding a rock near the shore. What is wanted in such cases is to cover not only the danger itself but some area of the surrounding sea by a characteristic which is different from that of the main light.

If in front of a fixed light apparatus whose optical property is to parallelise the rays in the vertical plane while not interfering with their natural divergence in azimuth, there be placed an arrangement of straight horizontal shades or screens similar to the Venetian blinds which are used for house windows, the means will be supplied for easily producing different distinctions. The breadth of those blinds must be such as to subtend from the central flame the same angle as that over which the necessary distinction has to be shown at sea. By opening and shutting simultaneously and *gradually* the different leaves of the blind, there will be produced the same characteristics as those of an ordinary revolving or flashing light, according as the leaves are moved slowly or quickly and kept shut for a certain period, and these distinctions will be accompanied by the necessary gradual waxing and waning of the emergent rays. By simultaneously opening and shutting the leaves of the blind *suddenly*, and keeping them open so as to show a fixed light for a certain length of time, and then keeping them shut so as to produce darkness for a certain length of time, the effect of an intermittent light in which there is no waxing or waning of the rays will obviously be produced.

Should it be considered desirable to vary the appearance over the given arc so as to show a gradually increasing length of light period when a vessel is approaching the danger, the maximum period when it is opposite to it, and a correspondingly shortening period as the vessel leaves it, a single straight opaque mask placed outside of the apparatus, and revolving horizontally and with uniform speed on a vertical spindle will produce the result. For while the periods of *change* will remain the same over the whole arc the *duration of darkness* will gradually increase as the danger is approached, and gradually decrease after the danger has been passed. And if this vertical shade be made to rotate at a slow and uniform speed it will produce the effect of a revolving light, and if at a quick speed it will produce the effect of a flashing light, with this difference that the flashes *will recur with only an instantaneous interval of darkness*, and in both cases there will be a gradual waxing and waning of the rays.

By these very simple and cheap expedients a fixed light illuminating the whole horizon (by means of a flame of he ordinary size in relation to the focal length) can easily be made to show accurately over any limited angle in azimuth the effects of the different distinctions referred to, and these combinations will therefore supply a desideratum which is often much wanted in coast illumination. In some experiments which were made all these characteristics were successfully produced by the two modes described.

Where no light is required in any part of the horizon but in one small arc only, as, for example, in illuminating the middle of a long narrow Sound, all the rays proceeding from the lamp should be spread equally over that arc. A fixed holophote with an opaque disk revolving horizontally in front on a vertical spindle will, if condensing prisms are placed between the disk and the holophote, produce either a revolving or flashing light according to the speed of its revolution, but without any intervening period of darkness. If colour distinction be required and a revolving disk of glass be substituted for the opaque mask the characteristic effect produced would be that of a revolving red and white light *without any intervening dark period between the flashes*, which would gradually dissolve into each other from red to white and then from white to red.

Edinburgh, October 22 THOMAS STEVENSON

A FEAT IN TRIANGULATION

A NOTEWORTHY advance in geodesy has recently been accomplished by the junction of the network of measurements covering a large portion of the surface of Europe, with the African continent. The entire triangulation of Algeria was completed by French engineers some time since, and extended to the edge of the Sahara, in lat. 37°. M. Perrier, who had directed in a great measure the triangulation of Algeria, has for the past eleven years been seeking the means of joining the network in that country with the perfect trigonometric system covering the surface of Spain, France, and England. The importance of such a junction is easily appreciated when we consider what notable changes in the accurate conception of the shape of the earth and of the length of meridians has been effected by measurements on a much smaller scale.

For such an undertaking the most careful and painstaking preparations were requisite. As the result of his reconnaissances between 1868 and 1872, M. Perrier found that from all the trigonometric points of the first order between Oran and the frontiers of Morocco, the loftier crests of the Sierra Nevada on the Spanish coast opposite, were visible in exceptionally clear weather. Arrangements were subsequently made with the Spanish Geographical Institute for the mutual and contemporaneous execution of the proposed plan. A corps of Spanish officers, under the direction of the well-known General Ibanez, was detailed for this purpose, while the French Minister of War placed a division of officers from the *État-Major* under the command of M. Perrier. The leaders chose for stations in Algeria the summits of Mount Filhaoursen and Mount M'Sabiha, west of Oran, and in Spain the summits of Mount Tetica and Mount Mulhacen, the latter of which is the most elevated point in the kingdom. The directions and distances between these four points were computed as carefully as possible, and preparations were then made for the final and determinative observations. At the Algerian stations the nature of the country and its inhabitants necessitated the use of a numerous force of soldiery as well as of means of transport.

In order to insure the accuracy of the observations, which required the passage of signals over a distance of 270 kilometres, it was decided to make use of solar reflectors and powerful lenses. The efficacy of such apparatus for even greater distances had already been tested by M. Perrier; still for the measurements in question they appear to have utterly failed to answer the expectations based upon them, not a single solar signal being visible from any station. Fortunately, the success of the observations did not rest entirely upon this one system of signals. Preparations had likewise been made for the employment of the electric light, and on the summit of each mountain one of Gramme's electro-magnetic machines worked by engines of 6-horse power had been placed in position.

On August 20 last, all the stations were occupied, and the electric lights were displayed throughout each night. Then the patience of the observers was submitted to a lengthy proof. The mists rising from the Mediterranean totally prevented the exchange of signals, until after a delay of twenty days, one after another the electric lights became visible even to the naked eye. Perrier compared the intensity of the light on Tetica nearly 270 kilometres distant, to that of α in Ursa Major, which rose near by. The observations were continued from September 9 to October 18, when this task for which such extensive preparations had been made, was completed in the most satisfactory manner. With its completion we come into possession of trigonometric measurements of the most exact nature, extending from lat. 61° in the Shetland Islands, to lat. 34° on the southern frontier of Algeria.

The extension of this network southward and eastward in Africa, desirable as it is for the elucidation of many nice points in geodesy, is unfortunately scarcely possible in the immediate future, and science must rest content with gaining a foothold in the great continent.

T. H. N.

A NEW STANDARD OF LIGHT[1]

IN the pamphlet before us we have a proposal for a new form of standard light, and the author has shown some considerable skill in drawing out his method of producing it. We cannot do better than quote his opening paragraph as showing the requisites of a standard that the author deems necessary. He says:—

"No exact measurement of any quantity, even with the most accurate and sensitive test measures available, can reasonably be expected unless the standard by which the unknown quantity is to be gauged is perfectly constant in itself; or if nature does not permit of such a desirable state of things, the causes to which the variation of the standard are due should be known, and in addition also, their quantitative effect on the standard, in order to be able to introduce a correction whenever accuracy of measurement should permit, and circumstances necessitate it."

The want of a standard of light has long been felt in physical researches, and the British Association has acknowledged the impossibility of obtaining scientific measures with the ordinary standards, and has appointed a committee to consider the question of fixing such a standard of white light, that a unit of light may be capable of accurate definition. It must not be forgotten that up to quite recent times the principal necessity for a standard at all has arisen through the introduction of gas into our dwellings and streets, and it has only been necessary to adopt one which should give the comparative illuminating powers of any variable qualities of gas. In fixing such a standard the points to be looked at were (1) that the standard should be capable of easy and exact reproduction; (2) that the colour of the light should be approximately the same; and (3) that in varying states of barometric pressure and temperature, proper corrections in the results of the comparisons should be feasible. It will be seen further on that a fourth desideratum should be introduced for scientific work. Perhaps on no subject has more attention been paid to small details than in the production of a standard candle, and as a result, when burnt under proper conditions, it gives fairly correct values of the illuminating power of gases.

In the record of Mr. Schwendler's experiments with the standard candle as against his new standard of light, we have some startling variations in the light of a standard candle, but we feel sure that, had the proper conditions been observed, there would never have occurred such a tremendous difference as 72 per cent. We are more convinced that ordinary precautions could not have been rigidly observed when we find that some of the comparisons were made after the candle had been freshly lighted. In gas photometry it is well known that the standard candle should burn at least a quarter of an hour before it can be considered to have settled down to a steady light. The standard candle, however, is not a nice unit of light; and two years ago Mr. Vernon Harcourt introduced to the notice of the British Association a gas standard which seems to meet every requirement. By making a mixture in a small gasholder of one part of the most volatile spirit from American petroleum which distilled at 50° C. with 600 of air, or seven of the vapour with twenty of air, he produced a gas which, whilst almost insoluble in water, was permanent at all ordinary temperatures and pressures, and which was of a known composition and easy of manufacture. A jet of such a gas could be compared with the ordinary coal-gas, and any variations affecting the one would equally affect the other. The colours of the standard and coal-gas lights are also approximately the same. It seems that a standard of such a character meets the requirements for comparing the illuminating value of different coal-gases. Mr. Schwendler proposes to use the light radiated from platinum foil, when raised to incandescence by an electric current, as a new standard, and we agree that a solid instead of a gaseous body as the source of illumination is a step in the right direction. The standards made, however, appear to have been used for determining the illuminating value of the light produced by dynamo-electric machines under varying conditions of speed of armature and resistance in circuit, and it is in reference to this that we will first judge of its probable effectiveness, since for gas measurements the standards already existent suffice. Some dynamo-electric machines are advertised as generating the light of 50,000 candles, and we will suppose for the moment we are comparing such a light with Mr. Schwendler's standard.

Now it may be safely said that a standard candle, farther away than twenty feet from the photometer, would give too small a light to be practically of use as a standard, whilst if approaching the photometer within one foot the magnitude of the illuminating source would seriously affect any accurate results. In the first case the electric light would have to be about 4,500 feet away from the photometer and in the last about 220 feet. For ordinary photometric work even the least of these distances would be objectionable. The platinum standard employed by Mr. Schwendler is only about ·7 of a standard candle, and these distances would have to be increased nearly 20 per cent.

For practical measurements of this description a candle-power of fifty candles is a far preferable value, which it would be difficult to attain by the method proposed. In this case we have the distances reduced, and if the electric lamp is fixed at a distance of 100 feet, we have the movable standard ranging between twenty feet and three to four feet, and the readings become easy and are not subject to be seriously affected by the magnitude of the illuminating source; in fact, the errors of observation then become of larger magnitude than any error arising from this cause. Another point which we have to note is that as far as the colour of the light from the platinum standard is concerned, it possesses very little advantage over the ordinary gas or candle flame, and it would be impossible, or at all events incorrect, to give the illuminating value of a light such as of that produced by the electric arc in terms of the new standard; some recent experiments have demonstrated that the red light emitted by one square mile of the hollow crater in the positive carbon is equal to about the red light radiated by 40,000 standard candles, whilst the mean green light of the former is equal to the mean green light of about 135,000 of the latter, and until such a time as the relative physiological values of green and red light are accurately known it will be impossible to give any true estimate of the illuminating power of the electric light by ordinary photometric comparisons. Both in magnitude and colour, then, the proposed platinum standard of light seems to fail for measuring light produced by high temperatures.

We now turn to the details of the lamp itself. We have, firstly, a U-shaped piece of thin platinum foil cut out about 20 mm. in total length, each limb of the U being about 3 mm. in breadth, the tops of which are clipped in thick metal clips. The usual arrangements are made for passing a current through this foil, the amount being registered by a galvanometer in circuit. A

[1] On a New Standard of Light. By Louis Schwendler. From the *Journal* of the Society of Bengal, vol. xlviii. Part ii., 1879.

glass shade is also employed for steadying the light, by keeping off convection currents. There seems to be an objection to this form of lamp for accurate scientific work, where it may be necessary to use an *image* of the source of illumination. For instance, in certain spectroscopic comparisons of different lights only a small portion of the image of the incandescent platinum would fall upon the slit. Now the first difficulty that would be met with would be as to the part of the platinum that would emit a standard light. Near the contacts the heat would be conducted away so rapidly that the colour of the light would be of a different tint.

Again, presumably near the middle of the limbs of the U-shaped foil the temperature would be slightly higher than at the outsides; in fact, no two portions of the foil would be exactly at the same temperature.

For work, then, of this class, the standard seems to fail in an important particular.

The writer of this notice made many experiments on this point some years ago, and it was this objection that led him to abandon the idea of a platinum standard light of a form somewhat similar to that of Mr. Schwendler.

For a standard perfectly suited to scientific work, perhaps the following definition will be found tolerably exact:—It should be a body (solid or liquid), some known area of the surface of which can be kept at a high constant temperature. It seems probable that a combination of a body of good with one of a bad conductivity will eventually be found to offer suitable materials for a really trustworthy standard.

It would be unjust to conclude this notice without paying a testimony to the great value of the experiments which have been carried out by Mr. Schwendler in this research. It is quite possible that a modification of his platinum standard may be constructed which will eliminate the defects which are to be found in it. It is certainly a step in advance of the gas or candle standard for everything beyond merely technical work, but it is not of the same accuracy as other scientific units. W. A.

FLOW OF VISCOUS MATERIALS—A MODEL GLACIER

THREE or four years ago an experiment was arranged by Mr. D. Macfarlane and myself for the purpose of showing the flow of a viscous mass and for illustrating glacier motion. The experiment then commenced gave rise to others of a similar nature. These experiments have proved so interesting that I venture to describe some of them to the readers of NATURE.

Shortly after his discovery of the true nature of glacier motion, the late Principal Forbes was much pleased when one of his students, now the Rev. C. Watson, of Largs, showed him a quantity of shoemakers' wax which had been gradually flowing down on the bottom of a vessel accidentally left on an incline. Forbes was delighted with the wax, and considered it an admirable illustration of viscous flow. This was told to me in conversation some four years ago, and it occurred to me that a pretty illustrative glacier might be made with shoemakers' wax, and we proceeded to construct it. The model glacier has been shown year after year to the natural philosophy class in Glasgow, and has proved interesting and instructive beyond expectation.

A little wooden ravine was constructed, with a number of steep declivities and precipices and some more gentle slopes. There is one place, also, where the ravine is narrowed by projections inwards, which nearly meet each other. At the upper end of the ravine there is a flat part, on which ordinary shoemakers' wax is piled—as where snow collects at the upper end of the natural ravine; and from this collecting-ground the material flows down steadily through the ravine, giving on a small scale a most perfect display of the flow of a semi-solid material. At the beginning of each winter session a supply of shoemakers' wax is given at the top, and during the session the flow goes on slowly and steadily; hardly perceptible from day to day, but progressing from week to week, and from month to month. Every one knows what a brittle substance shoemakers' wax is at ordinary temperatures. A lump of it allowed to fall on the ground flies into a thousand pieces. Watching this brittle apparent solid flowing down an inclined plane, brings very vividly before the mind the real nature of the glacier's flow. To imitate on the small scale Forbes's celebrated experiment of planting a row of stakes in the glacier, in order to compare the flow in the middle with the flow at the edges—the experiment which really established the fact of *viscous* flow—I have sometimes put a row of dots of white paint across our pitchy glacier. In a few days the more rapid motion of the middle portion, and the less rapid motion of the parts near the edges, is made apparent. There are others of the glacier phenomena which are also beautifully imitated by the shoemakers' wax. Little crevasses are sometimes formed, though not very often owing to the great effect of temperature on the plasticity of the material; and the cross-markings that are noticeable at the foot of a glacier are brought out extremely well.

Last year Sir William Thomson commenced a new and curious experiment on shoemakers' wax as a viscous material. A large circular cake of it about eighteen inches across and three inches thick was made. This was put into a shallow cylindrical glass vessel, which was filled with water to keep the temperature from varying with any great degree of rapidity. Below the cake a number of corks were put, and on the top there were put some lead bullets. The result has been that in a year the corks have floated up through the wax, and are coming out at the top; the bullets have sunk down through the wax, and have come out at the bottom; and this, it is to be observed, has gone on while the wax was at all times in such a condition as to be excessively brittle to any force suddenly applied, such as a blow from a hammer, or such as would be occasioned were the cake of wax to be allowed to fall on a stone floor. J. T. BOTTOMLEY

THE SCOTTISH ZOOLOGICAL STATION

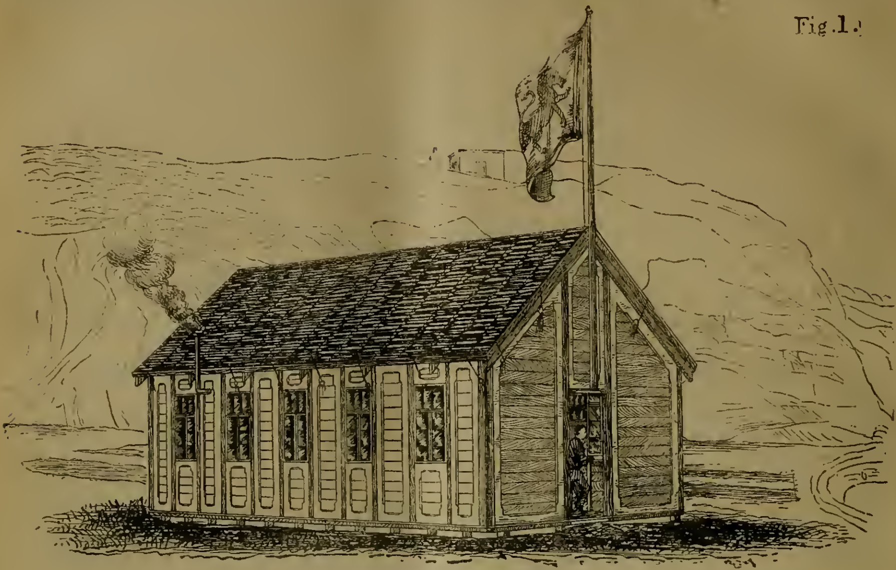
SOME months ago the opening of a zoological station on the Scottish coast was mentioned in these pages. This station—the first enterprise of the sort in Britain—has been established in connection with the University of Aberdeen, and under the directorship of the Professor of Natural History, Dr. Ewart, who was, this year, assisted in the conduct of the station by Mr. Patrick Geddes.

The site chosen was the little fishing station of Cowie, about half a mile north of Stonehaven, and fifteen miles south of Aberdeen. But one of the chief advantages of the station is that it is not a fixed building of brick or stone, but a movable one of wood, which can be taken, if necessary, to a new place every year, and, after the season's work, taken down and packed up for the winter.

The annexed cuts give an excellent notion of the appearance and internal arrangements of the place. It is a wooden structure (Fig. 1) about 32 feet long by 16 wide, supported on low wooden piers and having a thin wooden roof covered over with sailcloth. In each of the longer sides are five windows, in one of the shorter sides the door, in the other two windows. Inside (Fig. 2), a partition divides the building into two parts—a larger, the laboratory proper, with eight out of the ten side windows, and a smaller, the library and director's room, with two of the side and both end windows.

In the library there is a bench or working-table (Fig. 2, *T*) running round three sides, with shelves (*S*) above, for books, apparatus, and bottles. In the laboratory there is a table (*T*) to each window, intended to accommodate two students, and provided with sliding-shelves (T') for holding the worker's books of reference. Between every two tables is a shelf, of the same height as the table, with two drawers (D), one for each student, and above them

Fig. 1.

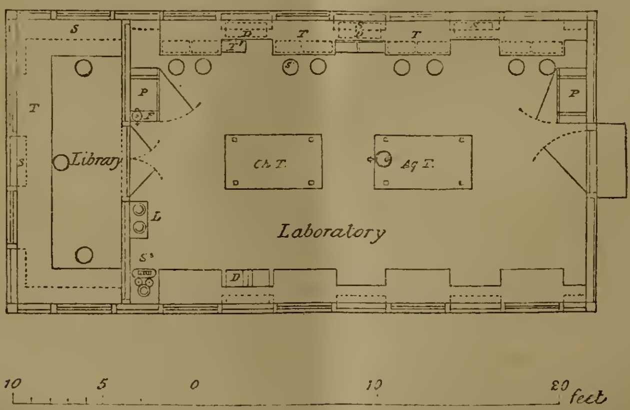


The Scottish Zoological Station—Elevation.

are other shelves (S) for holding bottles for specimens. The tables are fixed bracket-wise to the wall, and are remarkably firm and free from vibration.

In the middle of the room are two large tables, one (*Ch. T*) intended for chemical work, and provided with a sufficient supply of reagents, spirit-lamps, test-tubes, &c.;

Fig 2



The Scottish Zoological Station—Plan. *Aq.T*, aquarium table; *Ch.T*, chemical table; *D*, drawers; *F*, filter; *L*, wash-hand basins; *P*, presses; *S*, shelves; *S'*, stools; *St*, stove; *T*, working tables; *T'*, sliding shelves.

the other (*Aq.T*) bearing a large cask kept replenished with fresh sea-water, and several bell-jar aquaria of various sizes for living specimens. These latter were a great object of attraction to the numerous visitors to the station.

At each end of the room is a large press (P), used for stores; on one of these stands a filter for fresh water (*F*), and on the other side of the library door is a small table (*L*) with washing-apparatus. The whole building is warmed by a stove (*St*).

The station is neatly painted outside, and is rendered a very conspicuous object, both from sea and land, by the royal standard of Scotland, which floats from a flagstaff over the door.

Besides microscopes, dissecting-dishes, bottles, aquaria, books, &c., the station is well fitted with dredges, trawls, and canvas buckets for shore-collecting, and also provides wading-shoes, tarpaulins, and sou'-westers.

There are two boats attached to the establishment, a small fishing-smack and a "tub." But as these were often unable, owing to unfavourable weather, to sail beyond the mouth of the bay, a small steamboat is urgently needed to complete the efficiency of the station.

An Aberdeen fisherman was hired for the season, to take charge of the boats and to act as general factotum.

The Station was formally opened by Mr. Romanes on August 8, but the work actually began on the 3rd, and was continued until September 25. Altogether there have been sixteen workers, mostly Aberdeen students, the rest visitors from London and elsewhere. Several of these went out shore-collecting every day, a few dredged when practicable, and two dredging expeditions were made in H.M. gunboat *Netley*, the second of the two being a great success.

The fauna of the Aberdeen coast is not a remarkably rich one, but still a very respectable number of specimens was obtained in one way or another. I am indebted to Mr. A. W. Russell, M.A., of Marischal College, for a list of all the species collected; the list is too long for transcription, but may be abstracted as follows:—

	Genera.	Species.
Porifera	3	5
Hydrozoa	13	16
Actinozoa	6	8
Turbellaria	5	5
Hirudinea	1	1
Chætopoda	14	23
Echinodermata	13	20
Pycnogonida	2	2
Crustacea	12	30
Polyzoa	9	10
Tunicata	5	7
Mollusca	40	57
Pisces	5	7
	128	191

It is definitely decided that, next summer, the Station is to be pitched at Cromarty Firth, a far more promising locality than Stonehaven Bay. By that time it is hoped that the funds, which are wholly derived from voluntary contributions, will be in a sufficiently flourishing condition to admit of the purchase of a steamboat.

It would not be a very great matter, one would think, for our English universities to follow the example of Aberdeen, and to provide themselves each with such an establishment on some part of the English coast; and the benefit to their students, who get to think of nudibranchs, echinoderms, and cœlenterates as opaque, dull-coloured things in bottles, would be simply incalculable.

In the meantime I can, from experience, cordially recommend all English students of biology who are minded to begin research, as well as those who wish for nothing more than a thoroughly pleasant holiday and an opportunity of studying their science from the too-neglected "natural history" side, to spend two or three weeks of the long vacation at the Scottish Zoological Station.

T. JEFFERY PARKER

THE FOSSIL LOVERS

MISS ANN GELICA kindly sends us her reply to Bret Harte's Geological Madrigal, which she assures us is addressed to her. To enable the reader to understand the young lady's reply we prefix "Dear Bret's" verses:—

A GEOLOGICAL MADRIGAL
(*After Shenstone*)

I have found out a gift for my fair,
  I know where the fossils abound,
Where the footprints of *Aves* declare
  The birds that once walked on the ground;
O, come, and—in technical speech—
  We'll walk this Devonian shore,
Or on some Silurian beach
  We'll wander, my love, evermore.

I will show thee the sinuous track
  By the slow-moving annelid made,
Or the Trilobite that, farther back,
  In the old Potsdam sandstone was laid.
Thou shalt see, in his Jurassic tomb,
  The Plesiosaurus embalmed;
In his Oolitic prime and his bloom,—
  Iguanodon safe and unharmed!

You wished—I remember it well,
  And I loved you the more for that wish—
For a perfect Cystistidian shell
  And a *whole* holocephalic fish.
And O, if earth's strata contains
  In its lowest Silurian drift,
Or Palæozoic remains
  The same,—'tis your lover's free gift!

Then come, love, and never say nay,
  But calm all your maidenly fears,
We'll note, love, in one summer's day,
  The record of millions of years;
And though the Darwinian plan
  Your sensitive feelings may shock,
We'll find the beginning of man,—
  Our fossil ancestors in rock.

My Reply to Dear Bret's Madrigal

Thy epistle, dear Bret, I've received,
  And trust thou'lt not think me too bold,
If I frankly acknowledge I'm grieved
  At the thought that to thee I've been cold.

How sweetly thou managest wooing!
  What a way to my heart thou hast found!!
Abandoning billing and cooing,
  Thou tell'st me where fossils abound.

For ever henceforward I'm thine,
  To view Ornithichnites I'm sighing;
(Don't delay,—for a ramble I pine),
  To find them *in situ* am dying.

Tridactylous, struthious, and huge;
  With phalanges nicely indented,
Entombed when Dame Nature with rouge.
  The marl and the sandstone beds painted.

If thou wilt but extract me a femur,
  With matrix just near the trochanter,
I'll abandon all maidenly tremor,
  And at once name the day, thou enchanter.

I'll only make one stipulation:—
  That, avoiding hotel, inn, and tavern,
We improve the time-honoured lunation,
  And our honeymoon spend in a cavern.

There I'll labour, content in the fetter.
  To find, happy thought! if I can,
A dear second husband and better,
  A petrified pithecoid man.

A. G.

NOTES

LORD RAYLEIGH has been elected to the Chair of Experimental Physics at Cambridge, in succession to the late Prof. Clerk Maxwell.

A COMMITTEE has been appointed to receive subscriptions for the purpose of commemorating the retirement of Dr. Andrews from the vice-presidency of the Queen's College, Belfast, by a bust or portrait to be placed in the College, and a prize or scholarship to be founded in the same institution in connection with chemical science.

WE hear with regret that the Epping Forest Committee have rejected Mr. Alfred R. Wallace, whose candidature for the post of Superintendent of the Forest was supported by so many eminent men of science and also by a large number of the local inhabitants. The successful candidate is Mr. Alexander McKenzie, a landscape gardener, who may doubtless prove an able superintendent; but it is unfortunate that a man of Mr. Wallace's ability and knowledge should have failed to obtain a post which he could so well have filled for the benefit of the nation.

DR. PERCY has resigned the lectureship on metallurgy at the Royal School of Mines.

THE Rev. John Brown Maclellan, Vicar of Bottisham, Cambridgeshire, has been elected Principal of the Agricultural College, Cirencester, in place of the Rev. John Constable, who has resigned owing to ill-health. Mr. Maclellan is a distinguished classical scholar, having taken high honours in that department at Cambridge. He is the author of a work on "The Fourth Nicene Canon and Election and Consecration of Bishops," and of "A New Translation of the New Testament." We have failed to discover the special qualifications of this scholarly vicar for the position of head of an Agricultural College, which if anything is scientific. Of course the institution is a proprietary concern, and the Council has a right to do as it likes. By the by although this College has a charter, it has no right to the title of "Royal" which it assumes.

M. JANSSEN has been unable to see the sun for a number of days, owing to the almost constant prevalence of cloudy weather; but he states that, according to the results of his latest observations, the number of spots on the sun is very small, as well as the number of faculæ. He supposes that this last circumstance may be connected with the rigour of the present winter, although he is not in a position to state whether these faculæ are on the surface of the sun or produced by some change in the intervening medium. The construction of M. Janssen's observatory at Meudon has been interrupted by the inclemency of the weather. It will be resumed next spring. Meanwhile M. Janssen is completing his system of observation. An automatic instrument worked by a weight will take six photographs of the sun every twenty-four hours with a 9 inch refractor. The construction of a large refractor for observing celestial bodies is also proceeding.

OTHER three days' *Thunderer* gun experiments were made during the past week; the experiments will be resumed in a fortnight.

THE Belgian State-prize of 5,000 francs (200*l.*) which is awarded by the Royal Academy of Sciences every five years for scientific work was this year awarded to the director of Brussels Observatory, M. Houzeau, in recognition of his latest work, "Uranométrie générale, avec une Étude sur la Distribution des Étoiles visibles à l'Œil nu." There is another prize of 2,500 francs (100*l.*) awarded annually by the king, which was to be given away for the second time this year, and specially referred to architecture, but no worthy recipient could be found, although no less than ten different works had been submitted to the committee of judges.

THE University of Göttingen has become the possessor of a magnificent herbarium, containing over 40,000 specimens of plants from all parts of the world. It was left to the University by the late director of the Göttingen Botanical Gardens, Prof. Grisebach. There is no doubt that it is by far the largest collection of plants ever brought together by any single individual.

THE late Herr von Nathusius has left a very valuable library, consisting almost exclusively of works on natural history and agriculture, and numbering some 5,000 volumes. Besides this there is an osteological collection of some 2,500 animal skulls, 300 skeletons and parts of skeletons, a collection of some 20,000 pictures illustrative of animal life, and finally, a collection of about 8,000 samples of wool. Everything is in perfect condition, and arranged in the most scientific manner. The collections being of great value for agricultural museums, the Prussian government intends to purchase them for the Museum at Berlin. Their value is estimated at 60,000 marks (3,000*l.*), and a present they remain still at Hundisburg, near Magdeburg, the seat of the deceased statesman.

THE death is announced of M. Claude Etienne Minié, the inventor of the carbine of that name. He was born in Paris in 1804.

A FORTNIGHTLY scientific contemporary makes the following extraordinary announcement concerning the late award of medals by the Royal Society:—"The Copley Medal to Prof. Rudolph J. E. *Clamins*, of *Rome*, for his researches upon heat; the *Davey* (*sic*) Medal to M. P. E. Lecoq de Boisbaudran, for his discovery of gallium; a Royal Medal to Mr. William Henry *Perkins*, F.R.S., for his long-continued and successful labours *in geology and physical geography*"! Was there ever such a nice "derangement of epitaphs?" The italics are ours.

THE frost having continued in Paris, the Seine was frozen on December 9. The maximum of cold was observed about one o'clock in the night from 8 to 9. $-24°$ C. has been observed at Montsouris in the shade, $-25°$ at La Varenne St. Maur, $-27°$ at Versailles.

IT has been suggested by the *Temps* meteorological editor, that the whole of Europe and a large part of Asia and Northern America being covered with snow, the appearance may be analogous to the red spot discovered on Jupiter by astronomers, and this may be considered as an indication that some unusual cooling influence prevails on the whole solar system.

MRS. CHAPLIN AYRTON has received the degree of M.D. from the Medical Faculty of Paris. She presented an elaborate thesis "On the General Dimensions and the Development of the Body among the Japanese."

THE Thames Embankment system of electric lighting has been extended to the Victoria Station of the Metropolitan District Railway. The station, we learn from the *Times* report, is 350 feet long, 50 feet wide, and 40 feet high. There are two platforms, each 15 feet wide, the railway space between them being 20 feet wide. There are ten lights in all, of which five are placed over the down-platform, dividing the length into spaces which are unequal owing to the interference of constructive details. Over the up-platform are four lamps, which alternate with the five on the other side so as to afford an equable distribution of light. The tenth lamp is placed centrally over the foot-bridge which connects the up- and down-platforms. The lights are produced and maintained by the same steam-engine which is maintaining the forty lights on the Embankment and the ten on the bridge. The engine is, therefore, now maintaining a total of sixty lights—a point of considerable importance. Of still greater importance, perhaps, from a scientific point of view, as the *Times* remarks, is the distance to which the present machinery is transmitting the current. The distance marked on the map of the District Railway between their station at Charing Cross and that at Victoria is 2,383 yards, or 1·354 mile. The length of wire between the two stations, however, owing to curves and losses necessarily attending the laying, connecting, and fixing, is about 1·65 mile. The whole circuit is thus equal to a length of 3·30 miles. The ten lights are on two circuits, and are maintained by the two spare circuits of the Gramme machine which supplies the ten lights on Waterloo Bridge. The loading wire is similar to that used on the Embankment, being a cable of seven strands of No. 19 B. W. G. copper wire, highly insulated. The wires are laid through the tunnel of the railway, being fixed against the walls. There is a switch arrangement at the Victoria Station, so that the lights are started and extinguished on the spot, and are thus locally under control. This new development of electric lighting means something more than that sixty lights are now being successfully maintained from a single engine of twenty horse-power nominal. It means that very considerable distances have been bridged over, and that, other things being equal, the application of electricity for illuminating purposes can be carried to distances from the source of power previously unbelieved in and by some unthought of.

Mr. Thomas Fletcher, the well-known maker of scientific apparatus, of Museum Street, Warrington, must be a man of considerable public spirit, as well as enterprise. From a circular letter he has sent us we learn that a few friends interested in scientific matters, have decided to meet every Thursday evening for the winter months, at his house, with the object of discussing new or interesting scientific matters. The meetings will be informal, simply a social gathering of those interested in the progress of science. If the movement is appreciated by a larger number than can conveniently be accommodated, the question of forming a scientific club will afterwards be raised. The laboratory will, for the evening, be converted into a smoke room, and any apparatus will be at the service of all. Both these privileges will, we are sure, be largely appreciated. These meetings, Mr. Fletcher is careful to state, will be so arranged as to be little or no cost to himself, and therefore they will, so far as room permits, be open to all interested in matters likely to be brought forward, all being at perfect liberty to come and bring any friends. We heartily wish success to Mr. Fletcher's efforts to foster a love of science in Warrington.

Various statements have recently been published regarding the probable time of completion of the St. Gothard tunnel; few of them are correct. On Oct. 31 last, at 8.15 A.M., the boring machine on the northern side reached the centre of the tunnel at a depth of 7,460 metres. The meeting of the boring machines, however, cannot possibly take place before February next year. At the beginning of November there were still 717 metres of rock to be removed, and 50 metres per week is considered to be a fair average. On October 1 last the borings were some 261 metres short of the original programme, and on that day only 7,821 metres (total) of the tunnel were complete (instead of 11,579 metres, as stated in the original programme). A serious obstacle has quite recently been encountered in some soft strata, the enormous pressure of which has up to the present resisted all attempts at successful penetration. The most solid beams are bent like reeds after a little time, and a resistance-wall of 1 metre thickness was completely crushed. Another of 2 metres' thickness is now being constructed. The boring machine is useless in these strata, and only hand labour can be employed.

The works for the railway across the Isthmus of Tehuantepec have been commenced. The line will be 150 miles long.

The director of the zoological station at Trieste, Prof. Claus, of Vienna, has issued a report on the work done at the station since its opening in 1875 up to the end of 1878. It appears that no less than twenty-two zoologists have worked at the station (including ten Austrians and seven Germans), besides thirty-four students of zoology. Apart from a large number of smaller communications issued by the station, thirty-eight important scientific publications owe their origin to work done at that institution.

At Magdeburg a grand agricultural exhibition will be held from May 28 to June 6, 1880, in celebration of the fortieth anniversary of the foundation of the Magdeburg Agricultural Society.

For the International Piscicultural Exhibition which will be opened at Berlin on April 20, 1880, a great number of specimen-collections have been already promised. Complete illustrations of the state of pisciculture in the various countries will be sent from Sweden, Norway, Italy, Holland, China, Japan, Canada, and the Malay Islands. Several crowned heads and the free cities of Hamburg and Bremen will award prizes to the exhibitors.

The Paris Municipal Council has not yet taken any final decision on the question of gas *versus* electricity. At all events the Commission will propose to use Jablochkoff lights for illuminating the Place de l'Opéra, and new experiments will be tried in the green room of the opera for deciding whether the Jablochkoff or Werdermann light will be selected for the interior.

Details of the Temesvar earthquake of November 21 last are now to hand. It appears that two separate shocks were felt, a violent one at 12.5 A.M., and a weaker one shortly before 2 A.M. Numerous chimneys, vaults, cellars, &c., fell in in the town as well as in the surrounding villages. A third shock followed at 5.45 P.M., and a fourth one a little later. On the following days the shocks continued and were also noticed at Szakalhaza, Vukova, Stamora, Blazsova, Lippa, and other places in the district.

Two shocks of earthquake are reported from Switzerland: one at Geneva on December 4, at 5.34 P.M., Greenwich mean time; the other at Berne, Bale, Aarau, and Schaffhausen, on December 5, at 2.32 P.M.

Many of our readers will be glad to know that Messrs. Macmillan and Co. have published a translation of Pasteur's "Études sur la Bière," under the title of "Studies on Fermentation," by Messrs. Frank Faulkner and D. Constable Robb. The original work we noticed at length in Nature, vol. xv. pp. 213, 249.

A dangerous and infectious disease among bees is reported from Italy. It is caused by a microscopical fungus, and spreads with alarming rapidity. However, winter is not a favourable season for its propagation, and salicylic acid solution is said to be an infallible remedy against the disease.

In the course of some excavations now going on in the bed of the Rhone, near Geneva, many interesting objects, assigned by archæologists to the age of polished stone, have been brought to light, the most curious of which is a scraper of jade, highly finished, and in a condition as perfect as when it left the hands of the workman. The question arises, the *Times* correspondent states, and is being warmly discussed by the learned in lacustrine lore, how this instrument, made of a mineral which exists in a natural state only in Asia, can have found its way into the Rhone gravel at Geneva. Was jade ever an article of trade between the West and the East in prehistoric times, or is this scraper a solitary specimen brought by Aryan wanderers from the cradle of their race on the Hindoo Koosh? As yet no satisfactory solution of the problem has been suggested.

THE *School of Mines Quarterly* is the title of a journal published under the auspices of the Chemical and Engineering Society of the School of Mines, Columbia College, New York, the first number of which has been sent us. It contains several good articles on chemical and engineering subjects. There seems no keeping pace with the scientific enterprise of our friends on the other side of the water.

FRIEDLÄNDER AND SON, of Berlin, have sent us their new Catalogue of Standard Publications in Astronomy and Geodesy, brought up to the present time.

A FOURTH edition has been published of Mr. Thomas Christy's useful *brochure* on "Hydro-Incubation in Theory and Practice, a Guide to Commercial Poultry Farming." We have referred to the previous editions; the whole of the matter in this edition is stated to be new.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. F. G. Lightfoot; a Bonnet Monkey (*Macacus radiatus*) from India, presented by the Rev. E. C. Ince; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Mr. F. E. Colenso; a Black-headed Jay (*Cyanocorax nigriceps*) from South America, two Brant Geese (*Bernicla brenta*), European, purchased.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1652.—The observations of this comet made by Hevelius between December 20, 1652, and January 8, 1653, it is remarked by Pingré, were probably the most precise, and certainly the most complete, of all; generally the observations were very rough. They were mostly collected, he adds, in a short dissertation published at Padua in 1653, which would appear to be that by Argoli, entitled "Andreæ Argoli Brevis Dissertatio de cometâ ann. 1652, 1653 et aliqua de meteorologicis impressionibus." Halley's orbit, the only one for this comet which figures in our catalogues, was calculated upon the observations of Hevelius.

Zach found another series of observations, which Pingré probably had not seen, and which upon reduction and discussion may prove to be second only to those of the Dantzic astronomer in merit; indeed, he thought they might be even more precise. These observations were made by an ecclesiastic residing at Rome, an Englishman, one calling himself, or being called by others, *Riccardo de Albis*, a name which, Zach suggests, is probably to be read *Richard White*, and he conjectures that he was probably a Jesuit of the Anglican College, where we know that another English Jesuit, LeMaire, Boscovich's assistant in geodetic work, also observed. The observations were sent from Rome in January, 1653, by a certain Raffaelo Magiotti to his good friend Candido del Buono at Florence, with a commission to present them to Prince Leopold of Tuscany, brother of the reigning Grand Duke Ferdinand II. Magiotti mentions that he had procured the observations with difficulty since De Albis himself intended to print them, *con molte puntualità*. Whether he did so or not does not appear; his name is not mentioned in the cometographies, and though Lalande enumerates some twenty publications referring to the comet of 1652, there is none under the name of De Albis. We are told that he observed with a good quadrant, but there is no reference to telescopic sights, though Zach says, with two such opticians as Campani and Divini at this time in Rome, it may well have been that he had telescopic aid.

The observations in question appear in Angelo Fabroni's little known "Lettere inedite di Uomini illustre," as a supplement to his greater work published at Pisa in 1768. They were made between December 21 and January 3, "hora 2 post occasum solis," and consist of distances from conspicuous stars. It may be of interest to reduce the observations of this scientific Englishman, and to calculate an orbit upon them; a strict copy was given by Zach in Lindenau and Bohnenberger's *Zeitschrift für Astronomie*, vol. iv.

In the same communication will be found some observations by a Roman patrician, one Arcieri, with "a good telescope of 9 palms, by Eustachio Divini." He saw the comet for the first time on December 19, "instar nubeculæ rotundatæ et candicantis, e cujus centro quiddam subricundum instar prunæ emicabat, ejusque diameter visiva erat 10 circiter minutorum." On December 21, its diameter was fifteen minutes. It seems to have been well seen on the following night, when we read "Porro cauda illius (quæ rarissima quidem erat, tenuissimaque) in oriente vergens, æquabat longitudine spatium pene 8 graduum, et dimetiens visiva excreverat jam ad 20 fere minuta." On December 23 it appeared much more obscure, but on December 24 at the fourth hour of the night the tail was brightest, the head being one degree from the Pleiades. Five nights later it was distant "circiter 30 minutis à capite Medusæ versus Plejadas, multum imminutus obscuratusque, nullumque caudæ vestigium apparebat." On January 1 it was as bright as a star of the fourth magnitude, and two nights later was hardly equal to one of the fifth.

Pingré remarks that in the judgment of Hevelius and Comiers this comet almost equalled the moon in size. It was nearest to the earth on December 19, when its distance was 0·13 of the earth's mean distance from the sun, so that it approached our globe as close as its orbit admits.

METEORS ON OCTOBER 19.—M. E. Block, of Odessa, records a notable shower of meteors on the morning of October 19, between 3h. and 5h.; he says he had not previously seen so many meteors. In an interval of ten minutes he counted fourteen which passed through the field of his comet-seeker, two degrees in diameter; the radiant was at β Aurigæ, or in about R.A. 88°, Decl. 45°. This radiant agrees nearly with No. 92 in Major Tupman's list.

GEOLOGICAL NOTES

UPPER DEVONIAN ROCKS OF THE NORTH OF FRANCE.—In a recent communication to the Geological Society of the North of France, Prof. Gosselet has brought forward some important new data, obtained from some fresh railway-cuttings between Féron and Semeries, as to the classification and palæontology of the Upper Devonian rocks. Arranging the Upper Devonian into an inferior group—the *Frasnien* comprising the zone of *Rhynchonella cuboides* and that of *Cardium palmatum*, and a superior group—the *Famennien*, in which are placed the Schistes de Famenne, the Psammites de Condros, and the Calcaire d'Etrœungt, he proceeds to show that in sections exposed in the railway-cuttings with a perfect conformable succession of strata and of fossils, the zone of the Psammites de Condros, so well marked elsewhere in the north of France and Belgium, is absent. He regards this arenaceous series to be represented in the district between Avesnes and Fourmies by argillaceous shales. It is easy to recognise at least an upper and lower member in the Famennian group. The former is distinguished by the prevalence of Carboniferous forms, particularly *Spirifer laminosus*, the latter by the rarity of Carboniferous forms and by the abundance of *Cyrtia Murchisoniana*. Every fresh section which tends to elucidate the relations of the Devonian rocks to the formations below and above them possesses a special interest for British geologists.

TERTIARY QUARTZITES OF THE ARDENNES.—Dr. Charles Barrois has laid before the same Society an interesting paper on the extension of the Lower Tertiary beds of the Paris basin across to the Palæozoic plateau of the Ardennes. He shows that the lower members, consisting of sandstones and conglomerates, can be traced by their fragments for a long distance to the north-east, and that these fragments, like our own Grey Wethers or Sarsen stones, are portions of deposits which have been gradually broken up and weathered in place. The existence of these boulders has long been recognised and they have been variously explained, being sometimes considered as drifted blocks. Dr. Barrois, however, demonstrates their true origin by tracing them step by step to their source in the Grès Landéniens. He makes some suggestive remarks regarding the superficial alteration of some of these rocks. In the centre they are undoubted sandstones, but towards the exterior they become progressively harder till they pass into true quartzite. He even obtained specimens of sandstone covered with a mere coating of quartzite two centimetres in thickness. He observed that in proportion as they are traced eastward, that is, into tracts where they must have been longer exposed to atmospheric influences, the alteration penetrates further into them. A microscopic examination failed to afford him any clue to the process of alteration. The quartzite when examined in thin sections appears as a true quartz-sand, the grains of which are so minute that no interstice can be seen between them. It is an excessively compact rock, in which a matrix is hardly appreciable.

Pyrenees Marble.—In another paper Dr. Barrois gives information regarding the *Marbre Griotte*, now so largely worked for ornamental purposes in the Spanish and French Pyrenees. This rock, usually regarded as Devonian, and placed on a parallel with the red limestone of Westphalia and Nassau, is shown by him to rest unconformably on Devonian strata in the Western Pyrenees, to be covered by a *Productus* limestone of true Carboniferous date, and to contain in itself a fauna which, by its crustacea (*Phillipsia*), and more especially by its *Goniatites*, must be regarded as Carboniferous. He therefore concludes that the Griotte limestone or marble constitutes the basement member of the Carboniferous system of the region in which it occurs.

Petrography in Spain.—The progress of petrography is well illustrated by the appearance of an essay on the evolution of volcanic rocks in general and of those of the Canaries in particular, by Don Salvador Calderon, of Arana, just published in the *Annals* of the Spanish Society of Natural History. He reduces all the rocks of the Canary Islands into two grand categories—a sanidine-amphibole group and a plagioclase-augite group. Thus, out of a paste of augite and plagioclase he conceives that all the rocks of the second category may have been formed, with the addition of other accidental minerals, and by a variation in the proportions. So that at the end of the one series he places a nepheline-basalt containing sanidine, and he traces a gradation from this rock through the disappearance of the sanidine, the successive appearance of hauyne and olivine, and the final predominance of the latter mineral, till he reaches the felspathic basalts, dolerites, and modern lavas. He discusses the evolution of volcanic rocks under four periods:—1. The Lava period, in which section he treats of the vitreous fluidity of lava, the influence of temperature, pressure, and water in the formation of the rock, and the possibility of an arrangement or liquation of the component elements of the lava while still melted within the volcano. 2. The Refrigeration period. Here he discusses the crystallisation of the lava, noting particularly the results of the evaporation of the interstitial water, the formation of the "micro-fluctuation" structure, the development of porphyritic crystals, and the effects of sublimation. 3. Changes in the rocks after solidification; divided into (1) mechanical, which include fractures on the great scale, cracks in the paste of the rocks, fissuring of the crystals, and the formation of cavities and globules; (2) physical, embracing the phenomena of devitrification; and (3) chemical, under which are placed serpentinisation, zeolitisation, natrolitisation, &c. 4. The Decomposition period. Under this heading the author, citing the researches of Durocher, Bischof, and Delesse on the permeability of rocks by meteoric water, and the changes thereby produced, gives a brief account of the nature of the alterations of some of the more prevalent minerals in the rocks of the Canary Islands and elsewhere. The paper is illustrated by a few drawings of microscopic structures.

GEOGRAPHICAL NOTES

Further details are to hand concerning the sojourn of the Russian, Lieut. Tjagin, and a colony of Samoyedes in Novaya Zemlya during last winter and summer. The object of Tjagin's stay on the island was to complete the arrangements for a station for the help of shipwrecked sailors, and to carry out a series of meteorological observations for a whole year. Tjagin arrived at the harbour of Karmakul on August 15, 1878. By September 13 the necessary buildings of wood were completed, and the meteorological instruments installed, and by October 3 all the Samoyedes were collected about the station. The autumn of 1878 was dull, rainy, and cold. The mean temperature was about 4° Centigrade. The first frost was on September 26. The first snow fell on the 28th, and the sea froze on October 10. Ice-crust and drift-ice were seen on the sea in the middle of October, and the harbour of Karmakul, as well as all the small bays, were covered with ice on November 13. But Moller Bay did not freeze during the whole winter, except among the islands which lie thick along the coast. The melting of the snow began with the first thaw, about the middle of May, and the first green was seen on the cleared spots near to the snow-heaps. On June 14 the islands were covered with verdure and flowers, but the harbour of Karmakul and the little bays were not free from ice till July 16, and the small lakes July 22. The mean temperatures were in November, $-9°\cdot8$ C.; February, $-17°\cdot8$; March, $-11°\cdot8$. During the five winter months the mean was $-12°\cdot2$. In January the temperature sank to $-32°\cdot1$, and rose in November to $+0°\cdot8$, and in January to $+0°\cdot2$. The movement of the atmosphere varied from complete calm, rare mild winds from south-west and north-west, strong winds from east-south-east, rising to raging storms, which greatly impeded hunting operations. The quantity of snow which fell was inconsiderable; it snowed seldom, but the strong land winds drove the snow from the distant hills and the neighbouring heaps towards the west, and often covered the houses up to the roof on one side, while on the three other sides the snow was blown clean off the ground. Tjagin returned to Archangel on August 17 with two orphans belonging to one of the Samoyedes who died during the winter. He maintains that wintering in Novaya Zemlya is quite practicable, especially for Samoyedes. The practicability of erecting a refuge station with provisions has also been proved. But a store of provisions is absolutely necessary, as it seems impossible to obtain by hunting anything like a sufficient quantity of animal food during the winter.

Details have reached this country of the expedition led by Mr. Alexander Forrest into the unknown north-eastern part of Western Australia. Forrest left the Beagle Bay, south of King's Sound, on April 20 last, with seven companions and twenty-six horses, proceeded to the mouth of the Fitzroy River in 17° 41′ lat. S., and 123° 36′ long. E., investigated this unknown river as far as its sources in a mountain ridge 2,000 feet high, in 17° 42′ lat. S., and 126° 10′ long. E., then followed a tributary to its source in a mountain chain (in 18° lat. S., and 127° 40′ long. E.), crossed these mountains and discovered a large river in 128° 10 long. E., which he followed for nine miles. The eastern boundary of the colony was reached in 16° 50′ lat. S., and 129° long. E. Here almost all provisions failed the travellers, yet they proceeded on North Australian ground to the Victoria River, and reached Catherine Station of the overland telegraph (forty four miles south of Port Darwin) on September 18, in a very exhausted condition. Fifteen out of the twenty-six horses had perished, and three more had been killed and eaten. Mr. Forrest reports that he discovered 20,000,000 acres of excellent pasture land, of which a large proportion would be well adapted for growing sugar cane, rice, coffee, &c. Water was everywhere in abundance, except on the last twenty-two miles of the march. The numerous natives the party encountered all behaved in a most friendly manner.

A telegram from Col. Prshevalski has been received *viâ* Pekin. It appears that the traveller and his party reached Shatshkoo at the end of June, after marching through the Shami desert, which in its centre rises to an elevation of 5,000 feet. The oasis of Shatshkoo, situated at an altitude of 3,500 feet, is very fertile. On the south it is bounded by a mountain side which begins at Lake Lob-Nor, and is covered with eternal snow in many places. The travellers intended remaining on the mountains until the end of July, and then to proceed to Hlassa.

We have received from the U.S. Survey copies of several new maps of recently surveyed regions, beautifully finished. They are the Yellowstone National Park, on a scale of two miles to one inch; parts of Western Wyoming, South-eastern Idaho, and North-eastern Utah, and part of Central Wyoming, on the scale of four miles to one inch; a drainage map of portions of Wyoming, Idaho, and Utah, on the scale of eight miles to an inch.

Heft I. for 1878-9 of the *Mittheilungen* of the Hamburg Geographical Society, is entirely devoted to Africa. Dr. G. A. Fischer, of Zanzibar, contributes a valuable original paper on the Wapokomo Land and its inhabitants; Herr A. Woermann, a Hamburg merchant, discusses the products of West Africa from a commercial point of view; Dr. Hubbe-Schleiden, in a learned and elaborate paper, discusses the Negro's capacity for culture.

In the December number of *Petermann's Mittheilungen*, Dr. Junker describes in considerable detail the results of his journeys in 1877-8 to the west of the White Nile, from Lado to about 29° E. long., and south to 3° 15′ N. lat., results of great importance for a knowledge of a scarcely known region.

News from Zanzibar announces the safe arrival of the united Belgian expedition at Ugogo.

SUN-SPOTS AND THE RAINFALL OF PARIS

In a paper on this subject by Mr. C. Meldrum, F.R.S., read at the Meteorological Society of Mauritius, after some preliminary remarks, the author said :—

The rainfall observations made at the Observatory of Paris formed perhaps the longest series on record. They were commenced in 1689, and, with the exception of twenty-six years, viz., 1697-98, 1755-72, and 1798-1803, they had been continued to the present day.

From 1689 to 1870 there had been, according to Dr. Rudolph Wolf and Prof. Fritz, seventeen years of maximum and seventeen years of minimum sunspot. Now it would be seen from the following table showing the years of maximum and minimum, and (as far as possible) the rainfall in each of them at the Paris Observatory, not only that more rain had fallen in the former than in the latter, but that throughout that long period there had, as far as could be ascertained, been only two exceptions to the rule that the maximum were wetter than the minimum years.

Min. years.	Rainfall.	Max. years.	Rainfall.	Dif.
	mm.		mm.	mm.
1689	513·0	1693	613·5	+ 100·5
1698	?	1705	372·7	?
1712	573·3	1717	478·8	− 94·5
1723	229·9	1727	370·0	+ 140·1
1733	210·2	1738	400·0	+ 189·8
1745	337·3	1750	564·5	+ 227·2
1756	?	1761	?	?
1766	?	1770	?	?
1775	534·4	1779	560·1	+ 25·7
1784	442·5	1789	500·2	+ 57·7
1798	?	1804	703·1	?
1810	437·0	1816	545·6	+ 108·5
1823	457·0	1829	559·8	+ 102·8
1833	502·9	1837	547·5	+ 44·6
1843	542·2	1848	575·2	+ 33·0
1856	565·3	1860	655·2	+ 89·9
1867	565·1	1870	417·8	− 147·3

From the above table it followed :

1. That the mean rainfall of the thirteen minimum sunspot years in the second column was 454·6 mm., and of the fifteen maximum years in the fourth column 524·3 mm., giving a mean annual excess of 69·7 mm. in favour of the latter.

2. That the results in the fifth column, of direct comparisons of the rainfalls in thirteen minimum with the rainfalls in thirteen maximum years, gave a mean excess of 67·7 mm. in favour of the latter.

3. That comparing the rainfall in each minimum year, from 1689, with that of the *following* maximum year, there were only *two* minimum years (1712 and 1867) in which the rainfall had not been less than in the maximum year.

4. That comparing the rainfall in each maximum year, from 1693, with the rainfall in the *following* minimum year, there was, as far as was known, only *one* maximum year (1705) in which the rainfall was not greater than in the minimum year.

5. That, as a rule, therefore, the rainfall of a maximum sunspot year was greater than that of either the preceding or following minimum year ; a circumstance which seemed to indicate a tendency, at least, to a periodic variation in the rainfall of Paris.

The most important feature was, not that on the whole the rainfall of the maximum had exceeded that of the minimum years, but that the excess had occurred in eleven out of thirteen cases. This frequent repetition of the same phenomenon pointed to a periodicity. A mere excess of rainfall in the maximum years, as a whole, could not have done so ; for such an excess might have happened if only a much smaller number of the maximum years had been wetter than the preceding or following minimum years. But that was not the case. From 1723 down to 1867 there was not, as far as the observations went, an instance in which the rainfall of a maximum year did not exceed that of the previous and next minimum year.

To the possible objection that the years of maximum and minimum sun-spots of the seventeenth and eighteenth centuries had probably not been so well determined as those of the nineteenth century, it could be replied that the results for the nineteenth century, also, showed that the rainfall had been greater in the maximum than in the minimum years. From 1804 to 1867 there had been six maximum and six minimum years. Now in every case the rainfall of the former exceeded that of the latter, and the mean excess was 86·1 mm.

Since 1867 there had been only one maximum year, viz., 1870, and the next minimum year was not yet known. It was true that the rainfall of Paris in 1870 had been comparatively small, and it was not improbable that it would be less than that of the next minimum year ; but if such should be the case it would be the only exception to the general rule since the commencement of the century, if not since 1705.

The total rainfall at the Paris Observatory in the seven maximum years, since 1800, was 4,004·2 mm., and in the six minimum years 3,069·5 mm. A rainfall of 934·7 mm., therefore, would be required in the seventh minimum year to restore the balance ; and there was very little chance of this, the greatest recorded rainfall, since the observations had been commenced, having been 703·1 mm. in the maximum year 1804, and the least 210·2 mm. in the minimum year 1733.

The average duration of the sun-spot cycles was, according to Wolf, 11·1 years. The last five complete cycles, starting from a minimum year, were from 1810 to 1867. Taking in each of these cycles the three years of most and the three years of fewest spots, and comparing the rainfall of Paris in the former triennial periods with that in the latter, it was found that the rainfall in each minimum period was less than that in the following maximum period. The figures were as follows :—

Minimum periods.	Rainfall.	Maximum periods.	Rainfall.
	mm.		mm.
1810—12	1531·5	1815—17	1561·4
1822—24	1453·2	1828—30	1718·2
1832—34	1380·1	1836—38	1700·0
1842—44	1455·3	1847—49	1602·7
1854—56	1522·8	1859—60	1658·7
1865—67	1751·7	1870—72	1628·5

It would be seen, however, that the rainfall in the minimum period 1865-67 exceeded that in the maximum period 1870-72 of the cycle which had commenced in 1867 (and the end of which was not yet fully known), the rainfall of 1866 having been abnormally great. But as the rainfall in the three years 1871-73 (1817·9 mm.) when the sun-spots were still numerous, had exceeded that in the three years 1865-67, the usual excess in the maximum periods may have only been somewhat retarded.

By forming, in the manner described on previous occasions, a mean cycle out of the five cycles from 1810 to 1867, and comparing the rainfall of Paris with the sun-spots for each year, the following mean results were obtained :—

Years of mean cycle.	Rain variation.	Spot variation
	mm.	
1	− 2·3	− 32·3
2	− 20·3	− 19·2
3	− 22·2	− 1·1
4	+ 15·3	+ 30·2
5	+ 47·5	+ 40·0
6	+ 40·0	− 29·8
7	+ 12·6	+ 11·3
8	− 17·0	− 1·2
9	− 23·3	− 12·8
10	− 22·7	− 21·1
11	+ 2·0	− 23·6

The above table showed that both the spots and the rain were above (+) or below (−) their respective averages in the same years of the mean cycle, except the last, and that they both attained their maximum in the same year, namely, the fifth. The discrepancy, with respect to *sign*, in the eleventh year, was owing to the years 1854 and 1866 having been abnormally wet.

From the maximum year 1816 to the maximum year 1870 there had also been five complete cycles, which, omitting fractions, gave the following results :—

Years of mean cycle.	Rain variation.	Spot variation.
	mm.	
1	+ 20	+ 23
2	+ 14	+ 14
3	+ 5	+ 5
4	− 10	− 6
5	− 10	− 19
6	− 19	− 32
7	− 9	− 37
8	− 1	− 25
9	− 2	+ 2
10	− 1	+ 31
11	+ 24	+ 45

Although in both tables the rainfall variation was not so regular as the sun-spot variation, yet there was a remarkable parallelism. At all events, both tables showed that the rainfall was greatest when the spots were most numerous, and on the whole, least when they were fewest.

From the several results now obtained it was concluded that any relation that might subsist between the rainfall of Paris and sun-spots was direct, instead of inverse, and that excessive rainfall in the present minimum period, or year, would be merely an exception to the general rule.

M. Flammarion was careful to state that the recent wet weather and paucity of sun-spots might have been only a coincidence. Were the far more frequent cases (during nearly two centuries) of comparatively wet years and seasons when solar maculation was greatest, and of comparatively dry years and seasons when it was least, also mere coincidences? Various considerations had led to the conclusion that they were not.

The circumstance that the sun's physical state, as indicated by the changes that took place in and above the photosphere, was subject to periodic variations, afforded ground for supposing that corresponding variations took place on and near the earth's surface. As a matter of fact, it was now universally admitted, although long contested, that terrestrial magnetism and auroras were subject to variations corresponding directly with those of the sun. Would it, then, as M. Flammarion had asked, be at all surprising to find that meteorological phenomena were subject to similar variations?

Supposing it were fully proved that the rainfall of the whole globe varied directly as the amount of sun-spots, it could not be expected that the law would invariably hold good everywhere. At any given place there were exceptions to every meteorological cycle. For example, on an average, the diurnal temperature increased from near sunrise to an hour or two after noon, and then decreased; but in many parts of the world there were frequent exceptions, and these were so great that the coldest and warmest hours might respectively occur at any time of the day or night. Yet there was a daily cycle of temperature corresponding with the position of the sun. Again, there was a diurnal oscillation of the atmospheric pressure, which, within the tropics, was very regular, though now and then disturbed or entirely masked, but which, in many extra-tropical countries, could not be determined except by taking means of hourly observations carried on for many days. Hourly barometric observations made on ten or more successive days, or cycles, in high latitudes, might not show a trace of the mean diurnal oscillation, which nevertheless existed.

It could not be said, then, that because the rainfall of a place did not invariably increase and decrease as the sun-spots did, there was no rainfall cycle corresponding with the sun-spot cycle. On the contrary, considering the capriciousness of the climate of Paris, it was somewhat surprising that a mean of the rainfall for only five cycles gave such results. There were many five consecutive days on which hourly observations would not give more favourable results for determining the daily march of the pressure of the atmosphere. But while there were 365 cycles of the diurnal oscillation of the barometer in one year, the same number of eleven-year rainfall cycles, if such cycles existed, extended over 4,051 years; so that it was easier to discover the former than the latter by observations at a single station. If the rainfall of Paris and the sun-spots had been observed and compared for as many sun-spot cycles as there were cycles of the diurnal oscillation of the barometer in one year, an eleven-year cycle of the rainfall might now be as well established as the diurnal cycle of the atmospheric pressure or the diurnal cycle of the temperature of the air. But the number of sun-spot cycles during which observations of the rainfall had as yet been made were few. Was it necessary, then, to wait thousands of years before it could be known whether or not there was an eleven-year rainfall cycle? It was believed that such was not the case. The problem might be solved in a much shorter time.

If the total annual precipitation over the whole globe were accurately known for eleven years, and if it were found that it was not a constant quantity, but increased from a minimum in the first year to a maximum in the fourth or fifth, and then decreased to a minimum in the eleventh, there would be a strong probability that this variation was due to some cause operating from without, and that that cause resided in the sun. For to what could such a phenomenon be attributed but to a variation in the action of the great central luminary upon which the production and condensation of aqueous vapour depended? And if continued observation of the total precipitation over the globe showed repetitions of the same variation during several periods of which the mean length was about eleven years, it would be somewhat difficult to avoid the conclusion that the sun's radiant energy was subject to a corresponding variation, even if no trace of such variation had as yet been discovered.

Suppose, now, that in the course of time it were found that there was a periodic variation of the physical state of the sun, and that this variation had the same duration and characteristics as the previously known variation in the amount of aqueous precipitation, would it not be concluded that the latter variation was intimately connected with the solar variation, although the nature of the connection might be a mystery?

Similarly, it might be argued that if the sun, upon which aqueous precipitation depended, was subject to variation, precipitation would be subject to a corresponding variation.

Since, then, it was an established fact that the sun, as shown by a periodic increase and decrease of spots, faculæ, and eruptions, extending over a period of about eleven years, was subject to variation, it might reasonably be inferred that there was a similar variation in aqueous precipitation. And if actual measurements of the total annual amount of precipitation over the globe during *one* sun-spot cycle showed a variation similar in every respect to the solar variation, it would be concluded, not only that there was a rainfall variation, but that probably it was intimately connected with the sun-spot variation.

Theoretically, then, the object should be to ascertain the annual rainfall of the globe. If this could be done for a few sun-spot cycles, the question of a corresponding rainfall cycle would be settled. But the total annual precipitation could not be ascertained; for, in addition to other obstacles, some parts of the earth's surface were inaccessible.

It was more than probable, however, that, supposing a rainfall cycle existed, observations made at numerous points, in both hemispheres, would detect it in a comparatively short time. If, for example, in the course of a few sun-spot cycles, the rainfall in many remote parts of the world, and under every variety of climate, afforded strong evidence of corresponding cycles, if the evidence became stronger as the number of observing stations increased, and if a mean of all the results showed a rainfall variation closely agreeing with the sun-spot variation, it would be difficult to resist the conclusion that the rainfall had a periodicity connected in some way or other with the solar periodicity.

Now, taking only the four sun-spot cycles from 1824 to 1867, so as to avoid objections to earlier observations, it had been found, as shown at former meetings of the society, not only that the rainfalls of the British Islands, the Continent of Europe, America, India, Mauritius, the Cape, and Australia, had, as far as could be ascertained, been greatest when the sun-spots were most numerous, and *vice versâ*, but that a mean of all the observations taken at 138 stations gave the following results, when compared with the sun-spots for the same four cycles:

Years of mean cycle.	Rainfall variation.	Spot variation.
	in.	
1	− 2·0	− 38·2
2	− 0·9	− 22·7
3	+ 0·8	+ 5·7
4	+ 1·9	+ 33·3
5	+ 1·9	+ 41·9
6	+ 1·8	+ 30·7
7	+ 1·1	+ 13·1
8	+ 0·2	− 1·5
9	− 0·5	− 12·1
10	− 0·8	− 21·7
11	− 2·0	− 28·0

The above table showed that the rainfall and sun-spots were, with a single exception, both below or above their respective means in the same years, and it would be seen that as the one increased or decreased, so did the other.

The *separate* results for Europe, America, India, and the stations in the Southern Hemisphere were similar. Those for Europe, for example, derived from observations taken at ninety-nine stations, were as follows :

Years of mean cycle.	Rain variation.	Spot variation.
	in.	
1	− 0·7	− 37·2
2	− 1·7	− 22·8
3	− 0·6	+ 4·4
4	+ 0·8	+ 33·0
5	+ 1·2	+ 43·8
6	+ 1·8	+ 32·9
7	+ 1·7	+ 14·3
8	+ 1·4	− 2·9
9	− 0·3	− 16·6
10	− 1·1	− 24·7
11	− 0·1	− 24·0

Similar results were obtained by taking the sun-spot cycles *separately*. Those for the cycle 1856–67, were as follows :—

Years of cycle.	Rain variation.	Spot variation.
	in.	
1	− 2·2	− 39·7
2	− 1·8	− 39·9
3	− 0·8	− 16·9
4	+ 0·9	+ 24·3
5	+ 1·9	+ 56·9
6	+ 2·5	+ 57·6
7	+ 2·0	+ 38·1
8	+ 0·6	+ 12·4
9	+ 1·0	− 13·9
10	− 1·5	− 34·1
11	− 0·4	− 45·0

The observations at many single stations, when treated by themselves, gave similar results. Those for Edinburgh and Bombay from 1824 to 1867, and for the Cape of Good Hope from 1843 to 1867, were as follows :—

Years of mean cycle.	Rain variation.			Spot variation.
	Edinburgh.	Bombay.	Cape.	
	inch.	inch.	inch.	
1	− 2·8	− 9·0	− 2·3	− 37·2
2	− 1·8	− 5·8	− 2·2	− 22·8
3	+ 0·7	+ 1·3	+ 0·4	+ 4·4
4	+ 2·4	+ 7·3	+ 3·1	+ 33·0
5	+ 3·3	+ 3·5	+ 2·6	+ 43·8
6	+ 2·8	+ 2·4	+ 3·2	+ 32·9
7	+ 0·5	+ 3·8	+ 4·3	+ 14·3
8	− 0·4	+ 0·7	+ 0·8	− 2·9
9	− 1·0	− 1·9	− 2·8	− 16·6
10	− 2·5	− 0·3	− 3·9	− 24·7
11	− 1·7	− 1·9	− 3·3	− 24·0

It had also been found that the levels of the principal rivers of Europe, and those of the great American lakes, had on the whole varied with the amount of sun-spots.

Such were a few of the results for the four sun-spot cycles from 1824 to 1867. Now it was important to remark that the evidence had increased as the rainfall observations had increased. Hence, with the large number of observing stations now spread over the world, it was inferred that a few more sun-spot cycles would settle the question of a corresponding rainfall cycle, if it was not settled already.

Another way of testing the matter in a comparatively short time was to compare, as far as possible, the daily, weekly, or monthly rainfall of the globe with the sun's-spotted area; for the amount of sun-spots varied much in the course of a year.

The results for the sun-spot cycle which commenced in 1867, and which probably was now closing, were not yet fully known, but there was reason to believe that they would be similar to those obtained for former cycles. It could already be stated that a mean of a large number of observations made in all parts of the world showed that the rainfall in the years 1870–72 had been greater than that in the years 1865–67, and judging from the severe droughts that had occurred in India, China, Japan, Australia, South Africa, South America, &c., since 1876, it was not improbable that the rainfall of the last three years had been less than that of the years 1870–72. In 1877 and 1878 the Nile, at Cairo, was lower than it had been for many years, showing that in the regions drained by it there had been a deficiency of rain. There had also of late years been a gradual decrease in the depth of water in the upper portions of the Amazon, so that navigation had sometimes been impeded, and this was supposed to be due to a general diminution of rainfall in the interior of South America. Moreover, various parts of the United States had lately been suffering from drought.

It would appear, then, that the circumstance that the rainfall of Paris had for a long period been greater in the years of maximum than of minimum sun-spots, was not a mere coincidence, but the result of a general law, and a similar remark applied to the rainfalls of many other public observatories.

There were, as might be expected in the case of so fickle an element as the rain, great local exceptions to the general law, though not greater or more frequent than exceptions to the general laws of other cycles; but, as far as had yet been ascertained, the rainfall of the globe varied directly as the sun-spots varied, the deficiency at some places in the maximum years being more than made up by the excess at others, and the excess in the minimum years reduced by a proportionately greater deficiency elsewhere.

Great fluctuations occurred near the epochs of maximum and minimum, but at a large majority of stations the rainfall in the three years of most sun-spots was almost invariably greater than that in the three years of fewest sun-spots.

The general rainfall cycle for the whole globe might be conceived to be made up of a number of local cycles differing more or less among themselves and from the general cycle, according to local conditions, and in some places the general cycle might be reversed.

From this point of view, it was possible that, although the recent rainy weather in Western Europe, at a time when there were few or no sun-spots, was a deviation from the general law, yet it was not an exception to the particular modification of it which prevailed in that part of the world. As a matter of fact, the rainfall of Western Europe was considerably above the average in 1844–45, 1845–55, and 1866–67, that is at intervals the mean length of which was eleven years, and at times when there were few sun-spots. But Western Europe was only a small part of the earth's surface; and from such a deviation, it could not be inferred that the rainfall, *generally*, was above the average in the minimum years.

In Mauritius there had been continuous observations only since 1852. Since that time the rainfall had on the whole been considerably less in the minimum than in the maximum years, but it would take some time to eliminate the effects of local causes.

SCIENTIFIC SERIALS

Zeitschrift für wissenschaftliche Zoologie, 33 Bd., 1 and 2 Heft, October 29, with seventeen plates.—F. E. Schulze, researches upon the structure and the development of the sponges; eighth notice.—On the genus Hircinia of Nardo, and on Oligoceras, a new genus, Plates 1 to 4. The genus of Nardo equals Stematumenia of Bowerbank; Sarcotragus, O. Schmidt; Filifera, Lieberkühn; and Polytherses of Duchassaing and Michelotti. The structure of the filaments—algæ of some authors—is fully discussed. The new genus Oligoceras is established for a new species (collective) from Lesina, which, though a fibrous sponge, is almost destitute of fibrous material. —Prof. E. Selenka, on the germ lamellæ and the arrangement of the organs in the Echinidæ, Plates 5 and 7.—Prof. A. Weismann, Contributions to the natural history of the Daphnidæ, No. 6 and 7, with Plates 8 to 13.—Prof. P. Langerhans, on the worm fauna of Madeira, with Plates 14 to 17.

Gegenbaur's morphologisches Jahrbuch, 5 Bd., 4 Heft.—Reinhold Hensel, on the homologies and varieties of the teeth formulæ of some mammals.—Carl Rabl, on the development of the embryo in Planorbis, with Plates 32 to 38, and woodcuts.—A. Rauber on the formation of form and the disturbance thereof during the development of the vertebrata, first section, introductory remarks, Plates 39 to 41.

Cosmos, November.—Prof. O. Caspari, Darwinism and philosophy, with respect to the homonymous writings of Gustav Teichmüller, of Dorpat.—Baron Dellingshausen, the metaphysical foundation for the mechanical theory of warmth.—Dr. Wernich, on dying and on being killed in the lower forms of life.—Dr. Speyer, protective resemblance in some native insects (end) with woodcuts, communicated by Dr. Fritz Müller.—On Christian Conrad Sprengel; being sketches by two of his pupils.—Smaller contributions literary and critical.

Revue Internationale des Sciences, November 15, contains:—M. Vulpian, introduction to the physiological study of poisons.—Prof. Donders, on science and the art of medicine, being the introductory address to the International Congress of Physicians held this year at Amsterdam; this admirable address will well repay perusal.—M. Villot, the experimental method and the positive limits of natural history.—F. Lataste and R. Blanchard, on the peritoneum in Seba's python.—M. Hallez, on the classification and on the phylogeny of the turbellarians.—Proceedings of the Anthropological Society of Paris. — Bibliographical Bulletin.

SOCIETIES AND ACADEMIES

London

Royal Society, November 27.—"On the Changes in Pepsin-forming Glands during Secretion," by J. N. Langley, M.A., Fellow of Trinity College, Cambridge, and H. Sewall, B.Sc., Fellow of the Johns Hopkins University, Baltimore, U.S.A. Communicated by Prof. Michael Foster, M.D., F.R.S.

The Œsophageal Glands of the Frog.—In a frog three to four days after food, the alveoli of the œsophageal glands are, in the living state, granular throughout. The outlines of the cells are not visible.

Shortly after food is given, the granules thin away at the peripheries of the alveoli, and thus render the alveolar outlines more obvious. This thinning proceeds so rapidly that in a few hours there is a well-marked clear zone in the outer part of each alveolus, the part nearest the basement membrane.

Later the clear zone becomes larger, the granular zone becoming smaller, but as the clear zone enlarges it ceases to form in section a ring, it dips down into the granular zone at intervals.

Nuclei are not seen either in the resting or the digesting gland.

The points mentioned above as observable in the fresh tissue, can also in the main be observed in glands treated with osmic acid; the border granules, however, stain more deeply and readily than the central granules. The mucous cells are fewer in the active than in the resting glands; it is only in the fresh state that they appear granular.

The granules we consider as stored up cell-products, which, on suffering molecular re-arrangement during the secretion, give rise amongst other substances to the proteid ferment.

We cannot agree with Nussbaum's view that the depth of staining with osmic acid is a trustworthy index of the amount of ferment present in the cells. On his view, it appears to us, the border, rather than the central, granules should be connected with the ferment.

The Gastric Glands of the Newt (*Triton tæniatus*).—In the newt, the glands were observed through the muscular coat of the stomach with a rapid capillary circulation still going on.

Twenty-four hours after feeding, the glands of the fundus are thickly granular throughout; about three hours after feeding, the maximal change takes place; it corresponds in the main to that already described for the œsophageal glands of the frog.

The glands recover their granular appearance comparatively quickly; in six hours after feeding, the granules have usually again crept up to the periphery; they then increase in number throughout the cells up to about the twenty-fourth hour. Later than this they diminish somewhat; in six days the peripheries of the glands have become more sparsely populated.

In *Triton cristatus* the digestive changes are of the same nature, but much less pronounced.

The Gastric Glands of Stickleback.—In the gastric glands of the hungry fish the granules thin away somewhat from the centre to the periphery; the lumina are inconspicuous. Three to five hours after feeding, the lumina are much larger, the granules are aggregated about it, leaving a peripheral clear rim, the glands are more unequal in size, some having lost more granules and diminished more in size than others.

The Gastric Glands of Mammals.—In the glands of the fundus of the stomach of all mammals investigated, viz., dog, cat, rat, and rabbit, the chief cells are, in rest, crowded with conspicuous granules; the border cells are either without conspicuous granules or are finely granular.

During digestion the granules in the chief cells diminish.

The stomach of the rabbit has certain structural peculiarities; the principal of these is that a large portion of the greater curvature contains glands, in which the chief cells are not coarsely granular. The glands of the greater curvature contain scarcely more pepsin than the glands of the smaller curvature and pylorus. But in the smaller curvature and pylorus there are few if any border cells, whilst there are many in the greater curvature.

Hence the border cells are not directly connected with the formation of pepsin.

The glands of the fundus contain a very much larger amount of pepsin than the glands of the greater curvature; that is, where there are coarsely granular chief cells there is a large amount of ferment.

Further, during digestion the fundus-glands contain less ferment than in hunger—a fact observed first by Grützner—and it is during digestion that the chief cells have fewest granules.

Hence the conspicuous granules in the chief cells are directly connected with the formation of ferment.

Since in passing from the fundus to the greater curvature we meet all stages of granularity in the chief cells, and since the chief cells of the greater curvature do not differ in any essential point from the pyloric gland cells, we conclude with Heidenhain that the pyloric gland cells and the chief-cells of the fundus are fundamentally the same. We consider, however, the chief cells of the fundus to be a highly differentiated form of the pyloric gland cells, a form more especially designed for the production of pepsin, and probably other solids of the gastric secretion.

December 11.—"Thermo-Electric Behaviour of Aqueous Solutions with Mercurial Electrodes," by G. Gore, LL.D., F.R.S.

In this research the author has examined, by means of a new form of apparatus, the thermo-electric properties of a number of liquids in relation to mercury. The liquids include those of acid, neutral, and alkaline reaction. The results obtained are arranged in a table or series, with the solution at the top, in which hot mercury was the most positive at 180° F., and that at the bottom, in which it was most negative, the amount of deflection of the galvanometer needle with each solution being stated.

Another table is also given, in which the solutions are arranged according to the relative degrees of electro-motive force of the currents obtained from them. This series was arrived at by employing two similar apparatus with different solutions in each and ascertaining the difference of strength of their currents by passing the two currents simultaneously in opposite directions through the coils of a differential galvanometer, the amount of difference of deflection produced by each two consecutive pairs being given.

The results obtained from this research have not revealed any very striking phenomena nor disclosed any relation to chemical action or property, but are reasonably explicable upon the hypothesis that the rise of temperature of the liquid is attended by a change of molecular arrangement of the solution, of such a kind as to enable a portion of heat to be converted into an electric current.

The most peculiar phenomenon observed was, that if a solution of a salt, made with distilled water freed from dissolved air, was divided into two equal parts, one of which had been heated and cooled without loss of water or other constituent, previous to making an experiment, the non-preheated portion gave a stronger current than the other, probably in consequence of a change of molecular arrangement of the solution produced by the heating. The method may therefore be employed for detecting molecular differences in conducting liquids having the same che ical composition.

In the class of cases in which the differences of molecular arrangement were the least and the currents the most feeble, the direction of the currents was the most uniform. This is in accordance with the common truth in science, that the smallest phenomena are the most constant.

The author has ascertained by separate experiments of a different kind that mercury, when sufficiently agitated with solutions neutral to test paper, of salts of the alkali metals, renders some of those liquids feebly alkaline; the effect, however, is so slight, requires such extensive and long-continued contact of the substances that it appears consistent with the view that chemical action is not the cause of the currents in these thermo-electric experiments.

"Quantitative Spectroscopic Experiments," by Prof. G. D. Liveing, M.A., F.R.S., and Prof. James Dewar, M.A., F.R.S.

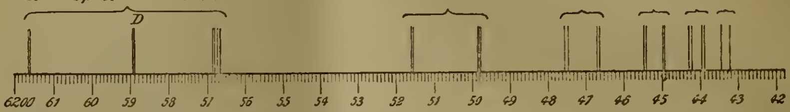
"On the Spectra of Sodium and Potassium." By G. D. Liveing, M.A., F.R.S., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

The authors notice that as seen in the electric arc in one of their lime crucibles, there are in each spectrum several lines hitherto undescribed, which make the whole very regular and symmetrical. The authors have generally used carbonates of the metals, sometimes chlorides.

The pair of lines (5155, 5152) are sharply defined, and have no other line close to them; but the bright green pair, or fifth group (4983, 4982), are diffuse lines, usually seen as one band, but noted by Lockyer to be a double line, and have a third line on their more refrangible side. The authors feel sure that there ought to be a fourth line in this group, but have never been able to detect it.

The sixth group consists of a pair of lines sharply defined. The first only of this pair is described by Lecoq de Boisbaudran. The seventh group is a pair of lines with diffuse edges, which the authors have seen reversed as fine dark lines in the middle of diffuse blue bands. The first only is described by Lecoq de Boisbaudran. By putting some titanic oxide into the crucible the titanium line 4666·5 was seen between the sodium lines, and the authors have no doubt that it is sodium which gives the winged appearance to the corresponding ray in the solar spectrum. The eighth group is a more sharply defined pair, the ninth a diffuse pair, the tenth group again a more sharply defined pair,

Dia. 1 Spectrum of sodium in the arc



and the eleventh group a very diffuse pair, sometimes seen as a continuous band dividing as the sodium evaporates. The twelfth group is a diffuse but narrow band, which the authors have not seen divided, and the thirteenth group a diffuse broad band nearly bisected by the iron line 4325.

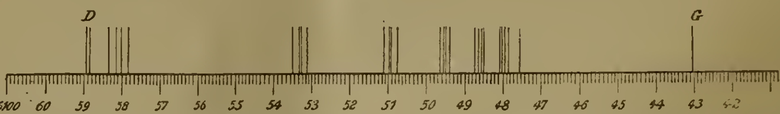
The successive groups become fainter and more diffuse as they are more refrangible, at the same time the distance between successive groups diminishes. Their positions are shown on the accompanying diagram to a scale of wave-lengths. It is worthy of note that every alternate group is much more sharply defined than the others. Moreover, it is only the diffuse groups (3) (5) (7) which show reversal except the first group, in the orange, which, however, is more difficult of reversal than the others. The whole series, exclusive of D, looks very like repetitions of the same set of vibrations in a harmonic progression; the first (visible) term consisting of the six vibrations represented by the orange pair (6160, 6154) and the four lines of group (3); the next term of the five lines of the fourth and fifth groups, one of the six vibrations being now too faint to be seen; the next three terms, of each of which only four lines are visible, consisting of the six and seventh, the eighth and ninth, and the tenth and eleventh groups, and the last term of the two faint bands of the twelfth and thirteenth groups.

Simple harmonic relations can be found to subsist between some of the groups, for instance, the wave-lengths of the fifth, seventh, and eleventh groups are very nearly as $\frac{1}{15} : \frac{1}{16} : \frac{1}{17}$, but the whole series cannot be represented as simple harmonics of one set of six vibrations with any probability. The smallest numbers, which are nearly proportional to the reciprocals of the wave-lengths of groups (1), (4), (6), (8), (10), (12), are 81, 97, 105, 110, 113, 115; and these numbers are only approximately in the same ratios as the reciprocals of wave-lengths.

Lines closely corresponding to all these lines except the faint ones of the 3rd and 5th groups, and the last two groups are found in the solar spectrum.

The potassium spectrum as seen in the arc, leaving out of account the two pairs of lines in the red and that in the violet, consists of a series of groups of four lines each, succeeding one

Dia. 2. Spectrum of potassium between D & G



another at shorter intervals and becoming fainter as they are more refrangible. They all are more or less diffuse, markedly more so on their less refrangible edges. They are shown on the accompanying diagram to a scale of wave-lengths.

The first and least refrangible group of this series consists of the four lines to which Lecoq de Boisbaudran assigns the wave-lengths 5831, 5812, 5801, 5783. The second of these lines (5812) is much less strong than the others as seen in the spark. In the arc they are all nearly equal in brightness, but the authors have not seen the second line reversed. Six groups of four lines each follow.

The sixth group has lines of about the wave-lengths 4808, 4803, 4796, 4788.

The seventh group is too faint and diffuse to be distinctly resolved. The wave-length of the least refrangible edge is about 4759.

None of the last three groups are seen by Lecoq de Boisbaudran, and they are too diffuse for exact measurement; on the other hand, he gives several other lines which are not noticed in the arc.

As in the case of sodium the repetition of these quartets of lines at decreasing intervals with decreasing brightness and sharpness as they proceed from the less to the more refrangible, gives the impression of a series of harmonics; but the wave-lengths do not seem to be in a simple harmonic progression, though simple harmonic relations may be found between some of the groups.

Linnean Society, December 4.—Prof. Allman, president, in the chair.—Mr. W. Carruthers exhibited a bottle of Pteropods (*Spirialis retroversus*) obtained in abundance by Dr. J. Grieve in the Gareloch, Ross-shire, Scotland, in July. A letter from Dr. Grieve was read, wherein he states that these mollusca swam rapidly to the surface, rising with a perpendicular fluttering motion, and having reached the top they raised their wing-like appendages above their heads, and thus upholding them motionless, would then drop quietly to the bottom. Some of the pteropods would occasionally stop half way, and paddle back to the surface to repeat the falling motion; seldom or ever did they swim along the surface. Dr. Grieve did not witness the creatures use their wings (epipodia) as feet to walk or crawl along the bottom, as A. Agassiz has stated to be the case.—Dr. Maxwell Masters gave a communication on certain relations between the morphology and the functions in the leaves of conifers (see *Science Notes*).—Prof. P. M. Duncan next read a paper on a synthetic type of Ophiurid. This specimen was dredged by Dr. Wallich in the *Bulldog* expedition, 1860, fifty miles north of Cape Valloe, East Greenland, and from a depth of 228 fathoms. On casual inspection this brittle-star might be regarded as an Amphiuran, but the spinulose disk and hooked side-arms oppose this notion. Again, resemblances to species of *Ophiothrix* suggest themselves, but the large scaling of the disk, absence of tooth papillæ, and the presence of accessory pieces around the aboral edge of the upper arm-plates, are distinctive characters, and which to a certain extent are indicative of Ophiolepian affinities, but the dental apparatus does not conform. Thus in shape and dental characters it (*Polyopholis echinata*) approaches *Amphiura*; spinules and arm-hooks are those of *Ophiothrix*; and the accessory plates resemble those of *Ophiolepis*. Provisionally the author places it among the family Amphiuridæ, and he remarks that, though rare, such forms cast doubts on the value of the characters employed in the classification of the Ophiuridæ.—Mr. C. B. Clarke followed with a paper on Indian Begonias. This is supplementary to the author's account of the group iu Sir J. D. Hooker's "Flora of British India." It treats of the classification of the whole genus (*i.e.*, order) except *Hillebrandtia* and *Begoniella*, and it is maintained that it (the group) can be naturally divided into the six subgenera employed in the "Flora of British India." The author discards the differences in the stamens and styles for subgeneric characters, and employs exclusively the structure and dehiscence of the fruit.—The following gentlemen were elected Fellows of the Society:—Messrs. Samuel Wright (St. Neots, Huntingdon), George Malcolm Thomson (Dunedin, N.Z.), J. Otto Tepper (Adelaide), Henry B. Spotton, (Ontario), John Cameron (Bot. Gard., Bangalore), Major Collet (Kurrum Field Force), and Sir Samuel Wilson (Victoria).

Chemical Society, December 4.—Mr. Warren De La Rue, president, in the chair.—The following papers were read:—On the comparative value of different methods of fractional distillation, by F. D. Brown. When fractional distillation is carried out on a large scale, either or both of two well-defined processes can be used: in the first "washing" the mixed vapours are passed through several layers of liquid obtained by their own partial condensation; in the second "cooling" the mixed vapours are partially condensed by allowing radiation to take place or by passing them through a coil kept at a given temperature; in both processes the liquids of highest boiling-point are kept back, and a better distillate is accordingly obtained. The author concludes that there is an essential difference between washing and cooling. The best distillate is obtained by keeping the still-head at the lowest possible temperature compatible with the passage of vapour into the condenser; he has contrived an apparatus to carry out this principle, and has obtained with it very satisfactory results.—On the influence exerted upon the course of certain chemical changes by variations in the amount of water of dilution, by M. M. P. Muir and C. Slater. The authors find that the amount of chemical change which ensues when solutions of calcium-chloride and sodium-carbonate are mixed decreases as the dilution increases, but when solutions of strontium-chloride and sulphuric acid, or barium chloride and potassium oxalate are mixed, various irregularities in the amount of chemical change are noticed as the dilution increases. These irregularities the authors have studied in detail; they conclude that they are due to the entire system being brought into a state of strain, the principal forces of which this stress is compounded being the force tending to produce cryohydrates and other hydrated molecules, the force tending to split up these molecules and the force tending to separate, and so to impart greater mobility to the chemically active molecules of the system.—On the influence of temperature upon the decomposition of barium chloride by potassium oxalate in aqueous solution, by M. M. P. Muir.—On α and β phenanthrene carbonic acids, by Dr. F. R. Japp. The author, since preparing the alpha acid with Dr. Schultz, has obtained a purer specimen melting at 266°; from a syrupy liquor left in the preparation of the calcic phenanthrene sulphonate, the author obtained the beta acid melting at 250°–252°; he also prepared the sodium and barium salts and studied the oxidation products of the acid. He discusses the constitutional formula of phenanthrene, and concludes that this substance consists of three benzene nuclei, one of which shares four adjacent carbon atoms with the two others.—On some derivatives of phenylacetic acid, by P. Philipps Bedson. The author has separated para- and ortho-nitro-phenylacetic acids, their bromo derivatives, a dibromo body, and a β bromonitro-phenylacetic acid, with its amido derivative.

Geological Society, November 19.—Henry Clifton Sorby, F.R.S., president, in the chair.—Edmund Knowles Binns, and John Dawson, were elected Fellows of the Society.—The following communications were read:—Supplementary note on the vertebræ of *Ornithopsis*, Seeley (=*Eucamerotus*, Hulke), by J. W. Hulke, F.R.S., F.G.S.—The author in this communication describes several cervical and trunk vertebræ of this remarkable Dinosaur. The former are characterised by great length; the anterior articular surface is strongly convex, and the posterior correspondingly hollow. In place of the side chamber characterising the trunk vertebral centra, is a long shallow pit. An upper and a lower transverse process are given off from an upper and a lower plate, which project from the side of the centrum above the pit, and these are connected by a short, forked cervical riblet. The neural arch is dwarfed, and there is no spinous process, and no zygosphenal and zygantеal mechanism. The structure of these vertebræ indicates a long, mobile, and light neck. In the trunk the convexity of the anterior articular surface lessens in passing from the neck to the loins, the anterior ball gradually subsiding till the great articular surface becomes plane, the posterior surface retaining, however, a slight hollowness. The trunk vertebræ have superadded to the ordinary articular processes a mechanism comparable to zygosphene and zygantrum, which must have given great fixity to this part of the vertebral column, contrasting strongly with the flexibibility of the neck. The longitudinal side chambers reach their greatest development in the vertebræ referable to the fore part of the trunk; they lessen toward the loins, and are absent from the neck, which is regarded as conclusive of their pneumaticity, and against their having been occupied by cartilaginous and fatty tissues, which might have equally occurred through the whole length of the vertebral column, and not been limited to a particular region in close vicinity to the lungs. The whole construction affords a notable illustration of immense bulk attained with the use of the smallest quantity of bony tissue, which occurs in the form of very thin sheets or plates. The transverse and spinous processes are strengthened by flying buttresses. The vault of the neural canal is beautifully groined, whence the original name *Eucamerotus*. The author then pointed out the family resemblances between the Isle of Wight Wealden form and the new Colorado Dinosaurs, which have many points in common, but are both generically and specifically distinct from *Ornithopsis*. — On the concretionary patches and fragments of other rocks sometimes contained in granite, by J. Arthur Phillips, F.G.S. There are two classes of inclusions, (1) the result of the abnormal aggregation of the minerals constituting the granite itself, containing generally more plagioclastic felspar, mica, or hornblende than it, with some other distinctions: most probably concretions formed contemporaneously with the solidification of the mass; (2) fragments of included schistose or slaty rock, often not very highly altered, caught up from the rock-masses through which the granite has forced its way.—Certain geological facts witnessed in Natal and the border countries during nineteen years' residence, by the Rev. George Blencowe. Communicated by the Rev. H. Griffith, F.G.S. Shales and sandstones are the prevalent rocks from the coast for about twenty-four miles inland. Here is a protrusion of granite; beyond the sandstones come ferruginous shales, with scattered boulders of trap on the surface. The northern third of Natal is white sandstone, formed into hills and ridges by denudation, with a long trap-capped plateau near Helpmakaar. Coal-seams occur in the sandstones. There are frequent vertical pipes in these sandstones which, the author thinks, mark the site of trunks of trees, round which the sand-beds had accumulated. Rorke's House and Isandhlwana are near the above plateau. Near the former is an extinct mud volcano. A remarkable "vitreous shale" is found near the Buffalo; isolated pinnacles of it occur at the spot where the few survivors of the fight crossed that river. A range of mountains, with mural escarpments, remnants of an ancient plateau, rising to a height of some 2,000 feet above another plateau which is 5,000 to 6,000 feet above the sea, extends for about 500 miles from the north of Natal to near Cradock in the Cape Colony; they are sandstone horizontally stratified, capped by trap. Some other geological features are described. The Transvaal consists of undulating hills of soft limestone, a sandstone range, and a country rich in metals,—iron-ore, cobalt, nickel, copper, and gold occur, as well as plumbago.

Zoological Society, December 2.—Prof. Newton, F.R.S., vice-president, in the chair.—A letter was read from Mr. E. L. Layard, F.Z.S., advocating the desirability of a fixed scale of colour for use among naturalists, in describing the plumage and pelage of birds and other animals.—A letter was read from Mr. R. B. White, C.M.Z.S., of Medellin, U.S., of Colombia, S.A., on a mode of protecting plantations from the ravages of an ant (*Atta cephalotes*).—A communication was read from Dr. G. E. Dobson, C.M.Z.S., containing notes on some species of chiroptera, from Zanzibar, with descriptions of new and rare species.—A communication was read from Prince Ladislas Lubomirski, containing the description of a collection of shells made in High Peru, by Messrs. Jelski and Stolzman.—Mr. G. French Angas, C.M.Z.S., read a paper in which he gave the descriptions of two new species of helix (*Eurycratera*) from south-east Betsileo, Madagascar.—Mr. Arthur G. Butler, F.Z.S., read a paper on some Arachnida of Madagascar and the Mascarene Islands, in which an account was given of a collection of spiders recently received by the British Museum from Réunion and Mauritius, through Mr. H. H. Slater.—Lieut.-Col. H. H. Godwin-Austen, F.Z.S., and Mr. G. Nevill, C.M.Z.S., gave descriptions of two collections of land shells obtained at Perak and in the Nicobar Islands by Surgeon-Major E. Townsend and Dr. F. Stolizka.—A communication was read from Dr. A. Günther, F.R.S., containing a notice of a collection of mammals and reptiles recently received from Cyprus by Lord Lilford.—Dr. F. Day, F.Z.S., read a paper upon the fishes of Weston-super-Mare, a locality he had lately visited in order to inquire into some species described by Yarrell and Couch as found on this coast. Mr. Day also gave some account of the results of Lord Ducie's trawling investigations in Ballinskelley Bay, on the Coast of Ireland, and described a specimen of the long flounder received from Mr. M. Dunn of Mevagissy, in Cornwall.

Institution of Civil Engineers, November 18.—Mr. W. H. Barlow, F.R.S., vice-president, in the chair.—The paper read was on tunnel outlets from storage reservoirs, by Mr. C. J. Wood, M.Inst.C.E.

December 2.—Mr. Bateman, F.R.S., president, in the chair.—The paper read was on "The Passenger Steamers of the Thames, the Mersey, and the Clyde," by Mr. W. Carson, M.Inst.C.E.

PARIS

Academy of Sciences, December 8.—M. Daubrée in the chair.—The following papers were read:—On the satellites of Mars, by M. Tisserand. By a different analysis from that of Prof. Adams, he concludes that, if Mars be homogeneous, or if the law of densities in it be the same as in the earth (a certain flattening being supposed), the orbits of the two satellites, Phobos and Deimos, will always coincide with the planet's equator, or at least will diverge from it very little.—Remarks on saccharoses, by M. Berthelot. He calls attention to the resemblance of the new substance, saccharine, in general reactions and crystalline form, to trehalose.[1]—Relation between the heat of solution and the heat of dilution in complex solvents, by M. Berthelot. The difference between the two heats of solution is equal to that between the two heats of dilution, observable when there is added to the concentrated liquor before and after having dissolved in it the third substance, the water necessary to bring it to the state of dilute liquor.—On the protochloride of copper, by M. Berthelot. This relates to heat of solution and heat of formation.—Reply to the two questions about chlorophyll in M. Chevreul's last note, by M. Trécul. Crystals of chlorophyll dissolve without residue in alcohol and ether. Each grain, in plants, composed of protoplasm and the chlorophyll it has secreted, should be considered a particular living organ.—Agronomic map of Seine-et-Marne, by M. Delesse. This shows the comparative fertility of the land, and its features, physical, chemical, geological, &c.—Experiments with divergent ajutages, divided into several parts by plates, by M. De Caligny.—On a function of direction in the flight of insects, by M. Jousset de Bellesme. Birds can, but insects in general cannot, alter at will the angle at which the wing is vibrated (the muscles of insects are not inserted in the wing, but in the piece of thorax which supports them). Direction of flight is determined in insects by altering the relative position of the centre of gravity and the axis of sustention, the former being most commonly displaced, and in some cases by movements of the abdomen, in others, of the elytra, in others, of the balancers.—Experiment relative to transport of phylloxera by the wind, by M. Faucon.—On the direct visibility of the photospheric network of the sun, by Dom Lamey. On November 16, observing the sun with a 6-inch equatorial at Grignon (Cote d'Or), he saw quite well that two spots on the left side were surrounded by a reticulated region. With a weak magnifying power the crateriform aspect was manifest.—On series relative to the theory of numbers, by M. Lipschitz.—Coloured rings produced at the surface of mercury, by M. Guébbard. Having carefully cleared off the grey pellicle which forms on the surface of mercury, breathe on the clear metal. Beautiful ring systems are formed in light by the layer of condensed vapour. They contract as evaporation diminishes the thickness. Better results are had by dropping a volatile oil on the surface, and the best with collodion. Diluted with ether, the latter gives pellicles which can be detached, after having regulated their thickness and colours, at will, and transferred to paper.—Reply to M. Trécul and M. Chevreul regarding crystallised chlorophyll, by M. Gautier.—Influence of phosphorus on the urinary secretion, by M. Cazeneuve. Experiments on the dog and the cat show that phosphorus, given in toxic doses, causes increase of urea, phosphoric acid, sulphuric acid, the total nitrogen, and iron. The author disagrees with the view of certain physiologists who regard the liver as the principal organ formative of urea.—On alcoholic fermentation (re ly to M. Berthelot), by M. Cochin.—On the inferior Pyrenomycetes of New Caledonia, by M. Crié.—Note on the general circulation of the atmosphere on the surface of the globe, by M. Brault. The fourth and last of the author's series of maps of winds is now published; it relates to the Pacific. M. Brault points out that the problem of atmospheric circulation falls into two parts; finding what the circulation would be if all the earth were covered with water (it would be in a system of zones oscillating from south to north, and *vice versâ*), and finding in the actual circulation what is due to the presence of continents and unequal distribution of land and sea. The former question is best studied in the southern hemisphere.—On a glazed frost observed at Angers on December 4, 1879, by M. Decharme. It commenced about 8 A.M., after a night of strong east wind, and lasted till 4 P.M.

[1] In last week's "Paris," on this subject, the phrase "or saccharine, not yet sugar" should read "or saccharose, yet not sugar."

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THURSDAY, DECEMBER 25, 1879

INDIAN ENTOMOLOGY

Descriptions of New Indian Lepidopterous Insects, from the Collection of the Late Mr. W. S. Atkinson, M.A., F.L.S., &c. Part I. *Rhopalocera*, by W. C. Hewitson, F.L.S.; *Heterocera*, by Frederic Moore, Assist. Curator, India Museum. With an Introductory Notice by Arthur Grote, F.Z.S., &c. 4to, pp. 1-88, with Three Coloured Plates. (Calcutta: Published by the Asiatic Society of Bengal, 1879.)

THE hot valleys of the Himalayan regions of our Indian Empire have always justly had especial interest from an entomological point of view. The number of peculiar and apparently strictly endemic, forms of insects already known from this region is great, and principally in the larger species, for even now we know less of the smaller insect-forms of North India than we do of many other less familiar districts not under the advantage of British rule. Indeed, with a few notable exceptions, much of the knowledge we now possess is not precisely of modern origin. The somewhat numerous military expeditions to, and across, the Himalayas, undertaken within the last quarter of a century, and the great recent extension of tea and cinchona plantations in these regions, have not resulted in a corresponding increase in materials for a Himalayan insect-fauna. In some respects it may be said that we are likely to know more of the entomology of the Lake region of Africa, or of the Amazons region of South America, than of a vast and varied district, for the most part under the government of our own countrymen, and of a commercial importance second (to us) to no other. Still, important and wonderful discoveries have been made of late years, but they are perhaps eclipsed by the acknowledged existence of forms discovered long ago which would have become almost traditional were it not that the "types" exist in collections, and that they were duly described and delineated with infinite care in works that are no longer modern. As a summary, then, to the foregoing short introduction to a notice of a modern work on Indian Entomology, it may be briefly stated that a great deal of our knowledge was initiated before the present generation, and has not since been adequately supplemented.

But, as before-mentioned, there have been notable exceptions, and of these the most notable exists in the fruits of the labours of the much-lamented and talented Mr. Atkinson, an entomologist who, before he left this country for India, had acquired a training in entomological pursuits that his keen powers of observation enabled him to use to the best advantage in the intervals of official duties during a long residence in our Eastern Empire. For a very faithful sketch of Mr. Atkinson's career in India, the introductory notice at the commencement of the part of the book now under consideration, from the pen of Mr. Arthur Grote, suffices so far as it goes, and nothing is more to be regretted than the melancholy *finale*. Mr. Atkinson left India on three years' leave, for the purpose of scientifically working out the results of his labours, and died almost suddenly in Italy, before having had time to unpack his stores; and science lost the benefit of what could not have been otherwise than one of the finest original works on Indian entomology that has appeared, or probably ever will appear.

The collections remain (but more or less dispersed); the MS. notes possibly remain also, but they have not been made use of; the more important personal knowledge was buried with its possessor. The collections passed nominally into the hands of the late Mr. Hewitson, but the larger and scientifically more important portions ultimately went to Germany.

So far this notice has been introductory and historical; it remains to refer more particularly to the book. At the outset nothing strikes one as more to be deplored than that Mr. Atkinson himself could not have recorded the results of his labours. In that case we should, without the slightest doubt, have had a complete list of the species observed by him, with copious biological, and comparative faunistic, notes. As it is, we are compelled to put up with a bare mechanical description of the new species, with only a few words on biology, added by Mr. Grote from his long experience in India. The few new butterflies are described by Mr. Hewitson, and this part was probably the last work done by him, the proofs having been corrected on his death-bed. The far more numerous and more important *Heterocera* were confided to the care of Mr. Frederic Moore, by Dr. Staudinger of Dresden, who became their possessor. It would have been impossible to find a more competent entomologist for this task; there is certainly no one who possesses a more exhaustive knowledge of Indian lepidopterous insects. We believe Mr. Moore has commenced, and will finish, the undertaking in the most thoroughly conscientious manner, and this first part treats mainly upon the *Bombyces*, a group in which North India is superabundantly rich, and which Mr. Moore has very closely studied.

If, then, we find fault with the work it is not with especial reference to Mr. Moore (its principal author), but rather to the system pursued, one which is especially the attribute of writers on exotic Lepidoptera, and which will continue so long as lepidopterists are without a general and intelligible generic guide. We find numerous species referred to genera as described by Walker, Felder, &c., and new genera based on characters compared with these. We ask, would it be possible for any entomologist to identify a vast majority of Mr. Walker's generic (or specific) descriptions without referring to the types? and if not, what, from a scientific point of view, is the use of them at all? In the case of Felder ("Reise der *Novara*") it is somewhat different, but the importance is equal. Had that author lived there is little doubt that full and comparative descriptions would have been to hand; as it is, we have little more than an extensive series of beautiful and accurate figures with names applied to them, or with a few words of diagnosis. If our lepidopterists will consent for a few years to an interruption in this interminable and eminently unsatisfactory work of bare "descriptions," and combinedly commence and continue an exhaustive illustrated generic synopsis, they will earn for themselves more fame hereafter than they appear to foresee. Their present system of working only tends daily to render the subject more complicated.

The plates in Part I. of this work are of the greatest excellence so far as they go, and the colouring appears to warrant the extreme praise of not being overdone. But we confess to being more pleased with certain parallel plates on the Lepidoptera of the Dutch Indies that have recently appeared in the *Tijdschrift voor Entomologie* (the publication of the Entomological Society of the Netherlands). Our English plates of butterflies and moths too often remind us irresistibly of the sheets of figures of these insects (often beautifully executed) that appear in the shop-windows to be utilised as "scraps," or in any way the purchasers may think fit. That in the majority of cases they serve to identify the species is probable, but they lack the slightest delineation of structural details other than those shown in the general outline of the body and wings. The figures of moths are innocent of legs, innocent of neural details, innocent of palpi (unless these organs be more than usually prominent), and equally innocent of other indications that are now often considered of importance.

Many of the species here described and figured have their evident palæarctic analogues; but, in the absence of a complete list of those found by Mr. Atkinson and other Indian observers, it is impossible to form an idea as to the general nature of the Himalayan lepidopterous fauna.

R. McLachlan

MINERAL DEPOSITS

Die Lehre von den Lagerstätten der Erze; ein Zweig der Geologie. Von Dr. Albrecht von Groddeck. 8vo. pp. 350. (Leipzig, 1879.)

IN this volume the phenomena characteristic of mineral deposits are concisely treated in a manner suited for students' use. The descriptive matter is arranged under three heads, the first dealing with the forms of lodes, beds, &c., and their relations to the containing walls or "country" rocks, the second with the contents, or more particularly, with the distribution in the deposits themselves of such contents in the shape of valuable minerals; while the third is a "system of mineral deposits" arranged under different sub-sections, such as original and reconstructed deposits, beds stratified and massive, veins and other deposits filling cracks and hollows, &c.; each particular case being referred to a so-called type bearing a special name. The fourth and final section contains a theory of the origin of mineral deposits in general.

Of the matter contained, much is reproduced from the late Dr. B. von Cotta's "Lehre von der Erzlagerstätten," the last edition of which was published in 1861, the remainder being for the most part derived from papers by various authors that have appeared for the last twenty years, in different German journals, devoted to geological and mining matters.

The principal novelty is the arrangement of the third part, and this is not very satisfactory, the fifty-six types making up the "System" being based partly on structural and partly on topographical considerations, the grouping being too artificial to be of any real geological value. Thus, for example, deposits of chromic iron ore in serpentine are said to belong to the "Wooded Peak" type, because an occurrence of this kind has been reported from a place bearing that not very distinctive name in New Zealand; the famous old mines of Chessy and Montecatini are examples of the Mednorudjansk type, whose "characteristic" is given as follows: "Pyritic ores . . . in unstratified (*massigen*) rocks oftenest Diorite Gabbro and Olivine rocks (serpentine)." This particular deposit, named as the type perhaps better known as the Nishne Tagilsk malachite mine does not, however, occur in unstratified rocks, but in a mass of chloritic, argillaceous, and talcose schists, inclosed in upper Silurian limestones; the author having been led into a mistake by not properly looking up his authorities, the account relied upon being one published in a German journal twelve or thirteen years ago.

In another case, the Tellemarken-Cornwall type, the characteristic is "Lodes in sedimentary rocks, preponderating contents quartz and copper ores in varying proportions, less common are barytes, carbonates, and silicate of zinc, tin-stone, galena, &c." The examples given of this type appear to show that the copper ores of Tellemarken are not in veins in stratified rocks, but in quartz strings in granite dykes, a tolerably common class of occurrence in Scandinavia, and about as much unlike the ordinary type of Cornish lode phenomena as can well be imagined.

Many other examples might be adduced of the incongruities arising from the author's method of classification.

The accounts of the different districts are very disproportionate in value, especially in non-German countries. Thus Cornwall is dismissed in a page and a half, reproduced from Cotta's work, and the whole of the carboniferous limestone lead regions of Central and Northern England are included in a word or two about Derbyshire and Cumberland, the Silurian districts of Wales not receiving any notice. Iron ores are still more capriciously treated, the thin, stratified, spathic and clay band ores of Westphalia taking the first place, while the mighty deposits of Styria are allowed eight lines. No mention is made of either Mokta-el-Hadid, Hodbarrow, or any other of the great mines in the Furness, Ulverstone, or Whitehaven districts, Sommorostro or any other of the Bilbao mines; and, generally speaking, the great sources of supply to the iron-smelters in Western Europe are conspicuous by their absence. Against this we have to set tolerably complete notices of the iron ores of the United States, derived for the most part from Dr. Wedding's Pennsylvanian Exhibition Report.

The work being primarily intended for the use of German students may perhaps account for the circumstance that in the references only German writers are noticed, and this is so completely carried out, that in the few cases where an English or American authority is named, the titles of their works are not given. This is the more to be regretted, as the use of original memoirs might in some cases have prevented the appearance of errors in the text, obviously due to the second-hand sources of information usually relied upon by the author. The careful study of a single good memoir, such as that of the late Prof. Axel Erdmann on the Dannemora Mines, for example, would probably be of more value as a means of preparing a student for recording original observations, than the most complete knowledge of the types of the very artificial system contained in the work.

H. B.

OUR BOOK SHELF

The Climate of Eastern Asia. By Dr. H. Fritsche, Director of the Imperial Russian Observatory at Peking. Pp. 210, Maps 18. (Printed at the *Celestial Empire* Office, Shanghai.)

IN this memoir Dr. Fritsche has very fully gathered together the various meteorological observations which have been made in Eastern Asia up to the present time, and discussed them in such a way as to cast additional light on the laws of meteorological phenomena ruling in that part of the globe. With the aid of the fresh information obtained from the observations of the past dozen years which it may be remarked have been made with instruments generally of improved quality and at known heights above sea-level, he has made several important rectifications on the isothermal and isobaric lines of Eastern Asia; and stated with more adequate emphasis than has been done heretofore the extraordinary climatic influence of that enormous mass of unbroken land practically destitute of lakes and of the cold arctic currents which wash its eastern coasts.

In winter, atmospheric pressure is high on the continent, and the general movement of the atmosphere being from north-west and north, intensely cold air-currents set in southward from the arid wastes of the interior, and are carried into lower latitudes than in any other quarter of the globe. Hence the mean temperature of January in the territory of the Amoor is 18°·0 lower than that of the eastern coast of North America in the same latitudes; and even at Canton, which is just within the tropics, the temperature sometimes sinks to freezing and snow falls. On the other hand, in summer atmospheric pressure is low on the continent, and the prevailing winds being south-east and south the cold ocean currents flowing along the coast from the north powerfully affect the climate in moderating the summer-heat for some distance inland. Dr. Fritsche's isothermals show that this influence is much greater than is usually indicated on isothermal charts. An extremely interesting comparison of climates is made by an elaborate discussion of their monthly and annual absolute maxima and minima of temperature, but the conclusions would have been more valuable as well as more telling if the methods of observation had been uniform throughout. Indeed, in dealing with extreme temperatures, want of uniformity of observation frequently lays a complete arrest on all discussion.

Dr. Fritsche places in a striking light the influence on climate respectively of the warm waters of the Gulf Stream and of the colossal dry continent of Asia. In January the difference between the mean temperature of the North Pole and that of the equator is, according to Dove, 106°·0. Now, since Western Europe, which is the same distance from Eastern Asia that the equator is from the Pole, has a January temperature 50°·4 higher than that of Eastern Asia, it follows that the influence of the distribution of land and water on the mean temperature of January is nearly a half of that occasioned by latitude.

An elaborate comparison of Buchan's charts of isobaric lines for the coasts and islands of Eastern Asia with recent observations is made, with the result of an average error of one millimetre (0·040 inch). Much, however, remains to be done in settling this important physical datum of the climate of Asia; and it can only be satisfactorily accomplished by the substitution of mercurial for aneroid barometers where such are used, a more accurate determination of the heights above sea-level, and the establishment of additional meteorological stations in eastern and northern Siberia.

Report on the Pathological Histology of Epizoötic Pleuropneumonia. By Charles S. Roy, M.D. (London: published by the British Medical Association, 1879.)

AMONG the many infectious diseases which domestic animals are subject to, pleuropneumonia of cattle is one of serious importance to this, and indeed to every country. Owing to the facility with which infection spreads, the comparatively long duration of the malady, and the high mortality of the affected animals, an epidemic outbreak of this disease inflicts heavy losses on the holders of live stock and on the community at large as the consumers of articles of food derived from cattle. Every contribution to elucidate its intimate pathology, is, therefore, of value, not only in furthering a better understanding of this particular malady, and thus probably enabling us to grapple more successfully with its prevention, but also in throwing light on infectious diseases in general.

The British Medical Association, by the assistance of grants, which it bestows with laudable liberality in all cases where they are deservedly needed, has for some years been foremost in promoting the advancement of the various branches of medical science, and it has in a similar manner enabled Dr. Roy, at the suggestion of Dr. Burdon Sanderson, to carry out an important investigation into the anatomy of pleuropneumonia. To enumerate all the details of this investigation would be more than is possible in a short notice like this, and, probably more than is customary in this journal, but some of the more important results may be here briefly mentioned.

In the earlier stages of the disease the lymphatics, especially those of the sub-pleural plexus and of the connective tissue separating the individual lobules of the lung tissue, are found very much distended, being filled with an exudation which at first is chiefly fibrinous, but later on becomes crowded with cells of various sizes. The lung-tissue itself is the seat of an inflammatory process, which is chiefly characterised by the "absence of uniformity"; in some parts it is similar to what is known to pathologists as lobular pneumonia, in others it resembles croupous pneumonia. In this respect the pleuropneumonia does not differ from the lung affection in many other infectious diseases.

Dr. Roy states that in some parts of the lung there is also a hypertrophy of the muscular tissue of the parenchyma, and illustrates this with a drawing, viz., Fig. VII.; but to this we must take exception, for this figure illustrates merely the structure of a normal infundibulum, very distinct as such by its epithelium and muscular tissue.

As the morbid process advances, large sections of the lung tissue become involved in the inflammatory change, and amongst them the bronchi themselves and the lymphatic trunks leading into the bronchial lymphatic glands. No distinct evidence of the presence of minute organisms in the affected parts could be obtained.

That the malady involves, to a great extent, the lymphatics of the lung, Dr. Roy learned by first making a special investigation into their distribution in the normal lung of cattle, and as the result of this investigation several important facts were ascertained: the individual lobules possess a certain independence from one another both in their blood- and lymph-vessels; the subpleural or superficial lymphatics form a stellate plexus for each lobule; the efferent branches of this plexus join the peribronchial and perivascular lymphatics. In this last respect the lung of cattle differs from that of many other animals, for in these latter there exist special vessels leading from the subpleural plexus through the ligaments of the lung to the root of this organ.

The Report is accompanied by ten lithographed drawings illustrating very capitally the more striking features of the morbid process. We should have liked, however, to see their number increased by several additional drawings showing the distribution of the lymphatics of the normal lung.

E. KLEIN

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.*]

The Temperature of the Air at Various Levels

In a treatise recently published at Prague,[1] the author, Mr. Schlemüller, proposes to establish a formula, by which the temperature of the atmosphere at any level above the surface of the earth could be calculated, a similar calculation giving also the height of the atmosphere.

Mr. Schlemüller's train of reasoning is about this:—

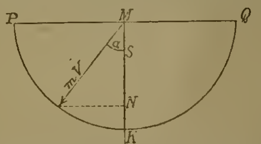
The temperature of a gas is dependent on the *vis viva* of the motion of its molecules. Now, the molecules of the air moving *upwards* are gradually *losing* their *vis viva* by the action of gravity, whereas, in moving *downwards* they *gain* velocity by the same action. It is, therefore, evident that the molecules must have more *vis viva* in the lower strata of the atmosphere than at higher levels, that is to say, the temperature of the atmosphere must *decrease* as the height *increases*.

If we know the velocity of an air-molecule at the surface of the earth, we can easily calculate the maximum height to which it can move when going up vertically. This height is the height of the atmosphere. At the upper limit of the atmosphere the molecules have no velocity at all, the temperature is there at the absolute zero. (It must be remembered that the author treats of an atmosphere not exposed to radiation.)

Now, these ideas are not new, as the author himself admits on page 9 of his treatise. He has, however, added to them two new suppositions of his own, and to these we shall confine our attention.

First, the author supposes that at any temperature of a gas the molecules have a certain velocity, which is *equal* for all of them, that is to say, the molecules move in all possible directions, but altogether at the same speed. This is, of course, a hypothesis, which can neither be proved nor refuted; it is, however, admissible. The other supposition of the author, however, is quite erroneous, and so the results arrived at by means of it are also valueless. Mr. Schlemüller supposes that the molecular velocity of gases has not been calculated rightly as yet, and he therefore proposes to correct the error. His own words are as follows:—

"Let M be a point of the wall PQ inclosing the gas. The molecules will strike this point in all directions, each of them having a mass m, and moving at a certain speed V. All the striking forces form, therefore, a hemisphere, whose radius is equal to



mV, the wall PQ being the basis of it. The acting componen of the striking force is evidently $MN = mV \cos \alpha$. All the possible components $mV \cos \alpha$ represent, therefore, ordinates of the hemispherical surface mentioned before, taking PQ as a basis."

As there is no preference for any of the directions, the mean striking force acting on the wall PQ will be measured by the mean value of all $m V \cos \alpha$, viz., by the ordinate of the centre of gravity of the hemispherical surface. As, however, this centre of gravity is situated at half the length of the radius MK from PQ, the mean value of the striking force will be $m u = \frac{m V}{2}$[2] or $u = \frac{V}{2}$ and $V = 2u$, that is to say, *the mean component of the molecular velocity taken at a right angle to the wall PQ is equal to half the actual velocity.*"

"Considering all this, we shall be able to establish a relation between the molecular velocity, the volume, and the mass of a gas inclosed in a cubical vessel. We shall follow the method indicated by Joule,[1] and introducing into the calculations throughout the mean value $\frac{V}{2}$, instead of V we get for V double the ordinary value, viz.:—

$$V = 2\sqrt{3 g P_0 V_0 (1 + \alpha t)}$$

g being the acceleration of gravity, P_0 the normal pressure, V_0 the volume of one kilogramme of the gas at 0° C. (32° F.), $\alpha = 0,00365$ the coefficient of dilatation, t the temperature in Centigrades above the freezing-point."

It seems that Mr. Schlemüller is not aware of the fact that Clausius fully twenty-two years ago published a very elaborate treatise,[2] in which he calculated the molecular velocity, supposing the molecules *to have equal velocities, but to move in all possible directions.* Now these are exactly the conditions supposed also by Mr. Schlemüller, and yet Clausius has found, just as Krönig before him—

$$V = \sqrt{3 g P_0 V_0 (1 + \alpha t)}$$

instead of Mr. Schlemüller's double value.

In another way Briot[3] has found the same result, whereas according to the theory published by the late Prof. Maxwell,[4] the molecular velocity is—

$$V = \sqrt{\frac{8}{\pi} g P_0 V_0 (1 + \alpha t)}.$$

There are thus pretty many calculations published already, all of them, according to Mr. Schlemüller, being wrong, and even *very much* wrong (viz., by 100 per cent.).

It can be shown, however, that the fault is Mr. Schlemüller's, and not Krönig's, Clausius's, Briot's, or Maxwell's. Mr. Schlemüller, according to his own statement, accepts the calculation given by Krönig (which he ascribes to Joule), simply replacing the value V by $\frac{V}{2}$. Now, in Krönig's final formula the value V^2 occurs, and this value is arrived at by a double step. First, it is shown that the force with which a molecule strikes the wall is proportionate to its velocity V; secondly, the *number* of strokes occurring in one second is shown to be also proportionate to the value V. Thus the final result is found to contain the value V^2. If the molecules are supposed to move in all possible directions, it might perhaps be admissible to make the mean striking force of a molecule proportionate to the *mean normal component* $m\frac{V}{2}$, (being the mean value of all $mV \cos \alpha$) but it is quite wrong to replace V simply by $\frac{V}{2}$, when the *number* of strokes is calculated. If a molecule of a gas contained in a cubical vessel is moving in the direction of one side of the vessel, it will strike one of the walls $\frac{V}{2a}$ times per second, V being the velocity and a the length of the vessel's side. If, however, the molecules move in all possible directions, it would be quite erroneous to suppose that the mean number of strokes per second will be $\frac{\frac{1}{2}V}{2a}$, viz., that V can be replaced simply by $\frac{V}{2}$. But that is exactly what Mr. Schlemüller does. The problem is not very easy indeed, and certainly not so simple as Mr. Schlemüller seems to think. The elaborate calculations of Clausius and Maxwell are a sufficient proof of that.

Mr. Schlemüller, having thus found his value of V, proceeds to calculate the decrease of *vis viva* of a moving molecule corresponding to a given increase of elevation above the surface of the earth, or, in other words, he calculates the decrease of temperature towards the higher regions of the atmosphere. The result found by him is a fall in temperature of 1° Centigrade to every 175·611 m. or 1° F. to 106·7 yards. Calculating further the height of the atmosphere, viz., the height which can be reached by a molecule starting at a given speed from the surface of the

[1] Der Zusammenhang zwischen Höhenunterschied, Temperatur und Druck in einer ruhenden nicht bestrahlten Atmosphäre, sowie die Höhe der Atmosphäre. Von W. Schlemuller. (Prag: Dominicus, 1880.)

[2] By a misprint the original has $\frac{m N}{2}$

[1] For we ought to know the formula for the molecular velocity was first given by Krönig.

[2] This paper was also published in the *Phil. Mag.*, 4th series, vol. xiv. p. 108.

[3] "Théorie mécanique de la Chaleur," chap. ix. § 141.

[4] *Phil. Mag.*, 4th series, vol. xix. p. 22.

earth, and going vertically upwards, Mr. Schlemüller finds the height of an atmosphere

Of pure oxygen	43,360m., or 27 miles
Of pure nitrogen	49,360m., or 31 miles
Of watery vapour	76,980m., or 48 miles

These results are, indeed, fair approximations to the ordinary values.

At the end of his treatise the author gives some formulæ which are destined to serve for the measurement of heights by means of the barometer and thermometer.

On p. 10 there is a curious statement. Supposing the air or gas to be inclosed in a vertical "narrow tube," the author thinks that the molecules will be able to make vertical movements only, and he introduces, therefore, into his calculations the mean value of the vertical components of their velocity, viz., $\frac{V}{2}$. The result is that, according to Mr. Schlemüller, the temperature in a narrow vertical tube, open at top and bottom, increases four times faster towards the bottom than in the free atmosphere. What the author considers to be a "narrow tube" he shows on p. 12, where he applies his rule to a pit or well (!). It is not too much to say that a perpetuum mobile might be constructed on that principle.

Mr. Schlemüller's formulæ for measuring heights might be perhaps accepted by some who would take the numerical results given by the author as a sufficient proof of his theory. It is, however, impossible that a theory resting on false assumptions should give correct results, and the coincidence of the results given with data derived from other sources is only apparent. First these data themselves are so varying that it is not very difficult to produce a number approaching pretty closely to some of them; on the other hand, the results calculated from a theory which supposes an atmosphere not exposed to radiation *ought not* to coincide with data derived from the *actual* atmosphere, which is far from fulfilling the conditions supposed by the theory.

L. HAJNIŠ

Prague, December 3

Alternative Interpretation of Sensation

THE curious optical phenomena which form the subject of Mr. Ackroyd's letter (NATURE, vol. xxi. p. 108) have their analogues, as many have probably observed, in other orders of sensation. When travelling by railway, or indeed in any closed vehicle, I have often noticed that, if passing objects be shut out from view, it is possible with a little effort to mentally reverse the direction of the train, so that if sensation only were concerned, there would be no doubt as to this reversed motion. Another example of this choice of interpretation is also afforded by the sensations of motion, but in a slightly different way. Standing low down by the water, on a moving steamer or on a bridge over a rapid stream, we can at will either *feel* that we are moving through the water or that we are stationary while the water is flowing by. The same, or at any rate a very similar, choice is presented when the clouds are scudding over the moon's disk; we can either see the moon travelling behind unmoving clouds, or the clouds passing rapidly across the moon.

It would appear from the above facts that we have in certain cases the power of selecting from the experiences which have been associated with a given set of sensations that one which we wish the sensations to convey. It is difficult to see how this can be explained without admitting a certain amount of freedom of will, as the sum of our previous experience, including the sensation itself, is the same, whether we choose to go backwards or forwards, to stand still or to move on.

FRED. D. BROWN

Science Schools, South Kensington, December 16

Curious Incubation

INDIAN birds avail themselves largely of natural heat in incubating; as breeding-time generally begins in March, the hot weather is generally well on by the time the eggs are laid, and as the temperature of the air is never below a minimum of 98° – 100° during the day, the eggs are but little sat upon except during the night, and so rest and duty are combined judiciously.

On one occasion I collected birds' eggs, and, until I could blow them, I used to place them in a drawer of my office table, and there they would lie for two or three days until I had leisure. One day, while writing, I heard strange sounds from this drawer, and opening it found a young crow (*Corvus splendens*) emerged from its egg. On a second occasion I similarly found a young myna. I tried hard to rear these strange hatchings, but failed.

One day I saw a kite's nest in the top of a fan palm, and sent up a native to bring down the contents, which turned out to be eggs. In a spirit of mischief I placed them, without saying anything to any one, under a hen which was sitting upon ducks' eggs, and awaited the result. Two days after, my fowl-man came to me with a long and solemn face, and asked permission to address me. That accorded, he mysteriously whispered, "My lord, a great wonder has occurred in the fowl-house; a marvel has happened; devils have been hatched in the fowl-house." Then began a *tableau* of descriptive acting which I cannot reproduce. "Did not I place ducks' eggs under that hen, and, my lord, have not ducks flat feet like this (flattening and extending his hand), and noses like this (compressing his thumb and index-finger); have they not, my lord?" On my solemnly assenting, he proceeded: "But these devils, my lord, have feet like this (clawing all his fingers), and noses like this (hooking his thumb and index together at his own nose)? Oh! my lord, what shall I do?" "Well, let me see these devils," I replied, sympathisingly; and we walked off to the fowl-house and found the hen sitting dazed beside her basket, in which were five recently-hatched kites. The *finale* was tragical, for the poor hen abandoned both her eggs and the kites, and the latter would have died had I not had them replaced in their nest. As it was, the ducks' eggs were abandoned.

R. F. HUTCHINSON

THE GEOLOGY OF THE HENRY MOUNTAINS[1]

THE Henry Mountains are a group of five peaks, ranging in height from 7,000 to 11,000 feet above the sea, which rise out of the table-land, now so well known to all students of physical geography, to which the American geologists have given the name of the Colorado Plateau.

They are situated in Southern Utah, and are crossed by the meridian of 110° 45′ and the thirty-eighth parallel.

They stand close upon the northern bank of the Colorado, which flows past their base in a cañon 1,500 feet in depth.

Mr. Gilbert's account of the geology of these mountains is specially interesting to the student of physical geology, on account of the explanation it contains of the machinery by which their uplift was brought about. His views have certainly the merit of novelty, and at the same time the evidence in their favour, if not quite conclusive, carries with it considerable weight.

All previous speculation on the subject of mountain-building may be grouped under two heads. Nearly all mountain ranges have a central axis or core of crystalline rock. By the older geologists this crystalline mass was looked upon as intrusive, and it was believed that the violent injection of a huge body of molten matter had lifted up the stratified rocks through which it forced its way, and shouldered them off on either side, giving them a dip coinciding in direction and approximately in amount with the slopes of the chain. A section across a mountain chain would show, according to this view, an anticlinal arrangement of the bedded rocks with a body of intrusive rock in the centre, and it was the intrusion of this central mass that was believed to have caused the upheaval. The force, then, which according to this view, raised mountains to their present elevation, was of the nature of a *thrust acting vertically upwards*.

Never, perhaps, did any theory collapse more completely than this when it came to be subjected to the test of examination in the field. As mountain chains were one by one investigated by geologists, the anticlinal arrangement of their rocks which this theory required was found to be more and more conspicuous by its absence. Marked peculiarities of structure were indeed found to be so universally present in mountain chains, that no range of hills was deemed worthy of that title

[1] "Report on the Geology of the Henry Mountains." By G. K. Gilbert. (Washington, 1877.)

unless it possessed them. But these characteristic structures were vastly different from the simple anticlinal tilting which the earlier speculators had believed to be the typical arrangement of the beds in a mountain chain. It was found that the rocks had been folded into a number of very sharp troughs and arches whose axes ran roughly parallel to the trend of the chain. The radii of some of the curves were measured by miles, while in other cases the beds had been puckered up into minute and complicated convolutions. Frequently the arches had been canted over, and inversion of the beds had been produced. Slaty cleavage had been largely developed, the planes of cleavage having the same general bearing as the axes of the range. Faulting had taken place on a large scale, and the rocks were often jammed and mashed together till a state of confusion that defied description had been produced.

No single thrust acting vertically upwards could have brought about such results as the repeated folding, the inversion, the cleavage, and the smashing; but everything pointed to powerful pressure acting in a horizontal direction which had wrinkled up a vast thickness of strata into mighty folds, and sometimes jammed them together till they became little better than a mash of shattered and ruined rock. The crystalline core was in some cases nothing more than the result of intense metamorphism; and where it was intrusive, there was every reason to think that the molten or pasty rock had been driven up through fissures by the squeezing which the rocks had undergone; in fact, so far from the crystalline centre being the cause of the upheaval, its presence was only one of the results which almost necessarily followed from the way in which that upheaval had been brought about.

All the facts then seemed to show that mountain chains had not been uplifted by a force acting vertically upwards, but had been ridged up by a *squeezing force acting horizontally* on a very thick mass of strata.

That denudation carved into shape the mass as it rose was soon realised, but we are here concerned only with the early stages in the genesis of a mountain chain.

Now one point of great interest in the geology of the Henry Mountains, is that they seem at first sight to form a striking exception to the law of arrangement, perhaps we might more properly say disarrangement, which prevails so widely in mountain chains. They might also, to a casual observer, seem to supply a case where the structure assigned by the earlier geologists to mountain ranges, and which has been looked for in vain so often, does really exist.

Careful investigation, however, shows that neither of these suppositions would be true.

The structure of the Henry Mountains is simple when compared with the complicated foldings and disturbances so characteristic of mountain chains. In the case of each of these mountains the strata are arranged in dome-shaped fashion dipping outwards in all directions from the centre. The strata of the plateau from which they rise are all but horizontal; around the base of each mountain the beds bend up and "rise, slowly at first, but with steadily increasing dip, till an angle of 45° is reached. The dip then steadily diminishes to the centre, where it is nothing." In some cases the beds slope away from a single centre, in others a great arch is made up by the confluence of a number of smaller domes.

Widely different as this arrangement is from the complicated contortion and disturbance usually met with in mountain chains, the Henry Mountains furnish no exception to the broad generalisation that mountain chains always exhibit intense convolution and smashing of their rocks. For the Henry Mountains are in no sense a mountain range. They are a group of peaks, each of which is an isolated individual; they show little or no tendency towards a linear arrangement; "they would prove perfectly intractable in the hands of those geologists who draw parallel lines through groups of volcanic vents by way of showing their trend. They are as perfectly heterotactous as they could be made by artificial arrangement."

In the case of several of the Henry Mountains the centre of the hill is seen to be occupied by a core of intrusive trachyte, from which intrusive sheets and dykes are given off. Reasoning from analogy Mr. Gilbert believes that in those cases where no such core can be seen, there still is one present under ground, but as yet uncovered by denudation. The upper surface of these cores is arched, and seems to run parallel to the bedding of the overlying rocks. It certainly looks as if we had here a case when strata originally horizontal had been bent up into a dome by the injection from below of a mass of molten rock. And this is the explanation adopted by Mr. Gilbert, but his views differ widely from those which the earlier geologists would have maintained had they been acquainted with these mountains. The earlier speculators gave to their intrusive masses a wedge-shaped form, representing them as broadening downwards and extending to the lowest depths to which geological speculation ventured to penetrate. The intrusive cores of the Henry Mountains, on the other hand, are represented by Mr. Gilbert as bounded on their under side by a horizontal plane and as resting on horizontal strata. They have, in fact according to him the shape of a huge plano-convex lens, with its flat face downwards; the curved surface is however rather a portion of an oblate spheroid than a sphere, for the trachytic masses are somewhat flattened on the top; some of them too are oval rather than circular in plan. To an intrusive mass of this shape he gives the name of a laccolite, from λάκκος, a cistern, and λίθος, stone.

His theory of the genesis of a laccolitic mountain is as follows:—Lava was pumped up through a chimney or fissure and at a certain point in its upward course spread itself out between two adjoining beds in the form of an intrusive sheet; by farther additions of lava from below the sheet is thickened, the overlying strata are more and more arched, till at last they are bent up into a dome.

Of course this involves the stretching of the overlying strata; in the case of one of the domes it is calculated that there must have been an extension of 300 feet in three miles. Mr. Gilbert has shown that this elongation is rendered possible by the fact that at the time of their flexure the beds were loaded by a crushing weight; directly the tension exceeded the limits of cohesion, and a fissure was torn open, or rather directly a fissure would have been torn open had the bending taken place at the surface, the weight of the pile of strata overhead crushed together the walls and closed the rent. That a cover of rock, perhaps 7,000 feet, and possibly 11,000 feet in thickness, would tend to this result is clear enough, but that it did not always prevent rupture is shown by the numerous dykes associated with the laccolites. Mr. Gilbert has attempted to show by mathematical calculation that at a given depth the overlying strata could not be lifted if the area of the laccolite falls short of a certain value. His method involves certain assumptions which render it somewhat unsatisfactory, and his conclusion seems to be inconsistent with the explanation he gives of the formation of a laccolitic mountain; for according to him the first step in that process is the production of an intrusive sheet. This in itself involves the uplifting of the beds above, and his calculations show that no uplifting could take place till the sheet had reached a certain size.

The failure, however, to solve by mathematical methods a problem of this difficult nature by no means implies a rejection of the theory. A much more important matter is the examination of the evidence by which the existence of these peculiarly shaped bodies of intrusive rock is supported. Mr. Gilbert has evidently seen enough to satisfy himself on this point, and we are quite willing to put every confidence in the statements of so accurate and skilful an observer; at the same time we cannot help feeling some regret that he has not been a little more explicit in his description of the sections which lay open the characteristic form of the laccolite. The horizontal base and the undisturbed state of the underlying strata are the first points on which we wish to be thoroughly assured. It is stated that "in five instances one side of the dome of strata has been washed away, exposing the core of trachyte to its base, and showing undisturbed strata beneath." We do not doubt the statement, but we should have been better satisfied if these cases had been described more in detail in the special account of the separate mountains. The views of the Marvine laccolite in Figs. 43 and 44, if we understand them aright, do seem to be conclusive on the point of the horizontal base; but the evidence would have been more convincing if these plates had been explained at greater length in the text. In fact, the one fault we have to find with the book is the difficulty of understanding the illustrations; they are not striking from an artistic point of view; in some the letters of reference are so indistinct that they can be found only with the utmost difficulty, and we confess that by some we have been fairly beaten; we should, for instance, very much like to know which is the laccolite in Fig. 33.

Again, the evidence for the parallelism between the upper surface of the laccolite and the bedding of the overlying rocks, has hardly been brought out with sufficient distinctness; after a comparison, for instance, of Figs. 25 and 26, an invidious critic might have something severe to say about the proportion which the part of the laccolite actually seen bears to that which is admittedly theoretical.

But we have made these remarks in no captious spirit; we wish merely to express our fear that the acceptance of Mr. Gilbert's ingenious speculations may be hindered by a lack of detail in the statement of the evidence he brings forward in support of them.

Assuming Mr. Gilbert's theory to be sound and good, it is not likely that the Henry Mountains are the only ones constructed on the laccolitic type. Mr. Gilbert is inclined to class under this head a number of mountains in the western territories, grouped together under one type by Dr. A. C. Beale, in a paper in No. 3 vol. iii. of the *Bulletin* of the United States Geological Survey. We cannot say that there is anything in Dr. Beale's description which would lead us to assign these mountains to the laccolitic group; and in one case, that of the Elk Mountains, the careful account given in the Report for 1874 of the Geological and Geographical Survey of the Territories, seems to show that they form a normal mountain range ridged up by horizontal pressure.

There is one problem which has been always more or less of a puzzle to the student of volcanic phenomena, on which Mr. Gilbert's speculations may possibly throw considerable light: we mean the formation of pit-craters. Mr. Scrope showed how these singular depressions had probably been blown out by one single explosion of unusual violence, and Mr. Judd has suggested their connection with intrusive sheets. If we suppose a rapid accumulation of lava in a laccolitic mass, and a sudden development within it of steam of high tension, we shall have exactly the conditions suitable for producing one of those explosions which there is every reason to think have been the cause of pit-craters.

The work contains a long and elaborate chapter on "Earth Sculpture," which space will not allow us to do more than mention, and concludes with a chapter on Economics, in which the author insists with almost pathetic earnestness, that the Henry Mountains, full of interest as they are for the geologist, can never be put to any profitable account commercially, unless possibly in parts for grazing. Nature would seem here to have laid herself out to frame a district which should have attractions for no one but the student of pure science.

A. H. G.

FINNIC ETHNOLOGY

A DECIDED stage in the progress of Finnish studies is marked by the sumptuous work on "Finnish Crania," recently published by the native ethnologist, Gustavus Retzius.[1] Continuing the investigations of his father, Anders Retzius, this distinguished anthropologist has at last been enabled to arrive at some definite conclusions both as regards the type itself and its geographical area. The elder writer was a warm advocate of what may be called the Finno-European theory, which is still popular amongst a certain school of fearless anthropologists, and which, since the discovery of the Cuneiform writings, has received a fresh impulse and a wider extension. This is not the place to discuss the angry question of the Finno-Ugrian relations to the Accad language and civilisation of Babylonia. But many enthusiasts will probably be disappointed to hear that the younger writer abandons his father's position, and deals a severe blow to the doctrine of a former wide-spread diffusion of the Finnish race over the greater part of Central and Western Europe. The laborious attempts of many ingenious philologists to discover traces of Ugrian affinities in the Italic and Teutonic tongues, and even to remove the Etruscan from the Aryan to the Ural-Altaic family, can scarcely be regarded as at all successful. On the other hand, a few ancient skulls presenting certain traits characteristic of the same race, together with some hatchets and other stone implements picked up here and there analogous in form to those often dug up in Finland, offered far too flimsy materials to supply a solid basis for such a vast superstructure. Hence it is not perhaps surprising that in the light of further investigation and more serious research the theory should prove to be somewhat visionary.

History had already pointed out that during the ascendency of the Goths from the Baltic to the Euxine the Finns were found nowhere to the west, but only to the east and north of that line; in fact in their present homes on the Volga, in Finland, round about the great Russian lakes, and more recently along the southern shores of the Gulf of Finland. It might doubtless be argued that at this period the race had farther west been already absorbed by the Slavs and Teutons of Aryan stock, intruders from Asia. But no reliable data can be appealed to in support of this position. The authenticity of the stone hammers and other objects of Oriental form said to have been found in France and elsewhere is now questioned, while the philological argument never gets beyond the purely etymological stage.

Hence Gustavus Retzius adopts the view now fast gaining ground, that instead of being the aborigines of Western and Central Europe, the Finns are amongst the most recent arrivals from Asia. Their own traditions point to the Altai region as their true home; the national usages and the spirit of the popular songs embodied in the great epic, the Kalevala, are all Asiatic rather than European, and the uninterrupted stream of their migrations westwards may still be clearly followed from their most advanced outposts in the Scandinavian peninsula through Finland, along the Volga and Kama valleys, over the Urals, and up the Obi basin to the probable cradle of their race in the Sayan highlands.

The narrower, though scarcely less interesting question of the position of the Finnic branch in the Ural-Altaic family is still surrounded with difficulties, which seem to be intensified rather than removed by the conclusions of M. Retzius. While the Finnish language is no doubt fundamentally connected with those of the other members of the group, the physical features of the race present

[1] "Finska Kranier." Skildrade af Gustaf Retzius, Stockholm, 1878.

many striking deviations from the ordinary Mongol standard. The elder Retzius had long ago distinguished four more or less marked ethnical groups in Finland itself, apart altogether from the intruding Swedes, Russians, and other foreigners. These, however, are now reduced to two only, which a careful investigation of the materials supplied by archæology, tradition, the Norse Sagas, the old national songs and philology, combined with an extensive study of a vast number of crania and living subjects, have enabled the younger writer to fix with some approach to precision.

Of the two, the Tavastian and the Karelian, he regards the latter as the genuine national type, in this differing from the commonly received opinion. The Karelians, occupying the country more to the east, are of slighter build, but better proportioned and taller than the Tavastians, of a light brown complexion, with longer head, narrower and less heavy features, long, straight, and pointed nose, dark hazel eyes, chestnut or dark hair falling in ringlets over the shoulders, open and animated expression, though still with a serious cast. The Tavastian, on the contrary, is of a much more solid, compact, and coarse build, middle size, light or ashy complexion, but always lacking the rosy tints peculiar to the Teutonic peoples, with straight silken hair of a flaxen colour, and often yellow at the tips, broad square head, short snub nose, dilated nostrils, slightly oblique greyish blue eyes, sullen and unsympathetic expression.

This description obviously corresponds far more closely with the common Mongoloid type than does that of the Karelians. Yet in the writer's opinion the latter are the true descendants of Illmarinen, the hero of the Kalevala, and the scene of his exploits is laid in the region still occupied by them. The Tavastians he regards as a distinct ethnical element of doubtful affinities, though allied on the one hand with the Esthonians of the Baltic provinces, on the other possibly with the Lapps of the Arctic regions.

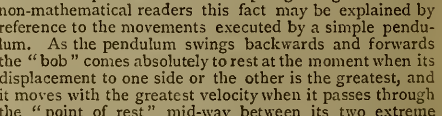
The question, as already remarked, has been advanced one stage; but much remains to be done before we can expect to see all the difficulties removed by which it is surrounded. Meanwhile it seems impossible to agree with M. Retzius, that the Karelians, rather than the Tavastians, represent the true Finnish type. Both have, no doubt, largely absorbed foreign elements. But if both are alike branches of the Mongolo-Tatar family, as has been hitherto supposed, and as their speech appears to place beyond question, it follows that of the two the Tavastians must be regarded as the nearest to the common stock. The Karelians are, of course, much the finer race, both physically and intellectually, and national prejudice may, therefore, feel inclined to regard them as the purer branch. But, ethnologists will probably be disposed to look on the improvements as due rather to a greater absorption of foreign elements, Teutonic or Slav, if not Lithuanian. They occupy a country which may well have been peopled by some of these races before their arrival, whereas the dreary lacustrine region of Tavastland must have been all but destitute of inhabitants previous to its occupation by the advanced wave of Finnish migration.

A. H. KEANE

RESEARCHES ON TELEPHONE VIBRATIONS

DR. RUDOLPH KONIG, the well-known constructor of acoustical apparatus, has recently brought before the Physical Society of Paris a research of the highest interest, upon the difference of phase which exists between the vibrations of a transmitting and a receiving telephone. In a paper published more than two years ago, Prof. du Bois-Reymond discussed the conditions which determine the intensity and the phase of different sounds transmitted telephonically; and from theoretical considerations deduced the conclusion that sounds of low pitch suffered greater loss by transmission than shrill ones, and that every simple vibration was retarded in phase by a quarter of an undulation. The former of these actions would produce an alteration in the timbre of the voice as received at the end of the line: the latter effect would remain unappreciated by the ear, since the retardation of phase was the same for waves of all periods. More recently Helmholtz has attacked the question in a paper in the *Annalen* of Wiedemann ("Telephon und Klangfarbe"), and, with a theoretical treatment of the question based upon somewhat deeper analysis, has deduced the results that all sounds are weakened by transmission in almost a constant proportion irrespective of their pitch, and that the difference of phase between the vibrations of transmitter and receiver are very small. Dr. König has endeavoured to put these conflicting speculations to the test of experiment, and with marked success.

It may be well, perhaps, to indicate the elementary considerations which led du Bois-Reymond to predict the existence of this hitherto unobserved difference of phase. The currents by which sounds are carried from the transmitter to the receiver in the Bell telephone are induction currents, excited in a coil of insulated wire by the vibrations of the iron diaphragm in front of the permanent magnet which serves as a core. The intensity of these induced currents is greatest when the vibrating diaphragm is moving with the greatest velocity. But the maximum *velocity* of the diaphragm does not occur at the moment when the *displacement* of the diaphragm is greatest. To non-mathematical readers this fact may be explained by reference to the movements executed by a simple pendulum. As the pendulum swings backwards and forwards the "bob" comes absolutely to rest at the moment when its displacement to one side or the other is the greatest, and it moves with the greatest velocity when it passes through the "point of rest" mid-way between its two extreme positions. Mathematically, the matter is equally simply stated. The displacement of a body executing a simple harmonic motion is determined by an equation of the form $u = a \cos \frac{2\pi t}{T}$, where the values of u pass through a regular series of maximum and minimum values as t increases. These successive values are geometrically represented by the heights of the ordinates of the well-known harmonic curve or *sinusoid*, the distances along the horizontal axis O x being proportional to the times. Thus the telephone diaphragm originally at rest begins to move towards the magnet under the influence of the voice. The displacement, which at the origin is nothing, increases until at A it becomes a maximum. Owing to its elasticity the diaphragm flies back, and passing rapidly through its point of starting suffers a displacement in an opposite sense. These movements are graphically represented on the harmonic



curve by the passage of the curve across the axis at B to its minimum or greatest negative displacement at C, the curve recurring from the point D. Now the equation which represents the *velocity* of the moving point will be obtained from the equation of the displacement by differentiating with respect to time. This gives us an equation of the form—

$$\dot{u} = -\frac{2a\pi}{T}\sin\frac{2\pi t}{T} = \frac{2a\pi}{T}\cos\left(\frac{2\pi t}{T}+\frac{\pi}{2}\right),$$

which is, neglecting the constant coefficient of amplitude, geometrically represented by another harmonic curve of identical form, but shifted on so that it begins at a point *a*, or a quarter of the length of the curve O O from the origin. In this second curve the heights of the ordinates represent the varying velocities of the diaphragm, the velocity being nothing at *a* when the displacement at A is a maximum, and being at a maximum at *b* when the diaphragm in flying back passes through its point of rest or has no displacement. Now of these two curves the former corresponds in phase to the movement of the diaphragm of the transmitting telephone, while the second curve corresponds to the variations of velocity, and therefore of the current transmitted, and consequently also corresponds to the motions of the diaphragm of the receiving telephone. Hence it is easy to understand that there exists a difference of phase of one-quarter of an undulation between the movements of the diaphragms of the transmitting and receiving telephones, which will be either a retardation or an apparent acceleration of phase according to the sense in which the transmitted currents traverse the coil of the receiving telephone. These considerations apply only to the telephone of Bell or its modification by Gower, in which the vibrations of the transmitting diaphragm generate the current. They do not apply to the transmitters of Edison and Hughes, which merely regulate the current. In these instruments the strength of the current is proportional to the *displacement*, not to the *velocity;* hence there is no retardation of phase.

The memoir of Helmholtz, which, by introducing certain considerations respecting the mutual inductive actions exercised upon one another by the individual turns of wire in the coil of the telephone, arrived at a somewhat different conclusion, and was principally devoted to the question of the timbre of the transmitted sounds. The previous researches in physiological acoustics of this distinguished physicist had shown that differences of phase affecting individual tones of a compound "clang" do not produce any effect which the ear can detect. This important law the present writer has, however, shown elsewhere to be true only when one ear receives the sound, and to hold no longer in the case of binaural hearing. The equations of Helmholtz indicated the unexpected result that the difference of phase between the vibrations of transmitter and receiver was a quantity so small that practically it might be altogether disregarded, and he arrived at the conclusion that all sounds were transmitted by the telephone with an equal proportionate degree of intensity independent of their pitch, and therefore with unaltered timbre. Here again, however, the writer of this article has shown that the relation between the thickness and diameter of the vibrating diaphragm affects the distribution of the magnetism induced in it by the magnet, as to whether it is lamellar or radial in character, and that this distribution has influence on the timbre of the sound emitted by the receiving telephone, the notes of higher pitch being better given by the disk in whose magnetisation the lamellar distribution preponderates, while the lower ones are better given with a preponderating radial magnetisation. The whole question of timbre of the emitted sounds requires further careful study.

The experiments which M. König has executed entirely confirm the *à priori* reasoning of du Bois-Reymond as to the existence of a difference of phase. Instead of using two vibrating diaphragms, Dr. König takes two tuning-forks accurately tuned to unison, each of them being placed in front of the magnet of a telephone whose disk has been removed, and which are united in the usual manner by wires. The first of the forks being set into vibration with a violin-bow, the second immediately begins to vibrate. The phase of each of the forks is next observed. This has been done in several ways: firstly, by direct comparison of each fork in turn with the vibration-microscope; secondly, by applying the well-known optical method of Lissajous, compounding together the two vibrations rectangularly by throwing a ray of light on to small mirrors attached to the two forks, and reflected from one to the other and then on to a screen. The figure thus produced exhibited unmistakably a difference of phase of an exact quarter of an undulation. A further experiment on compound tones was made with the same general arrangements; two forks, differing by three octaves, being made to take up, one as transmitter the other as receiver, sounds whose higher vibrations were eight times as rapid as the fundamental tone. Here again the difference of phase experimentally found for the higher tone was one quarter of a vibration.

Incidentally two very important facts have been observed by Dr. König. In experimenting he found that a tuning-fork, vibrating in front of the magnet of a telephone *whose circuit is closed,* comes to rest in a much shorter time than the same fork vibrating freely away from the telephone; also that this weakening of the sound is greater in proportion as the distance of the fork from the pole of the magnet is smaller, and also is greater for small amplitudes of vibration than for large ones. These results are not without interest in their bearing upon Mr. Edison's recent attempt to construct a dynamo-electric machine, in which the moving parts should be attached to a large vibrating tuning-fork instead of to a rotating axis. Doubtless the inventor's idea was to get rid of the friction accompanying rotation; for, as the vibrations of the tuning-fork are very nearly simple harmonic motions, and as the simple harmonic motion is the only type which can be propagated without loss by friction through a body, the motions of whose parts are coincident in phase, it might be anticipated that there would be less waste of energy in a "harmonic" engine than in a rotatory one. The important fact however remained behind that by far the greatest part of the work of driving a dynamo-electric machine was not spent in overcoming friction, but in doing the work of moving closed conductors across a magnetic field, a work which, to produce an equal amount of current, requires equal power, whether the motion be one of rotation or of "harmonic" vibration. Many years ago Foucault demonstrated the reality of this resistance to motion by spinning his gyroscope between the poles of an electromagnet; and with a Gramme machine, and also with a Holtz machine, the increased effort necessary to sustain rotation when work is being done is a familiar fact. Dr. König has now demonstrated the existence of a similar phenomenon in the case of the vibrations of the tuning-fork, which comes much sooner to rest when it is doing electrical work than when it is doing no work. SILVANUS P. THOMPSON

ON THE EOCENE FLORA OF BOURNEMOUTH

ON several previous occasions these columns have called attention to the eocene plant remains obtained at Bournemouth. The Palæontographical Society has undertaken their publication, but as this must be spread over many years, it may not be undesirable to note from time to time the principal additions to the flora as they come to light.

The specimens which I have collected this year may reach about a thousand. Among the more important are two from the marine beds east of Boscombe. One is a portion of the stem of a cactus measuring two feet three inches by three inches, showing eighty bosses of spines cleared from the matrix. A section which I have made of this presents a flattened ellipse in which the pulp is replaced by sand and the woody stem has sunk down to the lower side, though still preserving the characteristic radiating structure. The cuticle is now thin and glossy black, and bears the spines, varying from two to a dozen on each boss, arranged in the usual spiral order. Heer described similar spines from Bovey as those of a palm, notwithstanding that the regularly spiral arrangement of the clusters is perfectly shown in Mr. Fitch's drawings.

The second of the specimens is the largest of several branches with leaves, of a Sequoia-like conifer, which abounds in the higher beds east of Bournemouth Pier, yet has not been found in those west of it. The foliage and branching might be almost equally taken for *Sequoia gigantea*, *Araucaria Cunninghami*, *Creptomeria japonica*, or *Arthrotaxis selaginoides*. The stem is slightly curved and does not branch for ten inches, but then forks into six slightly diverging branchlets, each some six inches long. Two of these terminate in swollen buds which would perhaps have borne cones, and another ends in a compact cluster of budding needles without any swelling, and might have produced the male flower. This branchlet, and the great number of others that have been formed with it, were evidently shed from the trees exactly as they are seen to fall from the similar conifers at Kew. Nothing beyond branches clothed with leaves have been found, and we have only the peculiar Araucaria-like swelling of some of the terminal buds to guide us. On the other hand, branches very strongly resembling these have been found by Baron Ettingshausen at Häring with Sequoia cones attached. I think however that this resemblance to Sequoia should not at present have too much value attached to it, because both genera appear to have lived contemporaneously, perhaps from Oolitic times, until the present day.

Ettingshausen has detected what he considers the flower and a scale of Sequoia among the specimens just obtained from the Lower Bournemouth beds, so that the view I put forward that some of the coniferous twigs associated with Bovey ferns were identical with *Sequoia Couttsiæ* of Bovey is somewhat confirmed. It is again most fortunate that I was able last year to obtain a twig of one of the commonest Alum Bay conifers, formerly referred to Taxites, Cupressites, &c., with the peculiar fruit of Podocarpus, recognised by Dr. Carruthers, attached to it, and it now seems probable that there are several distinct podocarps in our eocenes.

The remains of palm obtained this year are few but instructive. I was fortunate in obtaining from a small isolated patch of clay imbedded in sand, the spathe of a palm; a slab ten inches square covered with over twenty fruit stalks; and about eighteen inches of the upper part of the broad pinna of a feather palm. There is hardly room to doubt that these all belong to the same species, and its accurate determination in that case is a matter of almost certainty.

One exceptionally large fossil dicotyledon was obtained. This is a peltate, bluntly lobed leaf fifteen inches long from the foot of the leaf stalk to the tip, and ten inches across, and is considered by Ettingshausen to be near Cecropia.

Another striking specimen is not only a perfectly new, but one of the finest ferns yet discovered. My attention was called to it by a lady, who was watching my work and whose quick eye caught sight of the unusual venation even before I did, and we gradually brought to light an almost perfect palmate pinna, large enough to occupy a plate in the monograph now being published by the Palæontographical Society. The position of the sori bodering each lobe is distinctly traceable, and this character with its membranous texture and very slender rachis place it almost unmistakably in Adiantum,[1] while the anastomosing veins further define it as belonging to the sub-genus Hewardia, now confined to tropical America. I am the more pleased with this discovery since small mutilated fragments had already attracted my attention and been figured, without our possessing any satisfactory clue to their identity. I have named it *Hewardia regia*.

[1] Or possibly Lindsæa, sub-genus Schizoloma.

While on the subject of ferns, I am pained to have to refer again to a statement I made in this paper with respect to the well-known eocene representative of *Osmunda javanica*. The Rev. Prof. Heer cannot take the expression of an opinion different to his own, in the spirit in which it is meant, however courteously it may be expressed, and I regret that I have hitherto had the misfortune to feel compelled to differ from his conclusions upon almost every subject. In a footnote to a small pamphlet entitled "Die Aufgaben der Phyto-Palæontologie," which was only accidentally brought under my notice, he replies in a manner which renders further discussion impossible. He affects to suppose that I, a much younger man, would venture to differ from him without having reasons founded on new and positive data to justify my doing so. I select one of the instances in which he thinks proper to tell me I do not speak the truth, not because this one is more easy of proof, but because it immediately concerns my present work for the Palæontographical Society. I have accurately traced the figure of what he calls *Pecopteris lignitum*, the figure of his *Dryandra rigida*, and a piece of a fossil Osmunda from Bournemouth. They are so like each other and unlike anything else that nothing need be added. Heer's voluminous work

Dryandra rigida, Heer (Skopau). *Aspidium lignitum*, Heer (Skopau). *Osmunda lignitum* (Bournemouth).

has certainly not tended to simplify the determination of this particular fossil. He had described it as *Aspidium lignitum*,[1] *Dryandra rigida*,[2] and *Pecopteris lignitum*,[3] supposing it to be a Hemitelia, and not until two years after Stur[4] had proved it to be an Osmunda, does it appear in one of his works, without further explanation, as *Osmunda lignitum*.[5] Yet the fossil agrees with the well-known *O. javanica*, which ranges from Kamschatka to Java, so exactly, and in such minute particulars (as detailed in the second part of our monograph upon ferns, in course of publication) that it seems impossible to excuse such a series of mistakes. With unexampled carelessness he has permitted the lithographer, in every one of the works quoted, to distort and make the leaf an impossible one by colouring the lower pair of veins as if they were the margins of the leaf. Having decided, in his own mind, in describing the flora of Bovey Tracey, that this Osmunda was a tree fern, he connected with it, stems, young shoots, and what he calls rhizomes, which never belonged to it, the latter resembling the stem of the Australian grass tree. Two very characteristic statements are founded on this erroneous belief, one that "in the shade of the forest throve numerous ferns, one species of which (*Pecopteris lignitum*) seems to have formed trees of imposing grandeur," the other, that *its* stems with those of Sequoia "certainly contribute the greatest amount of lignite." The real facts are that this was not at all an arborescent fern, and that no vestiges even of the trunks of

[1] "Beitrag zu näher. Kenntn. d. Sächs-thüring. Braunkfl." (Pl. ix. Fig. 2)
[2] *Idem*. (Pl. x. Fig. 15.)
[3] *Phil. Trans.* vol. clii. p. 1047, 1861.
[4] O. Grutschreiberi. *Stur. Jahrbuck k.k. geol.-Reichsanstalt*, vol. xx. p. 9.
[5] *Jahrbuch der k. ungar.-geol. Anstalt*, vol. ii. 1872.

tree-ferns have ever been found in English eocenes. In the same way on the evidence of three seeds, which he supposes to be grape stones, and some cactus spines, we read that "the trees of the ancient forest were evidently festooned with vines, beside which the prickly Rotang-palm twined its snake-like form." Indeed, in addition to the error he committed in calling them miocene, all Heer's determinations of the Bovey Tracey plants require revising.

The Alum Bay leaf bed, familiar to geologists for twenty or thirty years, appears at last to have almost given out, for the leaf bearing pipe-clay is washed away to such an extent that a fortnight's stay scarce yielded a dozen of the commoner leaves. The unusual rainfall has also nearly obliterated the Hempstead section, and the face of the hill resembles a glacier of mud, which has carried trees and bushes, in place of rocks, into the sea. A lady, my brother, and myself had the misfortune to select that route home, returning from Gurnet Bay when darkness was coming on. The only passage over the deep and perfectly soft mud streams lay through the dead brushwood which fringed them. The tide was high on one side, and up the escarpment on the other lay mud and brushwood of the most impenetrable character, while with a tide still rising and darkness increasing, it appeared as hopeless to attempt to retrace our steps as to press on.

The following, from my note-book, has even less connection with fossil leaves, but the experience may be of use to geologists visiting the district.

At Alum Bay a large area of weathered chalk, usually supposed inaccessible, can be explored without much danger, for it is almost everywhere possible to descend to the sea-level between the Needles and the beacon on Freshwater Down. The face of the cliffs is traversed by numerous faintly marked tracks, which it is difficult to suppose could ever have been of service except to smugglers, for the shore line is rocky and not used by fishermen. Those who appreciate the bolder coast scenery of our white chalk will be repaid by climbs even of 500 or 600 feet, to the perfect solitude of the water's edge. If accompanied by ladies, a rope will be found a proper precaution and useful in lessening the exertion to them. One of the easiest ways is directly under the beacon, and there is a path down into Scratchells Bay, just inside the railing of the fort, whence at low tide the second of the Needles can be reached.

At Bournemouth we had a rather narrow escape. I foresaw that during this year's digging unusual caution would be necessary, owing to the heavy and saturated state of the cliff. I was obliged, however, to go through some fifteen feet of sand to reach a lower bed from which I expected to get pinnæ of *Goniopteris Bunburyi*. I had dug out a piece of this bed from end to end; a distance of about twenty feet by three or four feet wide; and the cliff above this narrow excavation consisted of some fifteen feet of vertical coarse sand, capped by indurated ironstone, and a thick black clay bed, above which the cliff sloped away at an angle. To expose a little more of the leaf bed we ventured at one point to slightly undermine the verticality of the cliff, before replacing the sand and clay we had dug out. During a pause for lunch sand fell twice upon the leaf bed cleared for work and was shovelled off. On a sudden loose pieces seemed to be falling all along the face of our pit, and with no more warning than an impulse to throw ourselves out of danger, huge boulders of clay and ironstone tore by—which from their weight were afterwards immovable to us—our excavation was completely filled in, and our tools still lie buried under the *débris*. I was helplessly buried for a few minutes up to my shoulders in sand, anticipating another slip, which fell soon after I was extricated.

J. STARKIE GARDNER

RECENT EXPERIMENTS ON RADIATION

EXPERIMENTS on radiation have a twofold interest. Accurate measurements of the increase of radiation due to an increase of temperature have of course a great theoretical value, but in addition to this, there is the practical question of a possible measure of temperature by means of the radiation of a body. It is this practical question with special reference to the temperature of the sun which seems chiefly to induce experimenters to study the subject with improved methods. It has led at any rate Mr. Rossetti to furnish a most valuable contribution to the study of radiation.[1]

Newton was the first to give a formula connecting the quantity of heat radiated by a body with the temperature of the body; but his formula was not sufficiently accurate, and has been replaced by another first given by Dulong and Petit. But Dulong and Petit's formula also breaks down when the difference of temperature between the radiating body and the inclosure is large.

Mr. Rossetti, trying to improve on Dulong and Petit's formula, deduces from his experiments the following for the radiation of lampblack:—

$$y = a\,T^2 (T - \theta) - b\,(T - \theta),$$

where y is proportional to the thermal effect of the radiation, a and b are constants, and T and θ are the temperatures of the body and the inclosure, as measured on the absolute scale. This formula seems certainly to be as far superior to Dulong and Petit's as this latter was to Newton's. The last term generally is but small compared to the first, and Mr. Rossetti believes it to be due to the effect of the surrounding air, although we do not quite see how this can be. The following experiments prove how accurately the formula may be made to represent the facts. The constants a and b were obtained by measuring the radiation of a Leslie's cube filled with water or mercury, and gradually heated up to 300°. A piece of copper foil covered with lampblack was then heated in a flame of alcohol. The temperature of the flame lies between 390° and 400°; and two numbers obtained by means of the above formula were found to lie between these limits. The radiation of a red hot copper sphere was then determined, and its temperature independently measured by means of a calorimeter. The temperatures obtained by the two methods were 762°·1 and 763°·6 respectively.

In order to find the temperature of the copper sphere account was of course taken of the emissive power of copper as compared with lampblack. For this purpose, Mr. Rossetti has invented an ingenious method to determine this emissive power of various metals at the temperature of the Bunsen flame. That a formula obtained by means of experiments made between 0° and 300° C. should give such accurate results for a temperature of 760° is already a good proof for the usefulness of the formula, but Mr. Rossetti has pushed his verification even further. A cylinder of oxychloride of magnesium was heated in a flame of coal-gas and oxygen. The temperature was found to be about 960°, and in a flame it was found to be 2,167° and 2,397° in two experiments. Platinum melted easily in the flame, and hence the temperature could not have been far wrong.

Before Mr. Rossetti can apply his formula to determine the sun's temperature, he has to determine the absorptive effect of our atmosphere; but we shall not enter here into this part of the question. The sun's *effective temperature* is the temperature he would have, if he had the emissive power of lampblack. Mr. Rossetti finds this effective temperature by his formula to be a little below 10,000° C. Taking account of the fact that the sun himself is surrounded by an absorbing atmosphere, and accepting some data given by Secchi for the amount of this absorption, the temperature of the photosphere is found to be above 20,000° C.

[1] Reale Acc. dei Lincei (3) II. 6 Jan. 1873.

Prof. Langley's observations[1] were chiefly made with the view of shewing that the low estimates of the solar temperature which have recently been made on the basis of Dulong and Petit's formula must be wrong. Prof. Langley compared directly the heat and light received by the sun with that received by the hottest luminous source he could find. He chose the mass of liquid steel obtained in the Bessemer process. The result was that the solar heat radiation was at least eighty-seven times as strong as that of the liquid mass. It is impossible to compare this result directly with the values obtained by Mr. Rossetti; but a rough idea of a fair agreement may be obtained. Mr. Rossetti fround the solar radiation to be about forty times as strong as the radiation of a lampblack body in the hottest oxyhydrogen flame he could obtain. Taking account of the emissive power of iron, we find that the radiation of the molten steel must have been a little more than half that of a black body in the oxyhydrogen flame which is possible. Prof. Langley also compared the intensity of light sent out by his two sources, and naturally found a much larger difference. We do not agree with Prof. Langley's remark that the solar light radiation is a more trustworthy indication of the total difference between the sum of all degrees of radiant energy than the heat. In fact the heat radiation is the only correct indication of the total radiant energy.

Another interesting contribution to the study of radiation was lately made by Mr. Nichols.[2] Mr. Nichols heated a platinum wire to successive degrees of incandescence by an electric current, and compared the intensity of the luminous radiation in different parts of the spectrum with the incandescence of another platinum wire kept at a constant temperature by means of an electric current. There is a great experimental difficulty in determining the temperatures of the wires, and Mr. Nichols had to content himself with measuring simply their increase in length. Matthiessen's formula will give an approximate idea of the real temperature, but it must be left to future measurements to decide how far Matthiessen's formula can be applied to high temperatures. The chief part of Mr. Nichols' work consists therefore in finding the luminous radiation of platinum, not on an absolute scale, but in terms of an incandescent platinum wire of fixed but unknown temperature. In order to reduce his measurements to an absolute scale Mr. Nichols compared the radiation of his standard with the luminous radiation of the sun, and then employed Lamansky's measurements of the heating effects of different parts of the solar spectrum. The solar spectrum is however a bad medium of comparison, owing to its discontinuous character. There is, for instance, such a strong atmospheric absorption near D that the radiation of the region near D is seriously weakened; which weakening is entirely dependent on atmospheric conditions, and therefore makes comparisons taken at different times illusory. Thus the final curves obtained by Mr. Nichols for the absolute radiation of platinum wire at different temperatures show a discontinuity near D which is evidently produced by the above-mentioned cause, especially as Mr. Nichols did not use sunlight, but light reflected from clouds.

Mr. Nichols also tries to deduce from his experiments the fact that platinum a little below its melting point has a much larger absorbing power than at ordinary temperatures. The whole argument rests however on the assumption that the temperature of a platinum wire is the same as that of a lampblack body when the relative intensity of red and blue light given out by the lampblack body is the same as that given out by the platinum wire. That is to say, Mr. Nichols assumes that the emissive power of platinum is the same for rays of all refrangibilities. But it is evident from Mr. Nichols' own measurements that the temperature of a petroleum flame (used by Mr. Nichols) determined in this way is found much too high. It does not require a large correction in this temperature to bring the value of reflective power of platinum at the temperature and by Mr. Nichols to the same value as that found by Provostaye and Dessains for ordinary temperatures. In the memoir of Mr. Rossetti, an idea of which we have tried to give above, this reflecting power of platinum is directly measured at a temperature of the Bunsen flame, and was found to be strikingly in accordance with the number given by Provostaye and Dessains.

ARTHUR SCHUSTER

[1] Proceedings of the American Academy.

[2] "Ueber das von glühendem Platin ausgestrahlte Licht," E. L. Nichols. Göttingen: E. A. Huth.)

NOTE ON A CONSOLIDATED BEACH IN CEYLON

A SOMEWHAT interesting consolidated beach exists on the west coast of Ceylon, a few miles to the north of Colombo. The writer had only one opportunity of visiting and examining for a short time this formation: but there are certain features in connection with it that cannot fail to be of interest, however short the examination may be. The beach extends continuously in almost a straight line for about four or five miles, and is manifestly in process of formation at the present time, as some portions of it are so soft that they can be easily crumbled in pieces by the hand, whilst others are much harder than gneiss, and can only with the greatest difficulty be fractured by means of a heavy hammer. Between these extremes are all gradations of hardness, and the ordinary shells of the coast may be found in almost every part of the beach more or less firmly embedded in the rock. The highest part of the formation is just within reach of the waves at high tide; but it is difficult to ascertain with any degree of accuracy how far it extends into the sea, on account of the difference between high and low tide being only about two feet. The beach is seen at a glance to be composed chiefly of a faint brownish-coloured rock, with frequent strata of black material of very varied thickness and irregular shape. An examination of specimens shows that the brown rock is composed almost entirely of quartz fragments, and that it possesses only a low specific gravity (2·91), whilst the darker portions are extremely heavy as well as extremely hard. Several specimens gave a specific gravity of 3·9, 3·93, 3·94, the dried sand, freed from its carbonate of lime by means of dilute hydrochloric acid, possessing a specific gravity of 4·32. A microscopic examination of this sand and also of sections of the rock showed that the chief constituent, and that which gave it its dark appearance, was magnetite, corundum in various forms being also present, with here and there a fragment of quartz. One noticeable point was that the fragments of the harder constituents were in nearly every case hardworn, and rounded, whilst the quartz showed traces of recent fracture in the shape of sharp edges and angles. The size of these fragments varies very considerably, those of magnetite ranging from ·005 inch to ·02 inch, whilst those of quartz are much larger, frequently reaching ·04 inch. The corundum fragments are intermediate in size and rounded in form. It must be remembered that these specimens were taken from only one part of the formation, near the centre of its length and about the limit of high tide. In other positions the fragments will, no doubt, vary very much, the size depending in a great measure on the power of the current to carry them along the coast and up the beach. It was a matter of regret to the writer that he was not able to inspect carefully both extremities of the reef, and examine fragments from many different portions of it. The cementing material of the beach is carbonate of lime, no doubt from the coral reefs along the coast, as there is no limestone rock in the neighbourhood or along the course of the Kelani River, which debouches to the south of the reef. It is not known whence the magnetite and corundum have been derived, except that they have possibly come from the degradation of the gneiss rocks occurring along the coast. Although corundum is comparatively abundant in the interior of Ceylon, it has never been found in its matrix, but always either in pocket holes in streams, or in drift, intermixed with rounded pebbles of quartz. The character of the rivers in the neighbourhood of the coast apparently precludes the possibility of fragments of corundum being carried down to the sea.

A closer examination of the structure of the beach reveals the fact that the heavier particles are frequently deposited in extremely thin strata, transverse sections of which exhibit the most beautiful curves. Examples of this are seen in Figs. 1 and 2, which are half the natural size, the light parts representing quartz, the dark ones

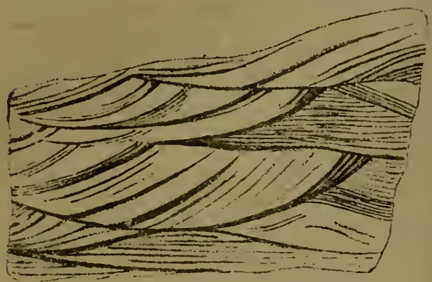


Fig. 1.—About one-fourth natural size.

magnetite. The explanation of this is apparently simple. When the quartz fragments of which the larger portion of the rock is formed have become consolidated, depressions will be formed by the heavy particles of magnetite under the influence of the waves, very much after the manner in which pocket holes are formed in the rocky beds of nearly all the mountain streams in the island. (It was in these pocket-holes that the earlier sapphires were nearly always found.) When once commenced this scouring process would go on as long as the water was sufficiently agitated to keep the fragments of magnetite in motion. Their superior weight would have a tendency to keep them in the hollows they had formed, and the carbonate of lime in the water would fix them in position as soon as they were left undisturbed by the waves. The succeeding waves

Fig. 2.—About one-fourth natural size.

hat reached the hollow would fill it chiefly with quartz fragments which would become cemented together, and the process of scouring would go on as before.

It may be noticed in explanation of the very beautiful skein-like appearance of Fig. 2, that when once a stratum of magnetite had become consolidated, it would be much less liable to be removed by the scouring process than the neighbouring quartz, on account of its superior hardness, and therefore the original shape of the basin has been retained, whilst other basins, represented by the dark lines, have been formed above it, differing only slightly in shape from the original one. Some portions of this beach are quarried for edging and coping stones which are sent to Colombo. R. Abbay

ON THE POTENTIAL DIMENSIONS OF DIFFERENTIATED ENERGY[1]

IN his great work, which appears to be but little known in England, "Ueber die stille Bewegung hypotetischer Körper," Prof. Hans points out that the dimensions of "ideal" matter may not only differ in degree, but also in kind. He deduces, by means of implicit reasoning from his three primitive "stations," that not only must there be space of 4, 5, 6, &c., dimensions, but also that there must be space of − 1, − 3, − 5, &c., dimensions, and that there may be space of − 2, − 4, − 6, &c., dimensions. Pursuing Hans's train of thought further, Lobwirmski has quite recently interpreted space of 1·1, 1·2, 1·3, &c., dimensions. Not only has fractional space been thus proved to exist, but the same philosopher has also conclusively shown that if space of $n . \sqrt{-1}$ exists, it has all the properties of angular magnitude; *e.g.* like all partly bounded infinities (*theilweise begränzte Unendlichkeiten*), it is unmagnifiable.

These speculations, which are really rather more hyperphysical than metaphysical, immediately suggest the analogous kinematic considerations, and have led me to examine the potential dimensions of differentiated energy. Before pointing out the main conclusion to which I have been led, let me make quite clear the meaning of the terms employed. "Differentiated energy" is that energy which would survive if all matter were destroyed, and simultaneously re-created in such a manner that all its properties were inverted. By "potential dimension" I mean the dimension which, by reason of the kinetic energy of all other dimensions, is only able to vary according to Lobwirmski's groove (*Kleise*).

Let us start from the idea of what is ordinarily conceived to be a Thing, and imagine the Thing itself (not its measure) to be saturated with the property *a*, after the manner in which the circle is saturated with the straight line in the spiral watch-spring (*spiralförmiger Haasesprung einer Wacht*). Further, let us suppose *a* to change in such a way that all previous values of any one attribute other than those dependent on its rate of variation can be arranged in a series, the functionally alternate terms of which, up to a certain number whose value will be given by taking each turn separately, and finding to what amount its *a* property may, under the influence of the given "groove" exceed the *a*-property of its immediately antecedent term, represent any convenient converging series. The vigour of this change being, as usual, measured by the degree of matter affected, and also by the index of change in a given time, we have at once the simple relationship

$$a = \left\{ \begin{matrix} \beta \\ \gamma \end{matrix} \right.$$

Accordingly, it is obvious as one of the simplest corollaries from the above, that if we know the present position, mass, direction of motion, and velocity of a given piece of matter, we should be able within certain limits to calculate its chemical composition.

As an example of the application of this let us suppose that the earth's satellite M has the mass C; let its direction of motion at *any* given time *q* be N. Let its rectangular co-ordinates, at the same time, measured from the absolute zero of position, be *m*, *n*, and *p*. Let O be its velocity, and H an arbitrary constant. We have, substituting in the above equation—

$$M = C_m N_n O_p H_q,$$

which has, at least, no closer resemblance to any other body than it has to caseine. A. V. Nudeln

[1] The correspondent who has received the above letter has forwarded it to us for publication. We are not aware that the general scientific opinion in Germany is in consonance with the results reached in the letter.

A TIDAL PROBLEM

THE so-called *seiches*, or alternate flux and reflux of water in the Lake of Geneva and other bodies of fresh water, have, as our readers know, formed the subject of an interesting study during the past decade by Dr. F. A. Forel, of Morges, near Geneva. Small local tides are constantly noticeable there, the difference between ebb and flow varying from a few centimetres to 2 metres. Their cause is to be traced to the wind, variations in atmospheric pressure at the extremities of the lake, &c. Dr. Forel, as the result of his investigations has established a formula by means of which the duration of a local ebb and flow can be determined—not only for the Lake of Geneva, but for any lake—when its average depth and its length are known. The following is the formula $T = 2\frac{2L}{\sqrt{gh}}$, in which L denotes the length of the lake, h its average depth, and g the acceleration of gravity. This formula gives for the Lake of Geneva, which has a length of 73 kilometres, a duration of tide of 13 minutes; a figure coinciding with the fact.

The law thus established by M. Forel has recently received an interesting application in solving a problem which has puzzled travellers and philosophers for over 2,000 years, viz., the explanation of the currents in the narrow straits of Euripus, where the famous five-arched bridge of Egripo joins the Island of Eubœa to the mainland of Greece. The currents sweeping below the bridge are so violent that mills are kept in operation by them, but they are noted for the changes in direction which occur from four to fourteen times daily. Tradition relates that Aristotle, in despair at his inability to explain this phenomenon, threw himself from the bridge into the water.

A comparison of the large number of observations made upon this strange tidal movement shows that there are two distinct periods: that in which there are but four changes of direction or two tides in a lunar day of 24 hours and 50 minutes, and that in which these tides number from eleven to fourteen daily. This latter phenomenon is observable invariably at the quadratures of the

moon. M. Forel, in his explanation, shows that the regular ebb and flow twice a day in the former period is due to the tidal movement of the Ægean Sea, which is then at its maximum. The increase in the number of tides daily becomes manifest, however, when the tidal force of the Ægean is at its minimum, viz., at the quadratures, and must be owing to some other force more powerful than the minimum but less powerful than the maximum force of the Ægean tide. This force is found in the local tides or *seiches* of the Gulf of Talanti to the north of the straits, which is so shut in by land that it can practically be regarded as subject to the same laws as the lakes of Switzerland and other countries. This basin is 115 kilometres long, and is from 100 to 200 metres in depth. Applying these figures to M. Forel's formula, the ebb and flow in the Gulf of Talanti would be for 100 metres, 122 minutes; for 150 metres, 100 minutes; for 200 metres, 86 minutes. The eleven to fourteen currents observable daily at Euripus during the quadratures last from 103 to 131 minutes. This shows so striking a conformity with the theory advanced by the Swiss *savant*, that we can but consider this problem, which so vexed the ancients, as fairly solved.

Dr. Forel asks intelligent visitors to the locality to verify his interpretation by attending especially to the following points:—1. Ascertain the exact duration of the flux and reflux of the Euripus, and determine its normal rhythm. 2. Ascertain if, as in the *seiches* of the Lake of Geneva, the amplitude of the flux and reflux of the irregular current is stronger in bad weather than when there are no atmospherical perturbations. 3. Ascertain if the connections between the direction of the current and the flow of the rising sea are, as he supposes, inverse, according as the current is regular or irregular.

NOTES

THE great osteological collection which Dr. Barnard Davis, F.R.S., has accumulated during a long life devoted to anthropological pursuits is well known, both in England and abroad, as the richest and most valuable ever formed by a private individual, exceeding, as it does, in variety and rarity of the specimens all the public collections of this country and most of those on the Continent. It contains about eighteen hundred specimens of skulls and skeletons of various races of men, the value of which is greatly increased by an excellent catalogue, called "Thesaurus Craniorum," in which each is fully described, and all known particulars of its history recorded. We believe that, at one time, Dr. Davis contemplated leaving the collection to the College of Surgeons; but considerations for the interests of his family do not appear to have justified this arrangement, and he has now offered it for the sum of 1,000*l.*—which, considering its extent, and the labour and time taken in its formation, must be considered very moderate. Upon this becoming known to the Council at their meeting on December 11, through a communication of Prof. Flower, we learn from the *British Medical Journal*, it was the unanimous feeling of all present that the opportunity of acquiring it upon the terms offered by Dr. Barnard Davis should not be lost. It was referred to the Museum Committee to consider and report whether the necessary sum could be provided out of the College funds, or whether it was desirable to seek for aid from other sources; for the latter alternative several liberal offers were at once made by individual members of the Council. We feel sure that all who are interested in the scientific progress of the country will have great satisfaction in knowing that the Council of the College have thus promptly stepped forward to save this noble collection from dispersion or expatriation; and that, if it should be thought that the College funds cannot judiciously be taxed at the present time, the country will as promptly respond to an appeal for such a truly national purpose. The Hunterian Museum, thus enriched, would more than ever become the great centre of osteological and anthropological research and instruction, and in the hands of Mr. Flower we may be sure that this collection would be so arranged, developed, and studied as to be rendered in the highest degree available for the advancement of knowledge. It is an opportunity which must not be let pass.

THE following translation of a Chinese placard regarding the highly immoral practice of consuming cow's milk is sent to the *Foochow Herald* for publication:—"Strictly refrain from eating cow's milk! Man should not rob the beasts of their food. Moreover of all beasts the cow is the most useful and meritorious. Men who do not discriminate between mankind and beasts are worse than senseless. Those who sell milk darken their consciences for gain, and those who eat cow's milk foolishly think they are benefiting their bodies. Men who take medicine should first carefully investigate and find out its nature. Why do not those who eat cow's milk consider and inquire into its origin? For instance, men beget children, and while the children are small they depend upon milk for their nourishment; so it is also with beasts. But when men buy milk to eat, do they not do injury to the life of the calf? And is there not bitter hatred and distress in the minds of both cow and calf? Beasts cannot speak: how then are they able to tell the man that, in eating the milk of beasts, his body becomes like that of birds and beasts? But if men wish to take strengthening medicine, there are numberless other articles in the world that are beneficial; and what necessity then is there for taking cow's milk? Besides this, the death and life of men have their fixed number and limit, and this cow's milk cannot lengthen out and continue the life of man. Since, then, all know the truth—that it cannot do this, all ought to act with loving and benevolent spirit. Especially all who receive this exhortation should keep from eating milk. The children of those who cause their families to refrain from eating milk will be preserved to grow up; they also will thus lengthen out their own lives, and will escape from evil in time of fatal epidemics. If such persons be able also to exhort others, who are ignorant of first principles, to leave off the eating of milk, their descendants shall surely prosper. Published by the Hall of Good Exhortations. The Xylographic blocks are deposited in the Ung Ling Kóh."

AN important discovery has just been made in the neighbourhood of Elbœuf, Seine-Inférieure, by M. Noury. He has found a multitude of pre-historic implements in the siliceous sands which form the sub-soil of the Seine valley, between Elbœuf and Rouen. In a single locality he collected more than 400 among bones of large quaternary mammals. These implements are said to belong to the palæolithic age; they consist of cut flints forming axes, cores, punches, and hammers of various dimensions.

WITH reference to the discovery of a jade scraper at Geneva, referred to in NATURE, vol. xxi. p. 163, Prof. Max Müller writes to the *Times*:—"Scrapers or cutting instruments made of real jade are very rare, in Switzerland and elsewhere, but I have myself seen several beautiful specimens—among the rest, one found by Dr. Uhlmann, of München-buchsee, whose collection of lacustrine antiquities, all taken out by his own hand from one and the same small lake, the Moossee-dorfsee, is perhaps the most authentic and most instructive collection in the whole of Switzerland." Prof. Müller does not see any difficulty in believing that the early "Aryan" immigrants into Europe brought with them and preserved, "from generation to generation, so handy and so valuable an instrument as a scraper or knife, made of a substance which is *ære perennius*." On the same subject Mr. B. M. Westropp sends the opinion of M. Desors, as follows:—"We cannot share the opinion which attributes extensive commercial relations to the tribes of the age of stone. In support of this opinion are cited the hatchets of nephrite (jade), of which numbers are found at Concise and other stations of that epoch; and as this stone now comes to us from the East, it has been inferred that the tribes of the remote period in question trafficked with Asia. But it should be remembered that the greater part of the hatchets which are assumed to be nephrite may very well be only varieties of indigenous rocks, proceeding from siliceous veins in the serpentine, and whose depository might be found, according to M. de Mortellet, in the higher Maurienne. It seems to us very difficult to admit that so distant a commerce should have been restricted to the exchange of certain stones, which, after all, are not very superior to common silex, while the East might have furnished objects of far greater utility, particularly metals."

ONCE more the New York correspondent of the *Daily News* telegraphs of Mr. Edison's success in electric lighting. "Mr. Edison," we are told, "has perfected an electric lamp of extraordinary simplicity, costing only 25 cents, with which he proposes a general illumination of the village of Menlo Park on New Year's Eve. He has discovered that a steady brilliant light is obtained by the incandescence of mere carbonised paper better than from any other known substance. Strips of drawing paper in horse-shoe form are placed in a mould and baked at a very high temperature. The charred residuum is then attached to the platinum wires and hermetically sealed in a glass globe from which the air has been exhausted. This attached to a wooden stand, or ordinary gas fixtures, is the whole lamp. No regulating apparatus is required, the flow of electricity being automatically increased and diminished at the central generating station. A single generating machine of simple construction, and applicable for domestic use, supplies about fifty lamps. The cost of the power is not stated. The quantity of electricity supplied to each householder is measured by the deposit of copper particles in an electrolytic cell."

M. A. GUYARD claims to have discovered another new metal of the platinum group which he names uralium, from the Ural Mountains, whence the ore is procured. There have been quite a flood of similar announcements lately. We have now gallium, davyum, mosandrum, neptunium, decipium, phillipium, norvegium, scandium, ytterbium, holmium, "X," thulium, and uralium. Chemists will have to keep as narrow a watch on these minor elements as our astronomers do upon the minor planets, or we shall not know where we are.

IN a paper on the destruction of obnoxious insects, by Prof. Hagen, of Harvard, in which he describes some experiments that had been made by Mr. J. H. Burns and others, he comes to the following conclusions:—1. That the common house-fly is often killed by a fungus, and that in epizootics a large number of insects which live in the same locality are killed by the same fungus. 2. That the fungus of the house-fly works as well as yeast for baking and brewing purposes. 3. That the application of yeast on insects produces in them a fungus which becomes fatal to the insects. 4. That, in the experiment made by Mr. J. H. Burns, all potato-beetles sprinkled with diluted yeast died from the eighth to the twelfth day, and that the fungus was found in the vessels of the wings. He admits that further experiments are necessary to find out the most convenient method of application.

WOOLWICH is taking a step ahead in the use of the electric light, a number of tradespeople in that suburb being now supplied by Messrs. Siemens, who have set up for that purpose three of their most powerful machines. Power is supplied from the steam-engines of Messrs. Rose and Mellish's establishment on the river bank, when the day's work is over. The lights are maintained from 6 P.M. till midnight.

A CORRESPONDENT sends us the following account of the recent severe weather at Mulhouse; it is contained in a letter from Mr. Alfred von Glehn:—"I must give you some description of the fearful weather we had last Friday (December 5). No one here ever remembers such a day. On Thursday night it began to rain, the thermometer being about 8° below freezing, then came lightning and thunder, and then the most terrible wind got up, with driving snow; it lasted all night and next day. It blew a hurricane, thermometer about 20° F. below freezing, and all the time the snow fell so thick that you could not see a yard before you. I really hardly know how I got to the works; one could hardly breathe, and at certain open places one could hardly stand, and I saw people have to turn back and take refuge in shops. No trains could run; one was stopped between here and Bâle, and the people had to come back as best they could on foot. A goods train was snowed up between here and Cernay, and was only got out on Sunday. Two factory chimneys were blown down, and numberless smaller accidents occurred. We had to allow the workmen who live in the country to start for their homes at three o'clock in the afternoon, as at night it would have been impossible for them to find their way. Everywhere in the streets stood carts abandoned by their owners, as the horses could not move them. One train was got ready for Strassburg, with four engines, but it stuck just outside the station, and could go no farther. The next day the weather was fine and cold. Sunday night the thermometer fell to 40° F. below freezing, and at 12 o'clock in the middle of the day with a bright sun stood at 0° F. This morning it went down to 51° F. below freezing, and when I went to the works it was only a few degrees less. The air is fortunately still, and as there has been bright sunshine everything is wonderfully beautiful. Skating is unfortunately out of the question, owing to the masses of snow. Sledges are to be seen on all sides, even the cabs are mostly sledges, and those who have horses are to be envied, as the roads are in a splendid state."

THE *Derry Journal* of the 10th inst. states that on the previous Saturday, at about 11.30 P.M., the inhabitants of Stranorlar, county Donegal, and for many miles around, were startled with a strange and unusual sound. It resembled the noise produced by the falling in of a large building, and in some cases the commotion was so powerful that chairs and other household articles were seen to move. The phenomenon is believed to be a slight convulsion of earthquake, and much resembled distant thunder. Mr. Thomas Watson, of Derry, writes that a similar disturbance was noticed at exactly the same hour at Barons Court, the seat of the Duke of Abercorn, in county Tyrone, and was sufficiently intense to cause the candelabrum in one of the large rooms to shake very perceptibly, the noise at the same time being very loud, and of a nature that puzzled those who heard it to explain. It seems to have been in some way connected with an earthquake wave which appears to have taken the direction almost east and west.

IN a recently-received report from Guayaquil, it seems that the bad season of 1878 had a most serious effect upon the produce of the soil in that country. The cocoa crop (*Theobroma cacao*) was the smallest on record, though the high prices obtained for this article in the European markets have in some degree compensated for the loss. The coffee crops gave even a worse result, as during the last months of the year it was found necessary to import coffee from Central America for home consumption. The quality of the coffee produced in Guayaquil during the year was very inferior. The rice plantations having been almost entirely under water, owing to the heavy rains, for a long period during 1877 and 1878, the production of this article of food (of which, in the coast provinces of the Republic alone, 5,000 quintals per month are consumed) was very limited. The cotton plantations were also destroyed by the same cause. The failure of the above-mentioned crops left a large number of men free to attend to the collection of india-rubber and ivory nuts. The export of the former during 1878 was a little below that of the preceding year, owing doubtless to the scarcity of the trees producing it, and the difficulties of bringing it down to the coast from the inland forests, where it is gathered, each year made more distant from the ports of embarkation owing to the continued wanton destruction of the trees. The quantity of ivory nuts gathered and exported by far surpassed all previous years.

THE *Pharmaceutical Journal* of December 20 contains a valuable report on the botany of the Kuram and Hariab districts, by Surgeon-Major J. E. T. Aitchison.

A NUMBER of papers on the hymenoptera and coleoptera of the United States, by Messrs. E. Norton, C. A. Blake, and Dr. Horn, are in course of publication in the *Transactions* of the American Entomological Society of Philadelphia.

FROM the *American Naturalist* we learn that Thos. G. Gentry is engaged in a work on the fertilisation of plants by insects, based on observations made in Pennsylvania and New Jersey, and that Prof. O. S. Jordan is preparing a work on the Fishes of North America.

A FAVOURABLE report was presented at the last meeting of the Eastbourne Natural History Society.

IN a recent volume of the *Ann. de l'Obs. Roy. de Bruxelles* (September, 1879, 84 pp.) M. Fievez gives a comprehensive bibliography of works, treatises, and notices on spectroscopy. An index facilitates the search for any particular point relating to the subject.

THE Russian Technical Society will hold an exhibition of the latest Russian and foreign technical machines, apparatus, instruments, and inventions, from December 15 until May 15 next, at St. Petersburg.

A PAPER of great value on the Geology of the Lower Amazons, by Mr. Orville A. Derby, read before the American Philosophical Society, has been issued in a separate form.

THE *Transactions* of the Cumberland Association for the Advancement of Literature and Science for 1878-9, is a volume of 340 pages, edited by the Rev. J. Clifton Ward. Among the numerous excellent papers contained in the volume are the following:—An ethnological paper by Mr. R. S. Ferguson, entitled "The Formation of Cumberland;" "Our Summer Visitors," a local natural history article, by Mr. T. Duckworth; an interesting paper on the Dipper (*Cinclus aquaticus*) by Mr. William Duckworth; "The Entomology of the District," by Mr. George Dawson; "The Great Lake, Lagoon or Bay of Triton," by Mr. B. A. Irving; "List of Cumberland Birds in the Carlisle and Keswick Museums," by Mr. George Dawson and the Rev. J. Clifton Ward.

PHYSICAL NOTES

SOME useful observations on the action of safety valves on boilers have been recently communicated to the Vienna Academy by Herr von Burg (November 13). Among other things it is proved that the authoritative directions given in different countries as to the size of safety valves are not at all adequate, and are based on erroneous conceptions. As to the cause of the small amount of lifting of the valve during escape of steam (seldom over ½ mm.), the author at first supposed a vibratory motion of the valve, but further study and experiment led him to the hypothesis that the steam jets, in lifting the valve, do not begin to move from its middle point, but from the periphery of a circle, ρ, out to the circumference of the valve of radius r; so that the pressure of steam on the under surface of the valve is composed of two parts, of which the inner, or *aërostatic*, is produced by the solid steam-cylinder of radius ρ, and the outer or weak *aërodynamic* part, by the external hollow cylinder of $r-\rho$ thickness of wall. The phases of development of steam tension, and other topics, are also investigated.

A SIMPLE method of perforating glass with the electric spark is described by M. Fages in a recent number of *La Nature*. The apparatus required consists (1) of a rectangular plate of ebonite, its size, for a coil giving 12 ctm. sparks, about 18 ctm. by 12; (2) of a brass wire passing under the plate and having its pointed end bent up and penetrating through the plate (not further). This wire is connected with one of the poles of the coil. A few drops of olive oil are placed on the ebonite plate about the point, and the piece of glass to be perforated is superposed, care being taken not to imprison any bubbles of air. The olive oil perfectly accomplishes the object of insulating the wire. One has then only to bring down a wire from the outer pole of the coil, on the piece of glass, above the point of the lower wire, and pass the spark. By displacing the glass laterally, for successive sparks, it is easy to make a close series of holes in a few seconds.

IT has often been queried what might be the reason of the high specific heat of water. Some light has been thrown upon this problem by the recent research of a Russian gentleman of the name of Beketoff, upon the specific heat of the hydrogenium-alloy of palladium, and upon that of the hydrogen in the alloy. The specimen examined by M. Beketoff contained about half per cent. of hydrogenium to ninety-nine and a half of palladium. On examination by careful calorimetric measurements the specific heat of hydrogenium was found to be not less than 5·88; which though probably requiring correction is certainly not greater than the true value. The value should be somewhere about 6·4 by the law of atomic heat of Dulong and Petit.

A VIBRATION micrometer for ascertaining with precision the amplitude of vibrations of tuning-forks and other sounding bodies was recently shown in Paris by M. Mercadier. It is an extremely simple device and can be applied to any vibrating bodies except such as possess very small mass. A small piece of thin white paper bearing one fine black line is affixed to the body whose vibrations are to be measured. If this line is upright, it will, when caused to vibrate, present the appearance of a pale grey parallelogram, the persistence of the visual impression being perfectly definite for the extreme positions of the vibration. To ascertain the amplitude of the vibration, all that is necessary is to measure the apparent width of this minute parallelogram in a direction at right angles to the axis of symmetry of the oscillations. To do this with still greater precision, M. Mercadier proposes to set the line not perpendicular to the direction of the movement, but inclined to it at a small angle, and marks also upon the paper a fine scale of lines parallel to the direction of the movement and distant from one another by equal distances of one millimetre. The width of the narrow parallelogram is thus read off along a straight line, which makes a small angle with its sides, thus giving the quotient of the amplitude sought by the tangent of a small angle. Using this method, M. Mercadier showed that the vibrations of a tuning-fork "interrupter," vibrating automatically under the influence of an electro-magnet, may be regulated so as to be greater or less at will by adjusting to a greater or less distance from the prongs of the fork the electro-magnet which maintains the vibrations.

PROF. TAIT has abandoned the enticing speculation that the thermal conductivity of metals is inversely proportional to their absolute temperature, a conclusion to which his earlier experiments on the conductivity of iron seemed to point. Many metals, indeed, present the opposite case, their conductivity increasing with the temperature.

A MEANS of comparing the intensities of lights of different colours has long been desired. Until quite lately there did not even exist a means of measuring the relative intensity of two lights of the same given colour. M. Gouy has been investigating the latter point by the aid of a particular photometer, and by flames of constant brilliancy produced by the combustion of a homogeneous mixture of coal-gas with air impregnated with saline powders. The photometer resembles in general appearance a two-prism spectroscope, having also an auxiliary collimator with a fixed lamp to serve as a standard light. In place of the usual eye-piece of the instrument a second slit is placed. By this means any one ray can be separately observed, and its intensity compared with the intensity of the same ray from the standard source. M. Gouy states that this slit eye-piece arrangement is capable of such accurate adjustment that each of the two D-lines can be separately examined and its intensity measured.

MARAT, the notorious hero of the first French revolution, the same who met his death at the hands of Charlotte Corday, was the author of several important essays on electricity. This fact, which is not generally known, was recently brought to notice by Mr. A. J. Frost, who is editing the catalogue of the Ronalds Library. Most of Marat's works were written between 1779 and 1785, and several of them were translated into German. Marat was not the only one of the prominent figures of the time who worked in physical science. Arago, though his fame does not rest upon his political achievements, once enacted the chief part in the crowning of the statue of Liberty. "Citizen" Charles was as famous amongst the revolutionists as for his scientific attainments. Robespierre wrote an article on the lightning-conductor for the *Journal des Savants*; and last, but not least, Napoleon Buonaparte on many occasions dabbled in scientific lore, and was the liberal patron of men of science.

EDISON'S telephone has, it is said, been successfully used over a line of 2,000 miles in length. A hunting party in Nebraska were thus enabled to converse with perfect distinctness with their friends in Pennsylvania, *viâ* Chicago and the Western Union Telegraph Company's line.

GEOGRAPHICAL NOTES

THE Neapolitans are preparing to *fête* Prof. Nordenskjöld, who intends staying a short time in Southern Italy before returning overland to Sweden. The *Vega* arrived at Galle on the 16th inst. We have received from Hongkong an account of the reception given to Prof. Nordenskjöld and the officers of the *Vega*, on arriving at that Eastern limit of the British Empire. At the close of an official banquet at Government House, Governor Hennessy congratulated Prof. Nordenskjöld and his staff in the warmest terms. "We behold," he said, "as it were in this remote outpost of Europe, the writing of the last words in the last chapter of heroic maritime discovery." Captain Palander brought down to the drawing-room the actual charts he had used during the voyage, and throughout the evening they were inspected by the Governor's guests with great interest. The charts were Russian ones, and one of the minor results of the expedition has been the establishment of the fact that they are not accurate, inasmuch as a great deal that was put down as land was actually sailed over by the *Vega*. The route was marked in red ink and pencil and showed these inaccuracies. Some specimens of the plants from the region where the *Vega* was so long bound up in the ice and photographs of the natives were also on the drawing-room tables. We understand

Prof. Nordenskjöld, before his departure, received from his Excellency, as a present to the *Vega* expedition, an herbarium of the plants of Hongkong and South China, prepared by Mr. Ford, the head of the Botanical Department of the Colony.

ZANZIBAR advices report that the Abbé Debaize, the French explorer, was on the 13th of June at Ujiji, on Lake Tanganyika. He was waiting for some boats to go to the north of the lake, and meanwhile was examining neighbouring rivers and some points on the lake. At the beginning of September he expected to start for the Uzige country, there to leave a depôt of merchandise under trustworthy men while he proceeded with the rest of his effects to Aruwimi or Stanley river, which joins the Congo, leaving there a second depôt, exploring with his best men the western slope of the Blue Mountains and the region between Lakes Albert and Tanganyika, and then returning to Uzige to despatch reports and explain his further plans.

THE enlarged edition of Whitaker's Almanack for 1880 contains an article on geographical discovery, written in a somewhat perfunctory manner. As instances of the want of proportion observable in it, we may mention the space given to the voyage of the *Isbjörn* to Novaya Zemlya, and Mr. McCarthy's journey across China, the former of which was admittedly unsuccessful, while the latter, which did not occur in the period under review, added nothing whatever to our geographical knowledge. Accuracy hardly appears to be the writer's *forte*, otherwise he would hardly discourse about Mr. E. Colborne Ba*k*er's journey in Western China, nor would he turn one of the Portuguese African explorers' names into Ives, not to mention his inability to make up his mind how to spell Thibet.

IN the course of their explorations last year in the unknown highlands of Eastern Perak, a party of Englishmen met with several small settlements of Sakis, presumably the aborigines of the peninsula, who still hold themselves aloof from the Malays. Few of these people have metal or earthenware cooking utensils, but roast their sago in large bamboos. The majority of them speak Malay, with an accent not unlike the Chinese; their own language is described as soft and guttural. Two specimens of these people—a man and a woman—on being measured, were found to be 4 feet 6 inches and 4 feet 1 inch in height, and these appeared to be about the average. The women are said to be not bad-looking, with thick lips and flat noses; their figures are good, though rather inclined to stoutness; and they have remarkably pretty little feet and hands. The dress of both sexes consists of a strip of bark about 9 feet long and 1 foot 6 inches wide, wound round the bodies. The bark used is that of a species of fig, and is very soft and pliable; there are two descriptions of it, obtained from different trees, one of a dirty white and the other of a reddish brown colour.

THE new number of the *Bulletin* of the Société Commerciale de Géographie of Bordeaux, contains an article on Cabul, and from its "Chronique Géographique" we learn that the French Minister of Marine has ordered the Governor of Senegal to send an expeditionary column to the country between the Upper Senegal and the Niger. The object of the column will be to explore the region in order to see by actual survey and examination whether the two rivers can be joined by a railway. The expedition will be accompanied by a skilled topographer.

MR. H. CONYBEARE, of the Bengal Civil Service, has published a carefully prepared report on the Pargana Dudhi, which extends from 25° 52′ 17″ to 24° 21′ 21″ N. lat., and from 82° 59′ 28″ to 83° 28′ 7″ E. long. The first portion deals almost entirely with geographical matters, and furnishes much interesting information respecting the various aboriginal tribes, their language, customs, and style of cultivation, &c.

THE *Hiogo News* states that the Japanese Government has decided upon at once going on with the construction of a railway between Shiwotsu, at the head of Lake Biwa, and Tsuruga, a town at the head of a large bay, which will probably before long become an open port. Some high officials connected with the Board of Works are to proceed to Tsuruga on this business without delay. It is expected that the opening of the line in question will have a most beneficial effect on the trade of the treaty port of Kobe. A large extent of rich country will be opened up to commerce, and it is probable that the whole of the produce of the silk districts to the north of Lake Biwa will be brought to Kobe for shipment to Europe.

ON THE NATURE OF THE ABSORPTION OF GASES

MORE than seventy years ago Dalton made the assertion that gases, when absorbed by liquids (*e.g.*, water), remain only mechanically included in the latter, without losing thereby any property which belongs to them as gases. This hypothesis of the nature of absorption is opposed by a still older one—the chemical—which considers the phenomenon as the consequence of an affinity between gases and liquids, and explains, for example, the absorption of CO_2 and N_2O by water by the formation of H_2CO_3 and HNO. Since the time when these two hypotheses were started, their proof has always been attempted with the aid of the statical method; *i.e.*, by the determination of the proportion in which the absorbed and absorbing bodies maintain their equilibrium under given conditions; or, in other words, by the determination of the coefficients of absorption. Mackenzie, who in this way has lately most thoroughly examined into the absorption of carbonic acid by means of a solution of salt in water, says that it would be presumptuous, on the basis of existing observations, to attempt yet to solve the problem whether absorption is a purely physical phenomenon or whether it belongs rather to the domain of the so-called chemical phenomena.

After these two hypotheses there comes yet a third, set forth by Graham, according to which gases are transformed into the liquid state in the case of their absorption by bodies such as liquids, caoutchouc, or by glowing metals. This hypothesis is supported on the one hand by the circumstance, already remarked by Mitchell, that membranes of caoutchouc are most easily penetrable for those gases which are most readily capable of being rendered liquid and are most soluble; on the other, by two assertions of Graham's—(1) That a body in the form of a liquid penetrates another body more easily than in the form of a gas; and (2) That liquids and such colloid substances as caoutchouc, have no pores at all, and, in point of fact, are, even in the thinnest film, impenetrable, to gases as such. According to Graham, then, it is impossible for a gas to penetrate such a substance without this conversion into a liquid state, which may or should be favoured in some measure by the chemical affinity between the gas and the absorbing substance.

My researches in the domain of diffusion gradually led me to the conviction that a much nearer approach will be made to a solution of the problem of absorption if conclusions are drawn, with reference to the state in which gases exist in these substances from the study of the phenomena of motion, which exhibit them in their diffusion through absorbing substances. Availing myself of the kind invitation of the editor of NATURE, I shall take the liberty of here briefly describing the results which I have in this way obtained. They refer to what takes place in the case of caoutchouc.

The application of the laws of the diffusion of gases through absorbing substances[1] to the phenomena which appear in caoutchouc shows that the quantity of gas which passes through a membrane of caoutchouc in a unit of time is, conditions being equal (*i.e.*, equal surfaces of diffusion, equal thickness of the membrane, and equal difference of saturation on both sides of the membrane) in proportion to the product $D\,S$. D is the *constant of diffusion* of a gas in caoutchouc, and corresponds to the thermometric conductivity of a body in the theory of the conduction of heat. S is the *coefficient of saturation*, and is expressed by the equation—

$$S = A_\theta \frac{p}{76},$$

in which A_θ denotes the coefficient of absorption of caoutchouc for the gas under consideration at the temperature θ, and p the pressure (in centimetres of mercury) under which the gas is. The coefficient, then, is that volume of gas reduced to 0° C. and under 76 cm. of mercury which can be contained in the unit or volume of caoutchouc at the given temperature and under the given pressure. It corresponds to the specific heat of the unit of volume of a substance in the theory of heat.

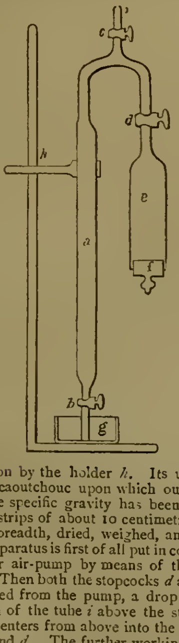
Mitchell and Graham, during their experiments with caoutchouc, have always measured the product $D\,S$ only, which can give us absolutely no explanation of the nature of the absorption of gases, and which has led Graham, as we shall see further on, to false inductions.

In order to determine the constant D, which shall form the basis of our examination, it is necessary to know the coefficient of absorption, by means of which the coefficient of saturation

[1] Wroblewski in Wiedemann's *Annalen*, ii., 481-513.

can then be ascertained. The determination of the coefficient of absorption presupposes, moreover, that the Henry-Dalton law of absorption holds good for caoutchouc as well. That this law is valid is proved by the experiments which I made several years ago on the passage of gases through membranes of caoutchouc,[1] and by means of which I have shown that, at the various differences of pressure between 74 cm. and 2 cm. mercury, the quantity of gas which passes through is proportional to the actual pressure of gas upon the membrane. This relation between the quantity of gas passing through and the pressure is only *possible* in the case of the coefficient of saturation being proportional to the pressure, or, in other words, when the Henry-Dalton law holds good for caoutchouc within the given limits.

The absorptiometer which I have constructed for the determination of the coefficients of absorption, consists of glass throughout. *a* is a tube which is divided into tenths of cubic centimetres, and from which even hundredths of cubic centimetres may be read off; *b*, *c*, and *d* are glass stopcocks; *e* is a space which serves as a receptacle for the caoutchouc, and is closed from beneath by a glass stopper which renders it air-tight when shut. The apparatus stands in a glass trough, *g*, of mercury, and is held



in a vertical position by the holder *h*. Its use is very simple. The membranes of caoutchouc upon which our experiment is to be made, and whose specific gravity has been previously ascertained, is cut into strips of about 10 centimetres in length, and 1·5 centimetres in breadth, dried, weighed, and introduced into the space *e*. The apparatus is first of all put in communication with the Jolly quicksilver air-pump by means of the stopcock *c*, and is pumped empty. Then both the stopcocks *d* and *e* are shut, the apparatus is separated from the pump, a drop of water is introduced at the bottom of the tube *i* above the stopcock *e*, and the gas to be examined enters from above into the space inclosed by the stopcocks *b*, *c*, and *d*. The further working of the apparatus explains itself. If the volume of gas which has been allowed to enter has been measured, and also the pressure under which it is, the stopcock *d* is opened, and after the lapse of from three to twelve hours, the volume of gas and the pressure is again ascertained. The calculation of the coefficients of absorption is made according to the known formula.

I will here remark that the pressure of the gas which remains in the caoutchouc after the apparatus has been pumped free therefrom can only be measured by the hundredth part of a millimetre of mercury, which at the same time is the limit of the power of action of the Jolly pump.

For the experiments, red vulcanised caoutchouc of about one-third of a millimetre in thickness was employed. Its specific gravity at 15° C. was 1·02685.

The coefficient of absorption of the four following gases was

[1] Wroblewski in *Poggendorff's Annalen*, clviii., 539-568.

ascertained: nitrous oxide (N_2O), carbonic acid (CO_2), hydrogen and atmospheric air.

It was shown that the coefficient of absorption of caoutchouc for gases, within the limits of the examination, are linear functions of the temperature, and that they diminish with an increase of temperature in the case of nitrous oxide and carbonic acid. The coefficient of absorption of hydrogen, on the other hand, grows larger with increase of temperature, and atmospheric air shows a similar tendency. The coefficient of absorption is as follows:—

	At 5° C.	At 10°.	At 15°.
For N_2O	1·8229	1·6896	1·5564
,, CO_2	1·1991	1·1203	1·0416
,, H	—	0·06121	0·08157
,, Air	—	0·09832	0·11710

With the assistance of these values the constant D can now be ascertained. For the description of the diffusiometer which I have constructed for that purpose and for the method of observation, I must refer the reader to my paper in Wiedemann's *Annalen*, vol. viii. pp. 29-52.

The experiments showed that the constant D amounted to—

	At 12° C.	At 14° C.	
For N_2O	56	62	$\times 10^{-8} \frac{cm^2}{sec}$
,, CO_2	54	61	

Nitrous oxide and carbonic acid have thus almost equal constants, a somewhat greater value being accorded to nitrous oxide (being the somewhat specifically lighter gas). The constant for these two gases increases with the temperature, and is at 10° 50 times smaller than D for carbonic acid in water,[1] and 300,000 times smaller than the constant of free diffusion for carbonic acid and air at the same temperature and the same pressure.

If the great difference in the coefficients of absorption of caoutchouc for both gases is taken into account, it is at once seen that the constant D depends neither upon the chemical nature of the gas nor upon the value of the coefficients of absorption. It can, in this case, depend only upon the physical properties of the gases, and since specific gravity is the principal property in which gases differ from each other in physical respects, the constant D must depend upon the specific gravity of the gases. Proof of this is afforded by the determination of the constant D for hydrogen gas: it comes to $353 \times 10^{-8} \frac{cm^2}{sec}$. The constants for these three gases is thus nearly in inverse ratio to the square root of the specific gravity of the gases.

If the behaviour of the nitrous oxide is held as normal, it is found that D is about 27 per cent. greater for hydrogen than it would be if the constant under consideration were exactly in inverse ratio to the square root of the specific gravity of the gas. The same variation here appears which Graham has observed in the diffusion of gases through plates of graphite. Hydrogen diffused itself through a plate of 0·05 centimetres in thickness—supposing the air to show its normal behaviour—about 9 per cent. quicker than is prescribed by the above relation. A similar variation was observed when hydrogen diffused itself in oxygen or carbonic acid instead of air. Granted that this deviation is in inverse ratio to the specific gravity of the gas, it would, in the case of the aforesaid graphite, amount to about 23 per cent. for hydrogen in comparison with nitrous oxide. The deviation is thus with such heterogeneous bodies as vulcanised caoutchouc and compressed graphite, not only of the same direction, but also of the same order, hence there is no ground for supposing that the gas, in its passage through a non-absorbent porous partition like a plate of graphite, should change its aggregate condition, and since the dependence of the constant D of a gas upon its specific gravity can only be considered a sign of the gaseous form of the aggregate condition of the diffusing body, it follows, then, that *gases cannot possibly exist in caoutchouc in a fluid form, and they retain also during their absorption by caoutchouc all the properties which belong to them as gases. Graham's hypothesis of the nature of absorption of gases must certainly, therefore, be regarded as false*, and a greater or less degree of penetrability of the layer for one or other of the gases

[1] The constant D for CO_2 in water is, according to my experiment, about $0·000025 \frac{cm^2}{sec}$. It depends neither upon the coefficient of absorption nor upon the coefficient of saturation. On the other hand it depends upon the viscosity of the fluid. If any body, *e.g.*, a crystalloid or a colloid, is dissolved in water, and a more viscous fluid is thereby obtained, the constant D decreases. This constant, however, as is shown by my experiments with glycerine in water, cannot be diminished at will by increasing progressively the viscosity of the medium in which the diffusion of the gas takes place. (See Wiedemann's *Annalen*, vol. iv. pp. 268-277, and vol. vii. pp. 11-23.)

has nothing—as Mitchell asserted—to do with its solubility or compressibility. *Just as little practicable is the chemical hypothesis upon what takes place in caoutchouc, and the absorption of gases such as nitrous oxide, carbonic acid, and hydrogen by caoutchouc must be considered as a purely physical phenomenon.* A layer of caoutchouc is, then, to be conceived as a *porous* substance, endowed with powers of condensing as well as of rarefying gases whose porosity is of the same order as the porosity of graphite. The motion of the gas takes place through the pores of the caoutchouc.

It is much to be regretted that Graham's experiments upon the passage of gases through metals were so conducted, that they cannot now be calculated with the help of the laws of the diffusion of gases in absorbent substances. I have been able to calculate only those numbers which, as they are not without interest, I will here communicate. They are the constant D for hydrogen in platinum at bright red heat, and D for carbonic oxide and hydrogen in iron at full red heat.

A platinum wire absorbed at red heat 0·17 volumes of hydrogen (taking the average of four experiments). A tube drawn out of the same mass of fused platinum, 0·11 centimetres in diameter, let 489·2 cubic centimetres of gas in the minute pass through a surface of 1 square metre; therefore

$$D = 0{\cdot}00053 \, \frac{\text{cm}^2}{\text{sec}}.$$

A tube of malleable iron, 0·17 centimetres in diameter, let 0·284 cubic centimetres of carbonic oxide and 76·5 cubic centimetres of hydrogen through the square metre in the minute. Since one volume of this metal can contain four volumes of carbonic oxide, so is for this gas

$$D = 0{\cdot}00000002 \, \frac{\text{cm}^2}{\text{sec}}.$$

Since the coefficient of absorption of this metal for hydrogen was less than four, so is the constant D for this gas greater than $0{\cdot}00000054 \, \frac{\text{cm}^2}{\text{sec}}$, whence it follows, if there can be any comparison between these two numbers, that in metals greater constants D belong to specifically lighter gases.

It has lately been asserted by Stefan that the constant D, in both water and alcohol, is greater for oxygen and nitrogen than for carbonic acid, and that the greatest constant pertains to hydrogen. It would be, however, premature to wish to draw from his experiments any conclusions with regard to the nature of absorption of gases in fluids.

Franz Exner has already shown, several years ago, that, on the passage of gases through a lamina consisting of a solution of soap in water, the interchanged volumes of two gases are directly proportional to their coefficients of absorption and in inverse ratio to the square root of their specific gravities. Hence Stefan has concluded that the constant D in fluids is in inverse ratio to the square root of the specific gravity of the gas, and that the gas molecules move by themselves and not in connection with the molecules of the fluid, which would correspond with Dalton's views on the nature of absorption in fluids. Meanwhile, these conclusions are contradicted by the experiments of Pranghe, who has shown that the above-mentioned relation in the case of the lamina is not at all borne out when pure unboiled linseed oil is used. We see from this, then, that what takes place in the case of fluids must be much more complicated, and that we must subject the matter to a much more searching and extended inquiry before we shall be in a position to say anything definite upon the nature of the absorption of gases in liquids.

S. WROBLEWSKI

NOTE ON PREHISTORIC STATIONS IN CARNIOLA [1]

THE most important of these prehistoric stations is the burial-field of Klenik, near Waatsch. During the year 1878 about 250 graves, covered with stone slabs, were opened at a depth of from ½ metre to 2½ metres. They contained skeletons, some remains of burnt corpses, and a great number of various objects. The bronze and other articles are very similar to those found in the well-known cemetery near Hallstadt, in Upper Austria. No Roman remains were met with. Thus there is no doubt of the pre-Roman age of these stations and cemeteries near Waatsch. They may be ascribed with great probability to the Taurisci, a Celtic tribe, known to have worked the salt at Hallstadt, and to have extended from Upper Austria, through Styria and Carinthia, as far as the Julian Alps. Strabo asserts explicitly that the very ancient landing-place Nauportus (now Ober-Laibach) was a settlement of this people, and, according to him, Italian merchandise was brought by carriage from Aquileja over Mount Okra (now Birnbaumer Wald), then by the River Savus to Siscia (now Sissek) and the Danubian districts. Thus it must be admitted that before the reign of Augustus a much-used water-communication existed on the Save and the Laibach between Siscia and Nauportus. The tradition ascribing the foundation of Emona to the Argonauts is an indication of the very remote beginning of this intercourse. Prof. Müllner, of Marburg, has lately offered some forcible arguments to the effect that Emona did not occupy the present position of Laibach, but was at the south end of the Laibach Moor, where Brundorf and Sonnegg now stand.

The graves, with skeletons, at Rojé, near Morants, contain objects referable to the Merovingian Period (fourth to seventh centuries); and a skull from one of them is of the type of those found in the successional sepultures.

[1] From the First Report of the Prehistorical Committee of the Vienna Academy, with 22 plates. By F. von Hochstetter and Ch. Deschmann. (*Proceedings*, Imper. Acad., July 3, 1879.)

GEOLOGY OF GREECE

1. *The Thessalian Olympus.*—In treating of the geology of Greece, as determined by a recent survey, Herr M. Neumayr, in the *Proceed.* Imper. Acad. Sciences, Vienna, July 17, 1879, describes this mountain-group as having a north and south direction, and consisting of a somewhat flattened dome of strata, with a subordinate syncline on the west. The limits on both sides are defined by lines of fracture. The constituent rocks are schists, of many kinds, with enormous intercalated limestones, at some places 3,000 metres thick. These latter are partly saccharoidal, partly semicrystalline, and sometimes nearly compact. In the last variety there are, in some localities numerous indeterminable organic remains.

2. M. Neumayr and L. Burgerstein state that the broad peninsular mass in South Roumelia, below Salonica, known as Chalkidiké (Chalcidica), is for the most part composed of micaceous and other schists, excepting its south-west portion and the Athos promontory. At some places considerable beds of marble are intercalated. The middle promontory of the three terminating the great peninsula is called Longos, and consists of gneiss, the oldest rock of the region.

3. The Island of Cos, according to Neumayr, consists for the most part of schists, marble, and Hippurite-limestone (with Rudistæ). The remainder is occupied by upper tertiary and diluvial deposits. Of the tertiaries the lower pliocene paludina beds strikingly resemble, in their fauna, the analogous Sclavonian deposits, and over them lie marine pliocene beds and rhyolitic tuffs; and eruptive rocks, trachytic in character, are also present. Being the extreme eastern member of the Cyclado-Sporadic series, traversing the Egean, and being connected with the neighbouring volcanic islands, Cos is well adapted to afford an insight into the nature of this submarine mountain-chain, and it yields an indication of the South-Egean basin being a depressed area of diluvial origin. The freshwater pliocene fauna offers interesting materials for the discussion of the upper tertiary freshwater deposits of the Egean region at present known, and of the evolution of the Eastern Mediterranean area. A number of passages have been collected by Prof. Hörnes from the Greek Classics, mentioning "giants' bones," which may point to places where remains of fossil mammals have been found.

NOTES FROM NEW ZEALAND

Wild Pigs and Wekas (*Ocydromus*).—Early in the spring of 1876 I spent several days in fern-collecting and botanising in the Malvern Hills district of Canterbury. Whilst so engaged, in many places I came across fresh pig-tracks and rootings, now and then sighting a boar. On one open hillside, bordered with fagus woods, I found three nests of that curious rail, the weka (*Ocydromus*); each of the nests contained eggs. It seemed remarkable that the nests should have remained unravaged by the wild pigs that were constantly roaming about the neighbourhood. It is highly improbable that the keen-scented swine were not aware of the weka's haunts. The trail of this bird is strong, readily followed by dogs; indeed, dogs take to this pursuit with so much of pleasure and relish that many good sheep-dogs become unreliable and almost worthless when they enter upon weka-hunting. It is a well-known fact that wekas usually abound in districts infested with wild pigs; they probably find their advantage in feeding on the varied forms of insect life disclosed in the soil upturned by the swine in rooting up ferns, spear-grass, &c.

The Kea (*Nestor notabilis*).—In NATURE, vol. iv. p. 489, I called attention to certain destructive habits developed in the Kea. Since the date when that notice was written the bird has become very much better known to sheep-farmers in the alpine districts. During the past winter sheep were attacked by the kea as far north as the Rangitata River; it is probable these birds came from the district known as the Mackenzie country, as they have been troublesome about Lake Ohou.

A New Zealand Gamekeeper's Return.—Naturalists may read with some interest perhaps the following return of animals killed by gun or trap, on a large estate in the Middle Island; the numbers given do not include animals that have been destroyed by means of poison, or "the bill of mortality" would have been very much heavier.

From January 12, 1879, *to August* 24, 1879

Wild pigs	108
,, cats	18
Rats	1,054
Falcons	10
Harriers (*Circus assimilis*)	790
Wekas (*Ocydromus*)	893
Pukekos (*Porphyrio melanotus*)	5,074
Paradise ducks (*Casarca variegata*)	175
Shags	9
	8,131

Ohinitahi, October 7 T. H. POTTS

SCIENTIFIC SERIALS

Journal of the Asiatic Society of Bengal, vol. 48, Part 2, No. 11, 1879, contains:—S. E. Peal, note on the old Burmese route over Patkai *via* Nongyang (viewed as the most feasible and direct route from India to China), with two maps and two plates.—Louis Schwendler, on a new standard of light, with a plate.—W. T. Blanford, a second note on mammalia collected by Major Biddulph in Gilgit.—Dr. J. Armstrong, Marine Survey Department, on some new species of hydroid zoophytes from the seas and coasts of India, with four plates.—Lieut. R. C. Temple, note on the formation of the country passed through by the 2nd column Tal Chotiali field force during its march from Kala Abdullah Khan, in the Khójak Pass to Lugári Bárkhan, in the spring of 1879, with a map.—W. T. Blanford, notes on a collection of frogs and reptiles from the neighbourhood of Ellore and Dumagudem.—J. Wood-Mason, preliminary notice of a new genus (Parectatosoma) of Phasmidæ, from Madagascar, with descriptions of its two species.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 11.—"On the Reversal of the Lines of Metallic Vapours," No. VII. By G. D. Liveing, M.A., F.R.S., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge.

The experiments of which the results are here given were all made with the powerful electric current from the Siemens dynamo-electric machine in limestone crucibles.

With sodium carbonate the green pair wave-lengths 4983, 4982 were reversed, showing dark lines in the middle of the bright ones, the less refrangible of the two giving the stronger dark line. The sodium line given by Lecoq de Boisbaudran at wave-length 4670 showed as a diffuse blue band with a *pair* of fine dark lines in it, of which the stronger and more lasting was the less refrangible. The diffuse blue band resolved itself into *two* diffuse lines as the sodium carbonate evaporated, and the measurement of their positions in comparison with a conspicuous titanium line, which lies between them, and was made to show at the same time by introducing a fragment of titanic oxide into the crucible, gave for this sodium pair the wave-lengths 4667, 4664. The red pair, wave-lengths 6160, 6154, were also seen reversed in like manner, but the authors failed to detect any difference in the strength or continuance of the dark lines in this case. The reversals of the red pair first ceased to be visible, next those of the diffuse blue pair, then the dark lines in the green pair, and then those in the yellowish green (5687, 5681). In some cases when a large quantity of sodium carbonate was put into the crucible a curious double reversal occurred. In the middle of an enormous dark expansion of D a bright yellow band appeared, which in turn had a narrower dark band, or a pair of dark lines, in its middle. A similar double reversal of the lithium blue line occurred so far as to show a bright line in the middle of the dark one. Of the two violet lines of potassium the authors observed that the more refrangible remained reversed longer than the other.

In addition to the reversals of calcium lines before observed by them, the authors have noticed the reversal of all the more conspicuous calcium lines of the G group and some others. The finer lines, wave-lengths 4434·3, 4454·5, slightly less refrangible than the strong lines 4434, 4454, were reversed, but only when one of the poles was a bar of iron, instead of carbon. The strong lines just mentioned were expanded so as to cover their neighbours, and all four lines were seen black against the bright background in the positions and of the same relative strengths as when bright.

When strontium chloride was put into the crucible twelve lines besides those before noted were observed reversed. Besides these, many dark bands were observed in the less refrangible part of the spectrum, of which three appear to be identical with bright bands ascribed to strontia, and one with a bright line given by strontium chloride.

Manganese, introduced as sulphate, gave with facility the violet triplet, as dark lines on the continuous background. The bright blue lines of manganese were not, however, reversed until some metallic magnesium was introduced. This brought out the reversal of the lines, wave-lengths 4753, 4783, and 4823, the last being the most easily reversed of the three.

Lead introduced in the metallic state gave a reversal of the violet line, wave-length 4058, which Cornu had previously seen reversed, but this reversal was far better seen, becoming a wide black band when the lead was introduced as an alloy with zinc. Probably the lead vapour was not so rapidly oxidised when mixed with zinc, and a thicker, if less dense, stratum interposed between the arc and the spectroscope. When lead ferrocyanide was used, not only the line above mentioned was reversed, but also, much less strongly, a line near it, wave-length 4062.

With zinc, only the less refrangible two of the three bright blue lines were seen reversed. The very bright lines, wave-lengths 4924, 4911, seen in the spark between zinc poles, were not seen at all in the arc, resembling in this respect the magnesium line, wave-length 4481, and the cadmium lines, wave-lengths 5377, 5336.

When cadmium was put into the crucible the lines, wave-length 5085, 4799, and 4677 were reversed, not the line, wave-length 4415. With a large dose of cadmium the red line, wave-length 6438, was once seen reversed for an instant only.

With silver, besides the reversals before observed by the authors, the line, wave-length 4053, showed a dark line in the middle of its expansion as noticed by Mr. Lockyer, but they could see no reversal of the line, wave-length 4208. Instead of the reversal of this line they observed that a second bright line came out close to it, rather diffuse, and about midway between the line 4208 and the calcium line 4215. This second line coming out near the other silver line gave the appearance of a reversal in the middle of a diffuse line, but besides the measurements made with a micrometer the authors assured themselves of the fact by watching the fading of the second line as the silver evaporated. The use of an alloy of zinc with silver did not alter the appearance of these two lines, or bring out a reversal of either of them. The authors failed to see any line of silver either bright or reversed with wave-length about 4240, as noticed by Cornu. With the carbons arranged vertically and the light viewed through the upper, perforated carbon, silver gave a channelled spectrum as described by Lockyer and Roberts. As this channelled spectrum was not seen with silver in any other arrangement of the crucibles, the authors are led to attribute it to a comparatively cool condition of the silver vapour ascending the carbon tube, a condition of near approach to a state of liquefaction.

Having observed that lines frequently came out with mixtures which were not visible when the separate ingredients were used, they tried a few amalgams. None of these showed any reversals of the mercury lines. But an amalgam of bismuth gave readily the reversal of the bismuth line, wave-length 4722, and with more difficulty that of the line, wave-length 4119.

Antimony did not appear to give any lines, or none easily distinguishable, in the arc.

With copper the reversal of two lines only were observed, wave-length 5105, 5153.

Iron introduced as metal, or as chloride, in the usual way, gave no reversal; with an iron rod used as positive pole instead of one of the carbons, the authors succeeded in getting the reversal of one line, wave-length 4045, which expanded and showed a fine dark line in its middle; but by passing an iron wire into the arc through the positive carbon, which was perforated, and pushing in the wire slowly as the end burned away, several of the brightest of the iron lines were reversed. The three violet lines, wave-lengths 4045, 4063, 4071, were the first to be reversed. They all expanded before showing reversal, and the order of reversal was that of refrangibility. Besides these seven other of the brightest lines were reversed.

Nickel, whether put into the crucible in the old way, or fed into the arc in small fragments filling a platinum tube which was passed through a perforated carbon pole, gave no definite reversal of any of its lines; nor did cobalt, even when a bar of cobalt was used as the positive pole.

Tin, palladium, and platinum gave no reversals.

It is worthy of remark in regard to the difficulty of obtaining substances chemically pure that the authors found that carbon poles which had been for some hours ignited in a current of chlorine and further intensely heated in the arc, while a current of chlorine was passed through perforations down their axes, still showed in the arc, of course without any crucible being employed, a multitude of lines amongst which the so-called carbon lines and those of calcium and iron were conspicuous.

December 18.—"On the Capillary Electroscope," by G. Gore, LL.D., F.R.S.

This paper contains a description of a modified form of the "Capillary Electroscope," together with full details of its construction and of the circumstances which affect its successful action. Numerous forms of the apparatus were constructed and a variety of solutions employed with the hope of obtaining an instrument capable of being employed for accurate measurements of feeble electromotive forces, but without success. The author is now engaged in examining the behaviour of a variety of liquids in the apparatus, and in completing an investigation of the causes and conditions of the movements. During this examination he has discovered the singular circumstance that in certain cases the mercury moves in an opposite direction to the electric current.

Mathematical Society, December 11.—C. W. Merrifield, F.R.S., president, in the chair.—The following gentlemen were elected members:—Mr. W. Burnside, Mr. J. R. Harris, Dr. W. Jack, Mr. W. J. Curran Sharpe, and Prof. W. Woolsey Johnson, St. John's College, Annapolis, Maryland.—The following communications were made to the Society:—Note on a method of obtaining the q-formula for the sine-amplitude in elliptic functions, by Mr. J. W. L. Glaisher, F.R.S.—Note on a numerical theorem connected with the cubical division of space, by the President.—Notes on Curvature, by Mr. J. J. Walker.—A property of a linkage, by Mr. A. B. Kempe.—Mr. Merrifield's note arose thus:—it is known that if space be cubically divided by three systems of orthogonal and equidistant planes, there must be an infinite number of ways of selecting points of the system, which shall be the corners of cubes obliquely placed and the theorem (*infra*) shows that the edges of such cubes will be commensurable with the unit of the system. Take $OA = OB = OC$, orthogonal to one another, and the co-ordinates of A, B, C referred to rectangular axes, rational numbers, it is shown that the length $OA = OB = OC$ is also a rational number. If $l_1\, m_1\, n_1$; $l_2\, m_2\, n_2$; $l_3\, m_3\, n_3$ are the co-ordinates of A, B, C respectively, then we have—

$$l_2 l_3 + m_2 m_3 + n_2 n_3 = 0,$$

and two other like equations. Also if

$$r = \frac{m_2 n_3 - m_3 n_2}{l_1} = \ldots = \ldots$$

then $(l_2^2 + m_2^2 + n_2^2)(l_3^2 + m_3^2 + n_3^2) = r^2(l_1^2 + m_1^2 + n_1^2)$, or $OB^2 . OC^2 = r^2 OA^2$. Therefore if any two of the three lines OA, OB, OC are equal, the third is rational. A few numerical examples are given:—

$$r = 9, \left\{\begin{matrix} -8 & 4 & 1 \\ 4 & 7 & 4 \\ 1 & 4 & -8 \end{matrix}\right. \qquad r = 21, \left\{\begin{matrix} -19 & 8 & 4 \\ 8 & 11 & 16 \\ 4 & 16 & -13 \end{matrix}\right.$$

$$r = 11, \left\{\begin{matrix} -9 & 6 & 2 \\ 6 & 7 & 6 \\ 2 & 6 & -9 \end{matrix}\right. \qquad r = 25, \left\{\begin{matrix} 9 & 12 & -20 \\ 12 & 16 & 15 \\ -20 & 15 & 0 \end{matrix}\right.$$

Values were also given for $r = 19$, 23, other values proved refractory. If the above are read as determinants, the groups are all symmetrical, 9, 11, 19 being symmetrical about both diagonals. The value of the determinant is always $\pm r^3$ as it should be, being simply the volume of the cube of which r is an edge. Mr. Glaisher pointed out that the diagonal about which there is symmetry has the sum of its terms $= \pm r$. The reason for this and why there should be symmetry, is not so apparent.

Geological Society, December 3.—Henry Clifton Sorby, F.R.S., president, in the chair.—Syed Ali, Wynne Edwin Baxter, Arthur Robert Boyle, Rev. John Lowry Carrick, M.A., Prof. Edward Waller Claypole, Rev. T. Dowen, Rowland Gascoyne, George M. Henty, John Marshall, Josiah Martin, Charles Maxted, Edward Provis, Thomas William Rumble, Rev. John Reuben Taft, Octavius Albert Shrubsole, Samuel Richard Smyth, and William Neish Walter were elected Fellows of the Society.—The following communications were read:—The gneissic and granitoid rocks of Anglesey and the Malvern Hills, by C. Callaway, F.G.S., with an appendix on the microscopic structure of some of the rocks, by Prof. T. G. Bonney, F.R.S., Sec.G.S. The author described the results of his investigations into the stratigraphy and petrology of the above districts, which have led him to the following conclusions:—1. The granitoid (Dimetian) rocks of Anglesey pass down into an anticlinal of dark gneiss (above) and grey gneiss (below). 2. Associated with the granitoid series are bands of felsite, hälleflintas, and felspathic breccias. 3. The succession of gneissic and granitoid rocks in Anglesey resembles so closely the metamorphic series of Malvern as to justify the correlation of the two groups. 4. The pre-Cambrian rocks of Anglesey and the Malverns, from the highest known member down to the base of the gneiss, may be thus classified:—A. Pebidian (to be described hereafter); B. Malvernian; (*a*) Dimetian, with associated quartz-felsites and hälleflintas (Arvonian) passing down into (*b*) Lewisian.—Petrological notes on the neighbourhood of Loch Maree, by Prof. T. G. Bonney, F.R.S., Sec.G.S. The author described the microscopic structure of a typical series of the Hebridean gneiss, and gave reasons for considering the mass of rock on the right bank of Glen Laggan to be not an intrusive "syenite," as has usually been supposed, but a mass of the Hebridean gneiss faulted against the *newer* series. By examination of specimens, collected both in Glen Laggan and at other points along the northern escarpment of the *newer* series, the author showed that its rocks have been rightly called metamorphic; and then, by comparison of these with specimens collected in Glen Docherty, he concluded that the latter belonged to the *newer* series, and that no part of the Hebridean series reappeared here.—On some undescribed Comatulæ from the British secondary rocks, by P. Herbert Carpenter.

Zoological Society, December 16.—Prof. Flower, F.R.S., president, in the chair.—Mr. H. Seebohm exhibited and made remarks on a collection of birds made by Captain the Hon. G. C. Napier, in the valley of the Atreck, near the south-east corner of the Caspian Sea.—Mr. R. G. Wardlaw Ramsay exhibited a specimen of *Pericrocotus flammeus* in an abnormal state of plumage, obtained on the Neilgherry Hills in Southern India.—Mr. Sclater exhibited a small collection of birds from the Island of Montserrat, West Indies, received from Mr. J. E. Sturge, of that island. This collection, though small, was of much interest, as nothing was previously known of the ornithology of Montserrat.—Mr. T. J. Parker read a paper on the intestinal spiral valve in the genus *Raia*. Mr. Parker showed that there were four types of valve exhibited in individuals of that genus, differing from one another in morphological characters, in the extent of absorption surface presented to the food, and in the resistance offered to the passage of food.—A communication was read from the Marquis de Folin on the mollusca of the *Challenger* Expedition of the genera *Parastrophia*, *Watsonia*, and *Cæcum*.—Prof. W. H. Flower, F.R.S., read a communication on the cæcum of the Red Wolf (*Canis jubatus*), in which it was shown that that animal differed from the majority of the *Canidæ* in possessing a very short and perfectly straight cæcum.—A communication was read from Mr. Edward Bartlett containing a list of the mammals and birds collected by Mr. Thomas Waters in

South-East Betsileo, Madagascar. The collection contained a new species of rodent belonging to the genus *Nesomys*, and two new species of birds of the genera *Cypselus* and *Zapornia*.—Dr. A. Günther, F.R.S., read the description of a new species of Dwarf Antelope, obtained by Dr. Kirk near Brava in the South Somali country. Dr. Günther proposed for this new species the name of *Neotragus kirki*.—A communication was read from Mr. Martin Jacoby containing the descriptions of new species of phytophagous coleoptera.—A communication was read from Prof. J. Reay Greene, F.Z.S., on a remarkable Medusa (*Charybdæa haplonema*), from Santa Catharina, Brazil.—Mr. Edward R. Alston read a description of a skull of a chamois with four horns, which had been exhibited at a previous meeting of the Society.—Mr. Henry Seebohm read a paper on certain obscure species of Siberian, Indian, and Chinese thrushes.

Physical Society, December 1.—Prof. W. G. Adams in the chair.—New Members—Mr. J. H. Poynting, Mr. R. T. Glazewood, Dr. R. C. Shettle, Prof. Rowland, Mr. John Gray, D.Sc., Mr. H. R. Brook, Mr. E. B. Sargent, Mr. E. Paterson.—On the graduation of the sonometer, by M. J. H. Poynting, Trinity College. The author had endeavoured to reduce the present arbitrary readings of the sonometer of Prof. Hughes to absolute measure by adapting the formula given in Maxwell's "Electricity," vol. ii. chap. xiv., to the induction of two circular coils on the same axis, separated by a distance greater than the radii of the coil, on a third coil intermediate. By applying the formula thus obtained to the results of Prof. Hughes for different metals, he finds that either the specific resistances of metals as given in the tables are not the same as the resistances of the metals employed by Prof. Hughes, or that the induction effect of the balance or sonometer is not proportional to the conductivity of the metal.—Prof. Ayrton reminded the Society that at a former meeting he had shown mathematically that the effect was not proportional to the conductivity, but to an exponential function of the conductivity. Mr. Chandler Roberts, F.R.S., stated that Prof. Hughes did not profess that the metals used by him to obtain his results were pure. Prof. Adams mentioned that Prof. Hughes had shown that the effect was dependent on other conditions than the mere purity of the metal.—Dr. J. A. Fleming, St. John's College, Cambridge, exhibited and described a new form of Wheatstone balance, designed principally for comparing the B.A. units of resistance deposited in the Cavendish Laboratory. The divided resistance is a circular platinum-iridium wire and an arm fitted with a contact at its extremity revolves round after the manner of circular resistance coils, thus altering the ratios of the divided resistances. The contact is a knife-edge of platinum, and it is made and broken by hand like a key. A series of ingenious copper mercury cups are fitted to the balance so as to permit of two coils being compared at any temperature with great exactness by the method suggested by Prof. Foster and adopted by Prof. Crystal, of Cambridge. This consists in exchanging the positions of the units on the balance and observing the difference in the results. By Dr. Fleming's arrangement this exchange can be effected without removing the coils from the heating apparatus in which they are placed or otherwise altering their conditions. The mercury contact cups and the heating cans were also improved by Dr. Fleming for the purpose of facilitating accuracy of results.—Prof. Perry described a dispersion photometer devised by himself and Prof. Ayrton for the purpose of comparing intense lights such as the electric with a standard candle without taking up much room, in order to put the stronger light at a distance from the screen proper, to give an illumination equal to that of the candle. To reduce the distance of the stronger light from the screen, the authors had inserted a lens in the track of the beam, so as to disperse the beam to a degree which could be determined by an easy formula. Thus by artificially diluting the powerful beam they could compare it with the feebler beam from the standard light in a shorter space. For an electric light of 6,400 candles only eight feet need be required by the new plan instead of eighty feet by the unassisted method. Dr. John Hopkinson, F.R.S., stated that he had actually used the same method for some months past in his electric light experiments. He recommended a plano-convex lens as the best to use, and suggested that the focal length should be calculated. He thought that the error due to absorption could easily be obviated.—Prof. Ayrton then described a method by which Prof. Perry and he had determined the value of g, or the coefficient of gravity at the Imperial Engineering College, Tokio, Japan, by means of pendulums. Their result is 980·06, and calculation from the position of the places makes it 979·8.—An improved form of spherometer, designed by Mr. W. Goolden and made by Mr. Adam Hilgar, was exhibited to the meeting. The frame is of aluminium, combining lightness and rigidity; the legs and screws of hard steel. The screw carries a drum divided into 1,000 parts, and the instrument gives a reading to the $\frac{1}{100000}$th of an inch by the usual method of touch. Increased sensitiveness is got by employing a galvanometer to indicate the contact of the middle pointer with the surface. By this means it is made correct to the $\frac{1}{500000}$th of an inch.

Anthropological Institute, December 9.—Edward B. Tylor, F.R.S., president, in the chair.—The President read some communications from the Rev. L. Fison and Mr. J. Forrest, on Australian marriage customs, which will materially assist in clearing away the difficulties which surround this interesting subject. Mr. Morgan in his "Ancient Society," says that amongst the aborigines of Australia there exists a state of communal marriage not found elsewhere, viz., that any man in a given tribe or class A is the husband of every woman in another class B. This view, however, Mr. Fison states, is not quite accurate, and he explains that men belonging to a class A can marry women belonging to another class B and no others; and that if a man from class A visit a station occupied by class B, he is provided during his stay there with a temporary wife. The offspring belongs not to either the father's or the mother's class, but to a third class C which is in its turn provided with wives exclusively from a fourth class D.—In the absence of the author the Director read a paper on savage and civilised warfare, by Mr. J. A. Farrer. It is interesting to note the existence of certain laws of war among the lower races, because it is generally assumed that they are only the product of an advanced civilisation, and the glory of a so-called civilised warfare. Even amongst the Khonds, it is necessary, previous to an attack, to allow the enemy to complete the same fetichistic ceremony as the offensive tribe itself performs.—The Caffres consider it shameful to attack their enemy without a declaration of war, and when war has broken out they refrain from seeking to starve him out; they spare the lives of women and children, and restore them after the war. The Canarians held it to be base and mean to injure the women and children of the enemy. War between civilised nations might well become a moral impossibility irrespective of any international treaty of disarmament. All that is wanted is a certain amount of human opinion and human will; of opinion, that quarrels may and should be settled peaceably, of will, that they shall be settled in no other way. Not more will is required than sufficed to put down the slave trade; nor is any stronger opinion needed than was enough for the extinction of duelling and torture.—Mr. Worthington G. Smith exhibited a collection of sixty specimens of Palæolithic implements chiefly from the valley of the Axe, many of them unusually large and heavy and in an excellent state of preservation.—Four water-colour portraits of Tasmanians were exhibited taken about forty years ago, and showing clearly all the physiognomical peculiarities of that interesting race.

Royal Microscopical Society, December 10.—Dr. Beale, F.R.S., president, in the chair.—Ten new Fellows were elected, and ten proposed for election at the next meeting.—The following papers were read:—Mr. Dallinger on a series of experiments made to determine the thermal death-point of known monad germs when the heat is endured in a fluid.—Mr. Gulliver on the classificatory significance of rhaphides in *Hydrangia*.—Prof. M. Duncan on a part of the life-cycle of *Clathrocystis æruginosa*.—Mr. Washington Teesdale on a simple revolving object-holder.—Amongst the objects exhibited were annelid jaws by Mr. G. J. Hind, sections of plants by Mr. G. J. Ward, a revolving table microscope for thirty objects, a Schmidt's microscope with spiral focal adjustment, and various hose-pieces and stage plates, by Mr. Crisp.

Meteorological Society, December 17.—Mr. C. Greaves, president, in the chair.—T. Buckland and J. Wigner were balloted for and duly elected Fellows.—The following papers were read:—On a sand-storm at Aden, July 16, 1878, by Lieut. Herbert H. Russell, 8th Regiment.—On a new form of hygrometer, by G. Dines, F.M.S. This is a modification of the hygrometer which was first described at the British Association meeting in 1872. The outside dimensions of the instrument, inclusive of the wood casing, are about 10 inches in length, 3 inches in breadth, and 2 inches in depth. The upper part consists of a vessel of thin metal, 6 inches long, 2½ inches broad, and 1¼ inch deep. Beneath this, and detached from it, but connected by a pipe, is a small chamber 2¼ inches long and 1¼ inch deep from back to front, standing about ½ inch more forward than the vessel above, and with a piece of thin, black glass in front. Inside this chamber, parallel to the front, is a division which separates it into two parts. This division does not extend quite to the top of the chamber, and is slightly turned over towards the front, so as to allow water to pass over it, and to induce the latter to flow more directly to the centre of the front of the chamber. The upper vessel is connected with the bottom and back part of this chamber by a small pipe with a tap to it, which is turned from the outside. The front of the chamber has a pipe attached to the bottom, passing upward in an inclined direction, and terminating at the outside in a small lip or spout. A thermometer, with the bulb inside and over the front of the chamber, passes through an india-rubber collar at the top of it, and is protected by a groove sunk in the face of the wooden case. The action of the instrument is as follows:—Water, of a lower temperature than the dew-point, is placed in the upper vessel, and, on the tap being turned, flows into the back of the small chamber, and thence, passing over the top of the middle division, flows downwards, cooling in its passage the thermometer and black glass, and eventually escapes by the small spout on the right side of the instrument. As soon as dew appears on the glass, the flow of the water is stopped by means of the tap, and the temperature is read off by the thermometer. When ether is used it is poured into the small spout, passes down the inclined pipe, and remains in the front part of the chamber. A piece of metal tube, ground so as to fit tightly the inclined pipe, and with an aspirator attached, is then inserted, and the dew-point is ascertained in the same way as by Regnault's hygrometer.—The diurnal range of atmospheric pressure, by R. Strachan, F.M.S. The author has compiled a table of constants from thirty places in various parts of the globe, which support Sir John Herschel's remark that "the diurnal oscillation of the barometer is a phenomenon which invariably makes its appearance in every part of the world where the alternation of day and night exists, and that within the Arctic Circle the diurnal dies out, or rather merges in, the annual oscillation."—Note on a curious fracture of a solar radiation thermometer, by G. M. Whipple, B.Sc., F.R.A.S.—Mr. R. H. Scott, F.R.S., exhibited and described a new form of sunshine recorder, which is to be used during the coming year at a considerable number of stations distributed over England.

Society of Telegraph Engineers.—At the annual general meeting of the Society on the 10th inst., the following gentlemen were elected office-bearers for the year 1880:—President—W. H. Preece. Vice-president—Prof. Foster, F.R.S., Carl Siemens, Willoughby Smith, Major Webber, R.E. Council—Prof. Adams, F.R.S., W. A. Andrews, W. T. Ansell, Sir Charles Bright, H. G. Ericksen, Col. Glover, R.E., Charles Hockin, Prof. Hughes, Louis Loeffler, C. E. Spagnoletti, Augustus Stroh, C. F. Varley, F.R.S., Members, and Alexander J. S. Adams, Capt. Macgregor Green, R.E., and J. T. Hill, Associates. Hon. Treasurer—Edward Graves. Hon. Sec.—Lieut.-Col. Frank Bolton. Secretary—F. H. Webb.—The Annual Report of the Council stated that fifty-nine new Members and Associates had been elected during the year. Among the losses by death the Society had to deplore those of Sir William Fothergill Cooke, Prof. Clerk Maxwell, and Mr. R. S. Brough. Special mention was made of the International Telegraph Conference, held in London in the summer, many of the most distinguished delegates being foreign members of the Society. Many valuable and interesting papers have been read during the session. The printing of the "Ronalds Catalogue," containing upwards of 12,000 entries, is being rapidly proceeded with, nearly 400 pages have been set up in type, of which 360 have been finally corrected and struck off. The valuable library bequeathed to the Society by Sir Francis Ronalds, including some hundreds of rare pamphlets, and constituting the most important collection of works on electricity and magnetism in the world, is being bound, and will shortly be available for the use of the members of the Society, and all students of electrical science. It was stated that steps were being taken for the incorporation of the Society, and that arrangements were in contemplation for the further development of its proceedings in respect to the purely scientific branch of electricity. The Society would be duly represented in the deliberations, being held to give effect to the proposal for the erection of a central hall to accommodate all the societies established for the encouragement of the applied sciences, towards which scheme Dr. Siemens had offered the munificent contribution of 10,000*l*. The financial position of the Society is very satisfactory.—A paper was read by Mr. E. Marsh Webb on the operations connected with the laying of the new Algiers-Marseilles cable, which led to an interesting discussion.

MANCHESTER

Literary and Philosophical Society, November 10.—Charles Bailey, F.L.S., president, in the chair.—Additional note on hydra, by Marcus M. Hartog, F.L.S.—On some undescribed hairs in Copepoda, by the same.—On an undescribed Acinetan, by the same.

November 18.—J. P. Joule, F.R.S., president, in the chair.—Recording sunshine, by David Winstanley, F.R.A.S.—On some notices in classical authors of the action of sunlight on purple dye, by James Bottomley, F.C.S.—On the origin of the word chemistry, by Carl Schorlemmer, F.R.S.

December 2.—R. Angus Smith, F.R.S., in the chair.—On a peculiar feature in the water of the well in Carisbrooke Castle, Isle of Wight, by Harry Grimshaw, F.C.S.—Note on the identity of the spectra obtained from the different allotropic forms of carbon, by Arthur Schuster, F.R.S., and H. E. Roscoe, F.R.S.

BOSTON, U.S.A.

American Academy of Arts and Sciences, November 12.—The following papers were presented:—On the relative replacability of the bromine in the three brombenzyl bromides, by Prof. C. Loring Jackson.—On a new form of astronomical level, by Prof. W. A. Rogers. This consists of a mercury surface to which any surface can be brought parallel by means of electrical contacts.—On orthobrombenzyl compounds, by C. Loring Jackson and J. L. White.—On measurements of the satellites of Mars, by Prof. E. C. Pickering. Prof. Pickering described the measurements of the position angles of the satellites of Mars, now in progress at the Harvard College Observatory. Instead of spider lines, two glass threads of such a diameter that they are visible without illumination are used. The settings are made accurately and rapidly by placing the lines so that they shall cut off equal segments of the planet and that the satellites shall be midway between them. The light of the planet is reduced by a shade glass, so that it can be seen at the same time as the satellite. The improvement of the method more than compensates for the increased distance of Mars, so that the observations are much more accordant than those taken in 1877. When the outer satellite is well seen, the probable error of the separate settings, compared with their mean, is less than half a degree. 180 settings of Deimos and 33 of Phobos have already been obtained.—Prof. Hagen read a paper on the destruction of insect pests by dilute yeast.—Prof. Trowbridge read by title a paper on dynamical ideas in the calculus.

CONTENTS

THURSDAY, JANUARY 1, 1880

GEOLOGICAL SURVEY OF THE UNITED STATES

IT will be in the recollection of geological readers that the chronic feuds to which so many independent United States Government Surveys with rival objects and officers gave rise, were last year referred by Congress to the National Academy of Sciences, and that, acting on the Report submitted by the Academy, Congress determined to abolish all the separate geological and geographical surveys then in existence under different Departments, and to consolidate the work under one establishment, to be termed the United States Geological Survey. In order, however, that the work already in progress might not be wholly lost or indefinitely postponed it was enacted that for the preparation and completion of the reports, maps, and other work of the Geological and Geographical Survey of the Territories, of the Geographical and Geological Survey of the Rocky Mountain Region, and of the Geographical Surveys West of the 100th Meridian under the direction of the Secretary of War, the sum of twenty thousand dollars, to be immediately available, should be given to each of these three offices. It is to be hoped that these provisions will suffice for the publication of several valuable memoirs which are known to have been in progress for some years.

One of the recommendations made by the Academy of Sciences was that a separate organisation should be provided for the surveys of mensuration, including the purely geographical and topographical work such as had been carried on by the Coast and Geodetic Surveys and the Land Office. For this fundamentally important and indispensable branch of the scientific examination of the country no special provision was, however, made by Congress; which is all the more to be regretted seeing that by the terms of the Act, so far as we can make out, the Engineer bureau was to be relieved of the important geodetic work it had so long and so ably been conducting west of the 100th meridian. There are ways indeed of driving a carriage and four through an Act of Congress, and the Engineers have shown themselves so able to hold their own under many successive administrations, that we wait with some interest to learn how far exactly their operations will be curtailed or modified.

The Act which constituted the new organisation of the Geological Survey likewise made provision for a Commission on the codification of the laws relating to the Survey and disposition of the Public Domain. Of this Commission the Director of the United States Geological Survey was *ex officio* appointed a member. The Commission began its work last summer in the Western Territories, and made rapid progress. Besides Mr. Clarence King, it included among its members Major Powell and Capt. Dutton, who have so long been known for their geological labours among the great plateaux and Cañons of the West. Doubtless the objects of the Commission were of paramount importance, and these three geologists, from their long and intimate knowledge of the Territories, were probably better fitted than any other citizens for carrying out rapidly and exhaustively the special inquiries entrusted to them. Otherwise some natural regret might be expressed that the services of such men should have been removed for practically a year from the geological work for which they have proved themselves so eminently qualified.

It is an excellent custom in the United States to define the time within which a Commission appointed by Congress is to send in its Report. This inquiry into the Land Laws and the classification of public lands was required to be completed within a year from the organisation of the Commission. We hear that the work is now finished so far as collecting evidence goes, and that the Report on the whole subject may shortly be expected. How long would a Royal Commission of similar nature and scope have lasted here?

The cessation of the labours of the Commission will free the geologists for the work of the Geological Survey. Much interest is felt as to the distribution of their staff and the areas over which it will be extended. Certainly no corps of geologists ever had a more magnificent opportunity of adding to the temple of science. They have large funds at their disposal, boundless territory, ground of surpassing geological interest, and the enormous advantage of a previous experience of many years spent in the West. Their doings are watched with particular care and even with some anxiety in the eastern States, owing to a curious episode after the passing of the Act establishing the Geological Survey. Subsequent to the appointment of the Director of the new organisation, an extra Session of Congress was held, in which a resolution was passed in the House of Representatives to the effect "that the Director may extend his examinations into the States." As this resolution was adopted on June 29 and the Session closed next day, there was not time to bring it before the Senate.

It will be seen that the addition of these words enormously widens the area of the Director's jurisdiction. As Prof. Dana complains, this area is "suddenly enlarged to the dimensions of the whole country from the Atlantic to the Pacific," and he adds that this was the view of the director himself, who had personally informed him "that it was his purpose under the Act, to send a party into New England next spring." We can hardly suppose that any such vast extension of the original scope of the Geological Survey was present to the minds of the representatives who passed the resolution. The additional words were probably meant only to authorise the work of the Survey to be prolonged into States adjoining the Territories, to such an extent as the necessities or advantages of the service might require. And this was a very proper addition. Geological boundary lines have seldom any close relation to political ones, even when physical features are used as lines of demarcation. But in America, where the limits of States and Territories are defined by meridians and parallels, it would be absurd to arrest a geologist's work in the middle of a prairie, or a cañon, or a mountain-range, because he had reached the limiting but invisible boundary of his territory. The idea of sending a party into New England looks like a joke, and as such we shall believe it to have been intended until authentic news of the arrival of the Survey party actually reaches this country. That it is not so regarded in the United States, however, is manifest by the flutter into which the geologists of the Eastern States have been thrown. We hear of the scheme being stigmatised as another example of the infringement of State rights, of the illegal assumption of State responsibilities, and of the danger to private interests as well as public morality to be apprehended from the temptations which such a vastly extended supervision would put in the way of the central authority.

The area in the West yet to be explored is so vast, the problems offered by it so numerous and so tempting, the field so free from "vested interests" of any previous explorers, that we cannot for a moment imagine that Mr. Clarence King and his associates, who, having already cleared a way for themselves through that wide West, know better than any other men its infinite variety and attractiveness, will trouble themselves with the geology of the East, where for generations past the labourers have been so many, and where, comparatively speaking, the field is so small and already so well tilled. With the humour of their countrymen they may have made use of the rather indefinite language of a congressional resolution to scare their less adventurous brethren in the Eastern cities. We would, therefore, counsel the geologists of the East to treat the matter as a joke. They have nothing to fear. It would be as absurd to give the Director of the United States Geological Survey control over the geology of all the States, as to make the Chief Constable of New York comptroller of morals for the whole of the Union.

A. G.

SAHARA AND SUDAN

Saharâ und Sudan Ergebnisse sechsjähriger Reisen in Africa. Von Dr. Gustav Nachtigal. Erster Theil, mit 49 Holzschnitten und 2 Karten. (Berlin, 1879.)

DR. NACHTIGAL'S wanderings came to an end more than six years ago. Most of his results have been brought at various times before learned societies and otherwise published, and the most important parts of his route are laid down in published atlases. The present work contains a detailed account of his entire travels and observations. The book now under consideration is only an instalment extending over his journey up to the end of the year 1870; a second is to follow. The volume is a large octavo of 750 closely printed pages with an appendix containing meteorological observations.

Dr. Nachtigal undertook the duty of conveying to the Sultan of Bornu, the country surrounding Lake Tsad, a present sent by the Emperor of Germany in acknowledgment of the hospitality and assistance afforded by the Sultan to the German travellers, Barth and Overweg, Vogel, von Beurman, and Rohlfs. In his journey from Tripolis to Bornu the author passed along the caravan route traversed before by Denham and Clapperton in 1822-23-24, and by Barth and Vogel in 1849-55, and also by Rohlfs. During all this portion of his journey he was therefore on ground comparatively well-known from the writings of the above travellers. He made however three long excursions to the eastward, one into Tibesti or Tu, another to Borku, and a third into Bagirmi to the south of Lake Tsad; finally he made his way eastward from Lake Tsad across Wadai and Darfor, to Chartum.

Of the present volume more than two-thirds is occupied with the account of the journey along the direct route between Tripolis and Bornu, and an account of Fezzan, and of Bornu and its capital, Kuka. The remaining third of the book relates to the journey into the unexplored region of Tibesti and is thus the most interesting and important portion of the work.

Lake Tsad lies almost due south of Tripolis and the caravan route follows an almost straight line between the two points. Dr. Nachtigal left Tripolis on February 18, 1869, and after his wanderings in Tibesti and many mishaps reached Kuka in June 1870. At Tripolis, and also in Murzuq he frequently met with the well-known traveller, Miss Tinne, of whose history and deplorable murder by the Tuaric he gives a full account. Miss Tinne or "the King's Daughter," as she was called by the inhabitants of the country, excited the greatest curiosity and was believed to possess supernatural powers. One story circulated about her at Murzuq was to the effect that her large pet dog which travelled with her was a bewitched man and changed into the human form from time to time.

The fourth chapter deals with the natural characteristics of the district of Fezzan. So scarce and dear are mutton and goats' flesh in Fezzan that recourse is had to minute crustacea and the larvæ of diptera from lakes of brackish water as food. The Bahâr-el-Dûd, or "worm lake," is so full of the larvæ and of the crustacea, the cosmopolitan inhabitant of salt water lakes, Artemia, that the inhabitants collect these animals in masses and knead them up with dates and an alga which also grows in the lake to form a repast which is highly esteemed. An Artemia occurs in the Great Salt Lake in Utah; the species in the present case is *A. Oudneyi.*

A long chapter on the climate and diseases of Fezzan follows, in which the maladies are described with an amount and character of detail which, though highly valuable, is perhaps more befitting a strictly medical publication than a general book on travel with a more or less popular aim. Similar medical details are given throughout the book and sometimes seem very much out of place. The native notions of medical treatment are curious and primitive. Thus patients suffering from cancer of the breast must most carefully abstain from all food derived from animals provided with tails, even such as milk and butter. To promote fruitfulness in women young suckling hares are prescribed. No one in Fezzan doubts that it is possible for a child to remain dormant within the mother for years or even for ever and this theory is most conveniently made use of when mishap necessitates it by wives whose husbands have been absent on very long journeys. As an aphrodisiac the fat of a Manatee, *Manatus Vogellii,* is used. The drug is sold at a high price being brought from the River Binüe a tributary of the Kowara in which the animal is abundant. Diseases are believed to be caused either by evil spirits or by the action of the evil eye.

During his exploration of Tibesti Dr. Nachtigal experienced many dangers and difficulties, losing his way, and suffering from want of water and forced night marches. A very interesting account is given of the ceremonials observed by the Tubu people in greeting one another. A most elaborate performance is gone through when two strangers meet in this wild country. Each of the performers covers all his face but his eyes with his turban, seizes his spear and throwing iron (a curious boomerang-like weapon with a long projecting prong on the concave margin), and thus prepared the two approach one another. At a distance of about six steps from one another they squat on their heels with spear upright in one hand and iron in the other. The one then asks "How do you do?" about a dozen times by means of four different words having that meaning used alternately, the reply being varied of the use of two words Laha, or Killala.

Then one of the two loudly sings the word "Ihilla," which is returned by the other in a similar tone. The word is exchanged again and again, being commenced in a loud high pitched note and gradually run down the scale until it reaches a low bass murmur. When it has become so low as scarcely to be heard, on a sudden it is shouted again in high key and the gamut is run through as before. This goes on for a very long while, the performers going through it as a strict matter of ceremony, and taking no interest in one another all the while but looking round at the horizon or elsewhere during their vocal exertions. After a while various forms of the question "How are you?" and the answer "Well," are introduced, at last questions or other topics are brought forward, although now and again the "Ihilla" bursts out in the midst of them, but the series of notes in which it is shouted becomes shorter and shorter. At last the Ihilla is got rid of altogether and ordinary conversation becomes possible. Strangers do not shake hands, but acquaintances do. The covering of the face when greeting or meeting strangers is considered as a most important matter of etiquette.

In the Zuar Valley the large baboons (*Cynocephalus babuin*) were met with in great numbers climbing on the rocks and trees, and, on account of their greenish grey colour, hardly to be distinguished from the tree trunks and stones. They tumble about amongst trees beset thickly with thorns many inches long without hurt. The Tubu do not molest them, partly because they are afraid of their strength and partly from superstitious motives.

On the cliffs bounding the river Udêno, near Bardai, in the centre of Tibesti, the author found a series of rude drawings of the same kind as those discovered by Barth in the north-eastern Tuârik region. The drawings are incised on the stone and represent almost without exception oxen with the horns bent forwards, all of which have a rope attached to the horns and drawn forward as if they were being led by it; some have on their backs the pack-saddle now used for oxen in Sudan. That the drawings were not inspired by reminiscences of the pack cattle of Sudan is shown by the circumstance that the leading rope is attached to the nostrils of the oxen and by the absence of the hump in them. The drawings are probably very ancient and date back from a time when cattle were used as beasts of burden in the country, and camels as yet not introduced. Barth remarked on the entire absence of the camel from amongst the very numerous drawings examined by him, in the present instance one drawing of a camel does occur, but Dr. Nachtigal thinks it has been probably added by a later hand in imitation of the ancient drawings. There is one figure of a man, a warrior of life size, with a spear in one hand and in the other a shield of a different form from that now used in Tubu and curiously enough divided into four fields by a cross.

Dr. Nachtigal had a hard time of it in Bardai, being kept a prisoner in his camp and cruelly stoned by crowds of girls of 12 or 14 years of age, if he attempted to move out. The children evidently thought it good fun stoning him as well as their religious duty to do so. They watched him closely in case he should dare to steal out during quiet hours and rallied one another with the shout of "at the heathen." Sometimes a drunken man joined in the sport with his throwing-iron and made matters very serious indeed. It was of no avail for Dr. Nachtigal to give the children sugar, or other presents, or to attend the sick; as soon as the presents were secured or the visit to the patient completed, the volleys of stones came flying as before. It was just before his flight from Bardai that Dr. Nachtigal heard of the murder of Miss Tinne; the news hastened his departure, and he returned to Fezzan.

A chapter is devoted to the natural productions of Tu. The best camels of the Eastern part of the Great Desert are bred by the Tubu. They belong to that variety of the animal which is peculiar to the Central and Southern Sahara, and which is distinguished at first glance from the Northern or Arab camel. The latter has short limbs, stout body, heavy head and neck, and shaggy hair; the former is higher on the legs and lighter built with smooth hair. The Arab variety looks built for weight-carrying, the Tuarik animal for pace.

The fat-tailed sheep of the coast does not occur in Tibesti, the sheep of the region having long legs, a long thin tail and pretty long black shining hair instead of wool.

The throwing irons of the Teda are curious weapons of boomerang form beset with projecting prongs of various shapes. They are double-edged in parts and single-edged with a stout back in others. The handle is bound with leather to give a firm grip.

The weapon is thrown horizontally with great precision and terrible effect. Children practise with a piece of bent flattened wood sharpened on one edge in imitation of the throwing iron and carry also a wooden-tipped spear. Being thus accustomed to carry weapons in their hands all their lives, the full-grown men when they are about their dwelling-places where they are strictly forbidden by custom to carry actual arms, return to the weapons of their childhood and carry about the wooden spear and throwing weapon.

The illustration given by the author of his reception by the Sultan of Bornu may be compared with the similar reception accorded to Denham and Clapperton so many years ago, and with their illustration of the ceremony. The then Sultan when he received Denham and Clapperton was concealed behind a lattice which was dispensed with in Dr. Nachtigal's case. Amongst the presents conveyed by the present author were life-sized portraits of the King and Queen of Germany and of the Crown Prince.

We cannot follow Dr. Nachtigal further, or pick out more interesting matter. The book seems to us rather too long and somewhat spun out; it is most sumptuously got up, with two large maps, well bound, and is full of good illustrations. Of these latter no list is given nor any information as to the sources from which those which have appeared before are derived. The familiar figure in Denham and Clapperton's work of a mail-clad warrior and horse of Bornu is copied without any kind of acknowledgment. Very slight differences have been made in the present figure: thus in it the great toe only is placed in the stirrup instead of the whole foot, as in the original, and the spear-blade is double instead of single, whilst the helmet has a plume added, but all the rest is directly copied without any reason being given for the alterations. A most remarkable defect in the book, considering that it is German and scientific, is the almost entire absence of references to former works of all kinds. As far as we have been able to discover there are only two references to other books in the entire work, one to Fournel's "Les Berbes," the other to the publications of the German Geographical Society. Though Barth and Duveyrier are mentioned and their views are quoted, no references to their writings are given. And Denham and Clapperton are entirely ignored even in the account of Bornu. A serious drawback is that the book is published so long after the travels to which it relates were completed. We hope that the second volume may not be long in appearing. We understand that the book is shortly to be published in English. It is full of interesting and valuable matter and of scientific details.

THE SCIENCE OF AGRICULTURE

First Lessons in the Science of Agriculture; for Use in Indian Elementary Schools or Classes. Pp. 67. By J. B. Fuller. (Calcutta: Stanhope Press, 1879.)

THIS little primer is issued under the authority of the Department of Agriculture and Commerce, North-West Provinces and Oudh. If its teachings be accepted and followed by those for whom they are intended, increased and improved crops must be the consequence. Of course, within the narrow limits of some seventy small pages, we cannot expect to find the scientific basis of the art of agriculture fully developed; indeed, the explanations of the materials and processes with which Indian farming is concerned are neither numerous nor full. But to show clearly a few of the worst mistakes made by Eastern cultivators of the soil, and to indicate remedies and improved methods of procedure in but half-a-dozen cases, is a useful beginning of an important work. We note, in passing, a few examples of the recommendations, based upon scientific knowledge, which Mr. Fuller makes in these "First Lessons." On p. 7 the usefulness of a good tilth and of a feeding-ground deepened by thorough ploughing for crops during seasons of drought, is illustrated and enforced. We learn from pp. 26 and 27 that due importance is not generally attached to the selection and securing of the best varieties and qualities of seed for sowing the fields. Too often they sow any seed they have by them, the produce of their own fields, and often of inferior quality. Good kinds of grain, &c., are thus found to be confined to one village, though they might be grown successfully in many neighbouring places. Thus, the village of Jaláli in the Aligarh district is well known for its fine white wheat; Sánkni, in Bulandshahar, for its safflower; some districts north-west of Allahabad for indigo, and Hinganghát for cotton. The value of new plants to India is discussed on pp. 31 and 32, the cases cited being tea, the potato, reana, and Egyptian cotton. Passing over a chapter in which some elementary facts about plant-food are given, we find many useful remarks (pp. 37 to 44) on the fertility of the soil and the means of restoring or increasing it. Here we are introduced to *reh* and *usar*. The former term is applied to the saline efflorescence, which, in some seasons especially, appear in many tracts of land in the North-West Provinces and elsewhere in India. *Reh* consists mainly of sodium and calcium sulphates, with some common salt and nitrates. The *usar* plain is infected with *reh*, but I cannot agree with Mr. Fuller in condemning the usar soils as sterile through deficiency of plant-food (p. 38). My analyses of such soils gave in most cases no evidence of deficiencies in the mineral elements of plant-nutrition, they merely showed an excess of soluble salts. What Mr. Fuller says about the best way of getting rid of *reh* is very judicious, so are his remarks about the sad waste of animal and vegetable residues (including indigo waste, and the bones of bullocks and buffaloes, in India)—residues which, instead of being burnt or neglected, should certainly be much more largely than at present ploughed into the land. His contrast between the work of the Indian plough and the English, the latter doing in one ploughing what the former needs twelve ploughings to accomplish, should be of some real service, especially as the new English-pattern ploughs made at Cawnpore are very light, and do not cost more than eight rupees apiece. By the use of this improved implement the "pan," which has been formed two or three inches under so large a tract of Indian soil by the rubbing of the old ploughshares and the trampling of the bullocks, would be broken up, and the rains would penetrate and moisten a much greater depth of soil. Mr. Fuller illustrates the advantage of increasing by such deep ploughing the depth of water-holding soil. He says: "In Madras, in the year 1878, when there was a great famine from the failure of the rains, some land was ploughed with the European plough, and some with the native plough, on the Government farm. Neither was irrigated, and both had to depend for their water on the little rain that fell. The European-ploughed land gave a rice-crop of six maunds per acre; the native-ploughed land did not yield a single grain." The two last lessons in this useful little book contain some quite satisfactory explanations as to the respective merits of canal and well water, and of thin and thick seeding in India. A. H. C.

OUR BOOK SHELF

On the Crystallography of Calcite. By J. R. McD. Irby, B.Sc., of Lynchburg, U.S. (Bonn: Charles Georgi, 1878.)

ONE is pleased to find that, in an essay on the crystallography of calcite, by a gentleman who has received his training in America and Germany, the system of representation used by Prof. Miller has been adopted, and not the objectional modification employed by Professors Groth and Dana, jun. One regrets that the paper is unaccompanied by a stereographic projection, which would have much simplified the discussion of the distribution and position of the forms.

The original part of the essay consists of a criticism and redetermination of some forms involving very high indices on crystals examined by the late M. Hessenberg. The measurements were made with one of the goniometers devised by Prof. Groth, which gives definite results when the faces are good. The collimator and telescope are fixed, however, at right angles to one another, so that the determination of striated faces, such as many of those examined were, is difficult and uncertain. Much more reliable measurements would be obtained were the angle between collimator and telescope small, and it would be very easy to arrange the collimator so that the angle of incidence and reflection might be varied at will. Prof. Miller used to arrange his goniometer so that the angle between the incident and reflected ray was less than 20°, and was thus able to get rid of a good deal of the difficulty arising from striation.

Mr. Irby has guarded himself from error by the comparison of several independent observations of the angles made by a new face with those adjoining it, with the angles obtained by calculation, and has avoided employing the angles made with faces on more distant parts of the crystal, though the latter would be often better adapted for purposes of calculation. He criticises Prof. vom Rath's method of observation by taking the reflection of a window-bar as signal. The error which would thus arise would not exceed 1′ in the case of good faces, and I believe Prof. vom Rath only employs this method of observation with very good faces. Another source of error would be due to the proximity of the signal which would give a considerable error if the edge were not well-centred. Moreover, a goniometer with vertical plane of reflection is very difficult to get into or keep in good adjustment, and errors might arise in this way. None of these errors will, however, account for the impossibility of getting simpler indices for the form $\{35, 17, \bar{32}\}$, considering how definite were the angles obtained from the several faces of the scalenohedron. A careful criticism of this form at the time it was published, and of all the different ways in which errors might be piled up in the course of the analysis, failed to lead to any result but that of admitting the possibility of forms with these high indices. In the Cambridge collection is a crystal of quartz with an extremely well-developed face, which Prof. Miller has determined to be $\{50, \bar{19}, \bar{19}\}$. It is very slightly rounded on the edge of the prism face. Of course, when the faces are rounded or otherwise distorted, indices calculated from the observations are mere approximations. Seeing the great variations which occur in the angles of well-crystallised minerals, good work might be done in testing the constancy of the angle of the cleavage rhomb in the specimens from different localities. Breithaupt's determinations of this angle are unfortunately not sufficiently reliable.

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.*]

The Molecular Velocity of Gases

YOUR correspondent, M. Hajniš, asserts in a foot-note appended to his letter published in NATURE, vol. xxi. p. 176, that "the formula for the molecular velocity (of gases) was first given by Krönig," and not by Joule. I am at a loss to understand how this statement can be justified.

Krönig's paper appeared in 1856, while Joule's calculation, which is that now generally received, is of date 1848. In his discourse on molecules (*Phil. Mag.*, December, 1873), Prof. Maxwell says: "The further development of the theory is generally supposed to have begun with a paper by Krönig, which does not, however, so far as I can see, contain any improvement on what had gone before." R.

Weaver Birds and Fire-Flies

UNDER the heading "Natural History Notes from Burmah," in NATURE, vol. xx. p. 362 of the present series, Mr. R. Romanis asked if any of your readers have ever seen or heard of weaver birds sticking fire-flies to lumps of mud on the sides of their nest for the purpose of illumination.

The tradition that certain birds of the weaver family (*Ploceidæ*) and their allies do this, is prevalent over a large portion of the globe inhabited by these birds. I have traced it personally from China, all parts of India, Burmah, Ceylon, the Malayan Peninsula, Indian Archipelago, Southern, Eastern, and Western Africa, and South America. I have examined "weaver birds'" nests from all these countries, and have found lumps of mud sticking inside them, and "*therefore it must be true, you know!*"

But for what use are these lumps of mud stuck there?

Some years ago I wrote an article in the *Cape Monthly Magazine* on this very subject, entitled "Strange Stories and their probable Origin," and I started by saying "Where there is smoke there must be fire," quoting the old proverb.

My belief is that these lumps of mud are used as *scrapers* on which to clean the birds' bills, as I have frequently found the wing cases, and other *débris* of *Coleoptera*, &c., fixed to them. Hence the superstition that they stick fireflies thereon. I should remind your readers that all the "weavers" are grain feeders, and perhaps only occasionally partaking of insect-food, they are bothered by the bits sticking to their bills. I see my tamed birds are most careful in cleaning their beaks.

At the time I wrote my article above alluded to, I was not so conversant with the African "hang-nests" as I afterwards became, but I can affirm that in all the places I have named the superstition, *and the mud*, is to be found. E. L. LAYARD

British Consulate, Noumea, October 22, 1879

The Papau

PERMIT me to add to my friend the Rev. S. J. Whitmee's testimony of the papau being eaten by birds in the Samoan Islands, that it is here (New Caledonia) a favourite food of the "white eye" (*Zosterops*), and in the Loyalty Islands was used as the only bait to attract these birds, of which dozens were brought me—of the three known species of that genus which inhabit that group (see my letters to *Field* newspaper) all caught by the boys through its means. If my memory serves me rightly, I have seen the papau in Mauritius eaten by a species of *Zosterops*. E. L. LAYARD

British Consulate, Noumea, New Caledonia,
October 22, 1879

Scale of Colours

IN NATURE, vol. xxi. p. 172, it is stated that at a meeting of the Zoological Society, December 2, 1879, "A letter was read from Mr. E. L. Layard, F.L.S., advocating the desirability of a fixed scale of colour for use among naturalists in describing the plumage and pelages of birds and other animals." Perhaps Mr. Layard is not aware that such a scale, in form of thin 8vo, was published by Patrick Syme in Edinburgh, in 1821, the tints being illustrated by carefully coloured examples. The exact title of the work, a copy of which is in my own library, is as follows:—"Werner's Nomenclature of Colours, with Additions, arranged so as to render it highly useful to the Arts and Sciences, particularly Zoology, Botany, Mineralogy, and Morbid Anatomy. Annexed to which are Examples selected from well-known Objects in the Animal, Vegetable, and Mineral Kingdoms." The date given above is that of the second edition, which was "Printed for William Blackwood, Edinburgh, and T. Cadells, Strand, London." L. BLOMEFIELD

Bath, December 22, 1879 (late JENYNS)

On the "Habitat" of Lophiomys

ON reading the review of "Cassell's Natural History," vol. iii., given in NATURE, vol. xxi. p. 136, I find that both the author and the reviewer do not appear to have been aware that the "habitat" of that most interesting rodent, *Lophiomys imhausi*, is well known. The rich and interesting Museo Civico di Storia Naturale, of Genoa, amongst its many rarities, contains a magnificent specimen of the *Lophiomys*, mounted skin and skeleton, which specimen was caught at Keren in the Bogos land, in June, 1870, and forms part of the fine collections made at that place by Dr. Beccari and Marquis Antinori. The native name of the *Lophiomys*, according to Antinori, is *Tzechiza*.

The reviewer cites M. Alphonse Milne-Edwards's impression of the resemblance of *Lophiomys* to certain opossums, a point in which I cannot completely agree; my impression is that this very remarkable rodent offers one of the best cases of "defensive mimicry," being strangely like a Viverrine carnivore in outward appearance. The granulation of the upper portion of the skull, which extends to the upper surface of the first cervical vertebra, is very peculiar; but it is not strictly correct to assert that nothing of the kind is met with in other mammals; in the very same order, Rodentia, we find a very similar structure in the cranium of the Paca (*Cœlogenys*), and I believe some allied forms.

HENRY HILLYER GIGLIOLI

Reale Istituto, Florence, December 17, 1879

On Haloporphyrus lepidion (Risso)

I HAVE recently had occasion to examine two specimens of this rare and remarkable gadoid fish of the Mediterranean, originally described as *Gadus lepidion* by Risso ("Ichthyologie de Nice," p. 118). The first was captured in my presence in the Gulf of Genoa, in July last, from a depth of about 900 metres, the second I received from Nice, where it was captured in deep waters on September 1 last, and I know of a third specimen taken at the latter place. All agree perfectly with Risso's description except in the general colour, a light brown, and not "*un beau rouge incarnat*," while Risso appears to have overlooked the presence of a small patch of vomerine teeth. But our Mediterranean specimens present notable differences from that described by Dr. Günther ("Catalogue of Fishes," iv. p. 358), and referred by him to this species; besides being considerably larger, the British Museum specimen, which is from Madeira, has a much smaller eye and much longer snout and barbel. Such differences *might* depend on age, but I am strongly inclined to consider them specific, and therefore beg to draw the attention of ichthyologists to the case; should my opinion prove correct, the Madeiran fish might go by the name of *Haloporphyrus güntheri*.

While rapidly completing the rich series of fishes belonging to the central collection of Italian vertebrata, formed by me in the Florence Zoological Museum, I have recently been able to add thereto a second very rare gadoid, the *Physiculus dalwigki*, Kaup, a new acquisition to the Mediterranean fauna. My specimen was captured at Nice on August 4 last, and strange to say was sent to me as *Uraleptus maraldi*.

Reale Istituto, Florence HENRY HILLYER GIGLIOLI

Edison's New Lamp

I OBSERVE in NATURE, vol. xxi. p. 187, a statement to the effect that Mr. Edison has adopted the use of carbon in his new electric lamp, and that the carbon he uses is charred paper or card of the shape of a horse-shoe.

Fifteen years ago I used charred paper and card in the construction of an electric lamp on the incandescent principle. I used it, too, of the shape of a horse-shoe, precisely as, you say, Mr. Edison is now using it. I did not then succeed in obtaining the durability which I was in search of, but I have since made many experiments on the subject, and within the last six months I have, I believe, completely conquered the difficulty which led to previous failure, and I am now able to produce a perfectly durable electric lamp by means of incandescent carbon.

JOSEPH W. SWAN

Underhill, Low Fell, Gateshead, December 29, 1879

Flow of Viscous Materials

MR. BOTTOMLEY, in his paper on this subject in NATURE, vol. xxi. p. 159, refers to experiments made four years ago, but if he refers to the *Philosophical Magazine*, vol. xxvi. 206, 1845, he will find a notice of an experiment made twenty-four years ago. It occurred thus:—A barrel of pitch, with one end partly knocked out, had been lying in the sun for some months, and a part of it had run out on the ground.

My late partner, Prof. L. Gordon, visited the wire-rope works one day in August, 1844, and I called his attention to the appearance of the pitch as being a good illustration of Prof. Forbes's theory of glaciers; thereupon he wrote the letter referred to; which is also quoted in Forbes's "Theory of Glaciers," p. 269.

Any sort of pitch, such as that obtained from gas tar, will answer the purpose. If the surface is rubbed over with some white material, the formation of crevasses will be well shown; and if a row of pins are stuck into the pitch about an inch and allowed to project they will soon lose their perpendicularity and thus indicate the movements in the model glacier. The rapidity of flow of course varies with the temperature.

I had a curious illustration of the power of plants in forcing their way through resisting materials. I had covered the ground with about two inches of asphalt, and a dandelion pushed its flower and leaves through this viscous mass.

Ferndene, December 28, 1879 R. S. NEWALL

Hungarian Earthquakes and the Kolumbács Flies

A NOTE in NATURE, vol. xxi. p. 89, speaking of the recent Hungarian earthquakes, contains, amongst others, the following passage:—"Near Weisskirchen, the old ruins of the Castle of Golubacz have fallen in completely, and in the vicinity several caves were rendered inaccessible. These caves were the *breeding places* of the dreaded Kolumbács mosquitos, and if this insect is thus exterminated the earthquake may, with all the damage it did, have yet been of some use."

This report is based on obvious error, for it is a well-known act that the small (3-4 millim. long) Kolumbács flies (*Simulia golumbacensis*, Fabr.), which, in the southern part of Hungary, especially in the old Banat and the county of Hunyad, cause considerable damage among the pasturing cattle (especially among horned cattle, horses, swine, and sheep), breed by no means in those caves which are to be found around the ancient Galambócz (known nowadays under the name of Golubácz or Kolumbács, on the Servian territory), but in the shallower parts of the waters extending in great quantities in that country. The course of life of the Kolumbács fly is, for the most part, in conformity with that of many families of the Nemocera, or Tipulariæ group, as are the Culicidæ, many species of flies (Brachycera), the Phryganidæ, &c. The mature and fecundated mother-fly lays her eggs upon the plants vegetating on the water-borders, whence they get on the stones under the water, and other objects, there living through their larva and nymph states until they arrive at their full development.

But, in the first years after 1850, under the rule of the Austrian military system of that time, there did occur the curious fact that —upon the advice of a military officer of the frontier-districts, who, as it was supposed, had made out that the breeding-nests of these flies are in the caves around Galambócz, Old Moldavia, and their environs—the Government of Vienna officially decreed the walling up of the openings of the caves. And actually they were walled up. But in the next mild spring, the conditions of development being favourable again, the Kolumbács fly appeared and ravaged once more. The Viennese Government, on learning this unpleasant and disappointing news, hastened to amend the blunder, and sent to the place a Hungarian *savant*, Vincent Kollár, and a German entomologist, Joseph Mann, to take the question under examination. These, in a brief space of time, succeeded in clearing up the true state of things, and in gathering such a series, as contained all the stages of the development of the Kolumbács fly in numerous specimens. This collection is to be seen now in the entomological section of the Naturalien Cabinet of Vienna, grouped in the best order.

The imputation, therefore, as if it were the Hungarians who had walled up the orifices of the caves in the vicinity of Galambócz, in order to exterminate the Kolumbács flies by that means—an opinion which, as I, this year, happened to hear at the lecture of an eminent German *savant*, is propagated even in Germany—is entirely erroneous and without any foundation.

Budapest, December 2 JULIUS LETHÖ

Unconscious Thought

RESUMING this subject, I again call attention to the circumstance that unconscious thought in children is more developed than conscious thought, though conscious thought or sensation lays the foundation of what becomes habitual or instinctive. In man, unconscious thought becoming habitual, it is the nursery again of conscious thought, the two conditions in the adult coexisting.

Turning to comparative psychology, a branch which has always appeared to me of particular importance, we find in intelligent animals, as the dog, either in community (commonly called wild) or in the domesticated state, the same nature of mind as in man and the like manifestations. In the young animal, however, there must have been the same precedent stage, though the conscious stage is of course produced earlier than in man.

This raises the question, on which we can speculate, but which we cannot as yet solve, whether some animals are not mostly in the state of unconscious thought, never attaining to that of conscious thought. Looking to the cases of degradation in man, it appears to me that in softening of the brain the man falls back to the unconscious stage, and in some instances remains for some time in it, so that here we get an example of prolongation, it may be called continuance, of the unconscious stage.

Such a state as that of habitual unconscious thought may be regarded as possible and probable, and we are justified in applying it to many animals of inferior nervous organisation. The condition of consciousness being absent, the degree of pain is less, as must be the case in infants. So far from the saying of the master painter of mankind being true that the worm feels as great a pang as when the giant dies, the worm must be less sensitive and less sensible. It is quite possible that the antivivisectionists may be in the wrong as to lower animals, whatever reason they may have as to those like the dog.

There will be at least the like gradations of mind as of form in the animal world, and the difference between an animalcule and a dog will be enormous, and still greater that between the animalcule and man. In the higher stages the differences will be vastly augmented by the agencies at work. Thus it must be that the conscious stage producing precision of action influences the habitual condition of the unconscious stage. Having applied this to man, we may better conceive it, and form some notion of its prodigious relative development by considering how man so constituted has his power of thought enhanced by the great instrument of speech.

These causes contribute to the great differences which I long since pointed out between the rapidity of thought of one man and another, or of the same man at different times of life or under various conditions. My paper "On the Geographical Distribution of Intellectual Faculties in England," following one at the British Association, being published in the *Journal* of the Statistical Society (June, 1871, p. 357), has escaped the notice of psychologists and physiologists, being esteemed statistical, whereas it is also psychological. At p. 357 I gave an account of an experiment, showing a fluctuation in conscious thought in one adult of from 1 to 4, or 100 to 400, denoting an enormous difference, and illustrative of the variations in mental power which exist in society. If, however, we were to estimate a child of 14 at 50, then the ratio would be as 1 to 8. If we take a child of 7 at the quarter of an adult, then we should have 1 to 16. These are not extreme measures, for in the babe we may find 1 to 100, 1 to 200, 1 to 400.

This is given as an illustration of what must exist in the animal world as to conscious thought, and that without reference to unconscious thought, which must be the condition of many classes. Physiologically the subject has been treated by many physiologists, and notably most admirably by Dr. Carpenter; but here the psychological aspect in the special forms indicated is alone brought into prominence.

The phenomena of unconscious thought, indeed, require much greater attention. Not only do they underlie the distinctions between animals and between animals and man, but they must be taken into consideration as explanatory of dreams and of many forms of mental disease. This has been partly dealt with by Dr. Carpenter.

While the later steps of dreams, the visible and pictorial stages, are greatly under the influence of conscious thought, the early stages are under the influence of unconscious thought. It appears to me quite possible that unconscious thought is not altogether latent in sleep. It is worthy of consideration what is the condition of a wakeful animal, say a dog—whether it is one succession of dreams or a form like delirium.

The recurrence of an error once implanted in the mind, notwithstanding our efforts to eliminate or counteract it, is probably due to the tenacious resistance of unconscious thought, storing up and reproducing the error.

Heredity of thought, whether as dealt with by Mr. Francis Galton or by myself in the paper quoted at p. 359, &c., may be assigned chiefly to the transmission of the habits of unconscious thought, if we consider more especially the condition of the lower animals.

As my last communication was mentioned in the *Daily Telegraph* of November 29, and with the assertion that Dr. Carpenter, Mr. C. T. Munro, and myself have provided in unconscious thought a new plea for unaccountability for criminal actions, it is well to remark that the phenomena discussed have no such bearing.

HYDE CLARKE

December 20, 1879

Stags' Horns

THE disappearance of the antlers of stags, in the Highlands and elsewhere, is to be accounted for by the fact that they are saleable articles; but although they do not assist as *entremets* at the animal's meal it may happen that they assist—in the form of knife-handles—in the distribution of his venison at our dinners.

When a lad I obtained many antlers of the Fallow Deer from a neighbouring park, the tines of which were sometimes broken but never gnawed or polished by licking.

It would scarcely be surprising that deer should crave for calcareous matter during the rapid development of their antlers, but neither are their tongues adapted for rasping nor their teeth for comminuting hard bones.

PAUL HENRY STOKOE

Beddington Park

No gillie that I know of has the honour of my acquaintance, and therefore no gillie can know, save indirectly, that I have picked up a horn of the red deer, in a park near Sheffield! I was told at the time by the gardener who accompanied me that these horns were eagerly sought after by the Sheffield knife-makers for the purpose of making bucks' horn knife-handles.

M. T. M.

A Query

I HAVE seen somewhere (but I am unable to say where) a statement to the effect that there is some evidence for the supposition that in the crystallising state of matter the forces between molecule and molecule are not directed in the right lines joining the molecules. Can any of your readers throw light on this subject, or give references to sources of information about any other case in which the mutual action of two molecules is not directed in the line joining them?

IGNORAMUS

THE ASSERTED ARTIFICIAL PRODUCTION OF THE DIAMOND

PROF. MASKELYNE sends us the following letter on this subject:—

I should be obliged if you would accord me space in one of your columns in order that I may answer a great number of letters and applications which have pursued me during the past few days on a subject of some little public interest, that subject being the asserted formation of diamonds by a gentleman at Glasgow.

Some ten days ago I had heard nothing whatever of the claim of Mr. Mactear, of the St. Rollox Works, Glasgow, to the artificial production of the diamond.

My name, however, was already in several newspapers as that of a person in whose hands the asserted diamonds had been placed for a decision as to their true nature. Ultimately a small watch-glass with a few microscopic crystalline particles came into my hands for this purpose from Mr. Warington Smyth, and subsequently a supply came to me direct from Mr. Mactear. I shall proceed to state the results I have obtained from the examination of these.

Out of the first supply I selected by far the largest particle, one about the $\frac{1}{50}$th of an inch in length, and it may be that I wasted some time in experimenting on this particle, as it might not have been an authentic example of the "manufactured diamond," since it differed in some respects from the specimens I have since received direct from Mr. Mactear.

The diamond excels all substances in hardness. Its crystals belong to the cubic system, and should not, therefore, present the property of doubly refracting light. Frequently, however, from the influence of strains within the crystal due to inclosed gas bubbles, or other causes, diamonds are not entirely without action on a ray of polarised light sent through them. Finally, the diamond is pure carbon, and, as such, burns entirely away when heated to a sufficiently high temperature in the air, and more vividly so burns, or rather glows away, when heated in oxygen gas.

The specimens I had to experiment upon were too light to possess appreciable weight, too small even to see unless by very good eyesight or with a lens, yet were, nevertheless, sufficiently large to answer the three questions suggested by the above properties.

A few grains of the dust, for such the substance must be termed, were placed between a plate of topaz—a cleavage-face with its fine natural polish—and a polished surface of sapphire, and the two surfaces were carefully "worked" over each other with a view to the production of lines of abrasion from the particles between them. There was no abrasion. Ultimately the particles became bruised into a powder but without scratching even the topaz. They are not diamond.

Secondly, some particles more crystalline in appearance than the rest were mounted on a glass microscope slide and examined in the microscope with polarised light. They acted each and all powerfully in the manner of a birefringent crystal. It seemed even in one or two of them that when they lay on their broadest surface (it can scarcely be called a "crystal-face") a principal section of the crystal was just slightly inclined to a flattish side of it in a manner that suggested its not being a crystal of any of the orthosymmetrical systems. Be that as it may, it is not a diamond.

Finally, I took two of these microscopic particles and exposed them to the intense heat of a table blow-pipe on a bit of platinum foil. They resisted this attempt to burn them. Then, for comparison, they were placed in contact with two little particles of diamond dust exceeding them in size, and the experiment was repeated. The result was that the diamond particles glowed and disappeared, while the little particle from Glasgow was as obstinate and as unacted on as before. I had previously treated the specimen I have alluded to as the first on which I experimented by making a similar attempt in a hard glass tube in a stream of oxygen, and the result was the same. Hence I conclude that the substance supposed to be artificially formed diamond is not diamond and is not carbon, and I feel as confident in the results thus obtained from a few infinitesimal particles that can barely be measured and could only be weighed by an assay balance of the most refined delicacy, as if the experiments had been performed on crystals of appreciable size.

Not content with merely proving what these crystalline particles are not, I made an experiment to determine something about what they are.

Heated on platinum foil several times with ammonium fluoride, they became visibly more minute, and a slight reddish white incrustation was seen on the foil. At the suggestion of Dr. Flight, assistant in this department, a master in the craft of the chemical analyst, these little particles were left for the night in hydrofluoric acid in a platinum capsule. This morning they have disappeared, having become dissolved in the acid.

I have, therefore, no hesitation in declaring Mr. Mactear's "diamonds" not only not to be diamonds at all, but to consist of some crystallised silicate, possibly one resembling an augite, though it would be very rash to assert anything beyond the fact that they consist of a compound of silica, and possibly of more than one such compound.

The problem of the permutation of carbon from its ordinary opaque black condition into that in which it occurs in nature, as the limpid crystal of diamond is still unsolved. That it will be solved no scientific mind can doubt, though the conditions necessary may prove to be very difficult to fulfil. It is possible that carbon, like metallic arsenic, passes directly into the condition of vapour from that of a solid, and that the condition for its sublimation in the form of crystals, or its cooling into crystal diamond from the liquid state, is one involving a combination of high temperature and high pressure present in the depths of the earth's crust, but very difficult to establish in a laboratory experiment.

NEVIL STORY-MASKELYNE

FURTHER NOTES UPON THE PAPUANS OF MACLAY COAST, NEW GUINEA

I.

HAVING recently received from my friend M. von Miklucho Maclay, by way of Singapore, some further notes upon the ethnology of the Papuans of Maclay Coast, in New Guinea, I herewith contribute the following abstract of them to the pages of NATURE, as the periodical in which they were published is not readily accessible to English readers.[1]

The Daily Life of the Papuans.—With regard to the application of pigment to the face and body, the Papuans paint the face with red and black colours, the red being such usually used by the young (those from fifteen to thirty years "malassi"), and the black by those of riper years. The young further use the colouring agents in the form of various devices. On ordinary days they are unpainted, or confine themselves to a ring round the eyes or a line along the nose, which goes to join another running from the temple to the vertex, over the shaved eyebrows. On formal occasions, however, the whole face is smeared with a pigment over which white and black are drawn. Sometimes half of the face is painted black, while the other half is red, which gives a very remarkable appearance. The Tamo, or men over thirty years old, almost never employ the real colour, but substitute black instead. On important occasions the whole head is covered with the pigment; in fact, in certain districts, *e.g.*, "Kar Kar," Dampier Island, where this is abundant, the inhabitants smear the whole body with it, and with such care that it would be readily taken for their natural colour.

The women of Maclay coast are seldom to be seen painted, and, when they are, in not so elaborate a mode as are the men. A description has been already given of the *coiffure*. Before the arrival of Maclay bamboo knives and fragments of flint were used for the removal of the hair; but during his stay sherds of glass collected in the neighbourhood of his hut were substituted. Another method was also employed for the removal of single hairs by means of a noose made with a stalk of grass, in which the hair was twisted out of its follicle. Although this operation would seem to be a painful one, a Papuan has been seen engaged for three or four hours on this occupation, without a shade of an expression of pain being seen to pass over his features. Although the Papuans of this region are not conversant with the art of tattooing, they are accustomed to burn rows of scars in lines upon the skin. The operation is thus performed:—The patient having been placed either upon his back or belly, a red-hot fragment of dry bark is laid

[1] "Ethnologische Bemerkungen über die Papuas der Maclay-Küste in Neu Guinea—Alltägiges Leben der Papuas" (Fortsetzung). Reprinted from the *Natuurkundig Tijdschrift voor Nederlandsch Indie*, Zevende Serie, Deel vi. p. 294. (Batavia, 1876.) This abstract may be regarded as a continuation of two articles by me upon the same subject, which were published in NATURE, vol. ix. p. 328, vol. xiv. pp. 107, 136.—J. C. G.

upon the skin until it is entirely consumed to ashes, and so on with each mark. This procedure, too, must demand great patience and self-control. The women, curiously enough, ornament their bodies much less than do the men, their costume being not infrequently reduced to a minimum. In Billi-Billi, Maclay saw a marriageable maiden in the most singular costume that could possibly be conceived, consisting, as it did, of a single large shell (a white *Cypræa*) upon the lower part of the *mons Veneris*.

The men employ four or five hours in the combing of their hair and in smearing it with a decoction of the fruit of the Súbari (*Calophyllum inophyllum*), also in adorning it with feathers and flowers, and in painting their faces and backs. The only decorations, on the other hand, in which the females indulge on festal occasions is in a little dye with which they smear their hair, cheeks, and forehead, and a number of necklaces composed of shells of various sizes and gaily-coloured fruit kernels.

With regard to the social position of the women. Although it can hardly be said that the Maclay Coast Papuans ill-treat their wives, or that these latter have no influence upon the men, it is nevertheless the case that the women in almost every particular play an inferior *rôle*; for even when they are not overworked they have always enough employment throughout the year, while the men, with the exception of a few weeks spent in heavy work—the laying-out of plantations and cultivation of the ground—can for three-fourths of the time enjoy a *dolce far niente*. The women, moreover, have a worse diet, and dare not take their meals in company with the men, and in comparison with the latter wear scarcely any ornaments, nor do they take any part in their feasts.

Neither the marriage nor the birth of children are celebrated with any particular festal observance. Circumcision, on the other hand, is a somewhat important rite. This is performed at the age of twelve years, in the forest, at a distance from the village, and, as Zipporah did it, with a sharp flint, and after the ceremony the neophyte is escorted with songs back to the village. He is now no longer regarded as a boy, but as having come to man's estate, and enjoys, accordingly, many privileges which are not accorded to mere children.

The mode of salutation is somewhat laconic. When a neighbour comes into a village he says to the children, "*E-Wau!*" "Hey, children!" while the men and women are greeted respectively with a "*E-Nangeli!*" and "*E-Mem!*" "Hey, you women!" and "Hey, fathers!" The greeting of the Tamo among themselves is "*E-Aba!*" "Hey, brothers!" Relations, however, and friends are not accustomed to greet one another. The Papuans reach out their hands one to another, with a kind of movement, but without any mutual pressure. On departure the guest says "*Adi-angarmem*," "I am going," to which the host and any others who may be present reply "*E-Aba*," or "*E-Mem*," and the guest answers in corresponding terms. Upon this the host says, "*Glembe*"—"Depart, then"—and escorts his guest as far as the entrance of the village, carrying with him the presents and the remnants of the feast. Hereupon the guest frequently remarks, "Stay you here, but I must be off." If the parting be of a particularly feeling character, one presses the other on the left side of the breast, embracing him at the same time with one arm, while with the other hand he pats him gently on the back. In the village Bogat, and in the Archipelago of Contentment, Maclay remarked that the people greeted a particularly honourable guest by squatting in a particular position on the ground.[1]

The custom of mutual exchange of names is pretty widely spread throughout the coast, and Maclay was frequently begged to change his name with that of one of the natives whom he might have distinguished in some way or other. In order, however, to avoid any misunderstanding, he always refused this request, and only as a particular favour allowed his name, "Maclay," to be borne by the newly-born boys, whose fathers regarded themselves as his special friends. He was, moreover, frequently requested to choose a name for newly-born boys and girls.

As regards the treatment of the dead, the news of the death of a man is announced to the surrounding villages by a fixed succession of strokes on the *barum*. On the same or the next day the whole male population assembles in complete war equipment in the neighbourhood of the village. To the sound of the *barum* the guests stream into the village, and are awaited in the neighbourhood of the hut of the deceased by a crowd likewise in warlike accoutrements. After a short palaver those present divide into two opposite camps, after which the performance of a sham fight takes place. They go to work, however, somewhat carefully in that they make no use of their spears; dozens of arrows, however, are shot off, so that not a few are somewhat seriously wounded in this make-believe encounter. The relations and friends of the deceased seem in particular to get excited and behave like madmen. After all are tired out, and all arrows have been shot away, the *quasi* enemies sit down in a circle and comport themselves merely as lookers-on. The nearest relations of the deceased then bring a pair of mats and the sheaths of the petioles of the fronds of the sago-palm, and lay them in the midst of the open space. Next they bring the corpse out of its hut, maintained in the stooping posture, with the chin resting upon the knees, and the arms embracing the legs, by means of strips of rattan. Close to the corpse are placed its property, gifts of its neighbours, and a couple of bowls (*tabir*) full of freshly-cooked food, while the men sit in a circle round the open space, the women, but only those nearest related to the deceased, merely look on at a distance. The corpse is then, with great neatness and art, wrapped in the mats and palm leaves, and tied up fast with a quantity of rattan and lianas, so that the whole finally resembles a well-made parcel. This, after being fastened to a strong stake, is brought into the hut and the stake is fastened under the roof; finally, after arranging all the property, presents, and food in the neighbourhood of the corpse, the guests leave the hut and return to to their respective villages.

Some days later, when the corpse has become very decomposed, it is buried in the hut itself, a proceeding which in no wise hinders the relations from continuing to use it as a dwelling-place. About a year afterwards the skull is dug up and separated from the body of the corpse; but it is not the whole skull, but only the lower jaw which is preserved, and that by the nearest relation of the deceased, being carried, not infrequently, in the *gun*, or worn as a kind of armlet.[1] This bone is most carefully preserved as a *souvenir* of the deceased, and it was only by the help of much persuasion, backed by numerous presents, that Dr. M. Maclay prevailed upon its possessor to part, under the seal of secresy, with this treasured memento. The burial of a child or of a woman is attended with much less ceremony, being heralded by the sound of no *barum*, and accompanied by no assembly of neighbours, nor martial pomp and circumstance.

[1] "Niederhocken." This position has been already described in the first paper on the Papuans of Maclay coast. NATURE, vol. ix. p. 329.

[1] This is not the only instance of the bones of the dead being worn by their surviving relatives. For instance, the Tasmanians (*vide* NATURE, vol. xiv. p. 211), according to Dr. Barnard Davis, carry as necklaces fragments of the bones of their relatives; and it is moreover stated by Prof. Allen Thomson, that the widows among the Andaman Islanders—the Mincopies according to Dr. B. Davis—actually wear the skulls of their late husbands upon their shoulders (NATURE, vol. xiv. p. 489). Prof. Flower, in a recent lecture on ethnology at the Royal College of Surgeons, showed the skull of an Andamanese man, to which was attached a very elegant webbed sling by which it had been suspended from the neck of the widow.—J. C. G.

With regard to the language and dialects. This study was attended with great difficulty because there was at hand no go-between who could play the part of a mutual interpreter, for the terms which were required could only be learnt either by pointing to the corresponding object, or through such signs as would be employed in barter. These two methods were, however, the source of many misunderstandings and mistakes, for the same object was variously named by different people, and for weeks Maclay was uncertain as to which term was the correct one. Here is an instance of what frequently happened. Dr. Maclay showed a leaf, hoping to arrive at its name, a native mentioned a name, which was forthwith written down; another Papuan gave another name on being shown the same thing; a third, fourth, and fifth, each gave a different word. Which out of all these was the proper name of the leaf in question?

After a time and by degrees it was discovered that the word first mentioned was the proper name of the plant to which the leaf belonged, the second betokened its colour, *e.g.*, *green*, the third *dirt* or *useless*, probably because the leaf had been picked up from the ground, or belonged to a tree not turned to account by the Papuans. And so it came to pass with many words with abstract expressions and such as could not be explained by signs. Maclay, too, had obviously greater difficulties, for instance, how to inquire the equivalent word for "friend," and that for "friendship," and it was only after the lapse of four months that the corresponding word to "seeing" was arrived at, but as to the equivalent of "hearing," this was never come upon. The writing down of words was involved in further difficulties; there were certain tones of the Papuan language which were absolutely impossible to imitate. This Maclay rightly attributes to fundamental differences in the anatomical structure of the larynx and the whole muscular system of the organ of speech in the two races. Not only the organ of speech but also that of hearing plays an important part, for the same word may be heard in a totally distinct manner by different individuals. There is, too, in the denotation of the words of such a tongue quite a series of sources of fallacy—(1) the aborigines have not the same pronunciation; (2) the translator hears the words with his individual organ of hearing; (3) previously to writing it down he pronounces it with his individual organ of speech; (4) and finally, after pronunciation, the foreign word must be expressed in the characters of a known language. Nearly every village on Maclay Coast has its peculiar dialect, and these vary so much, that when making an excursion of two or three days, M. Maclay required the assistance of two, and even three, interpreters. It is only the old who understand two or three dialects, and it not infrequently happens that young persons do not know words of their own dialect, in which case they resort for information to some old Papuan. From this it may come to pass that upon the death of elders new words must be brought out by the young and introduced into the vocabulary. On the other hand the Papuans are fairly quick at learning a new language, consequently there are now to be heard on Maclay Coast a number of Russian equivalents for such words as axe, knife, nail, &c. The names of various birds are founded upon the cry which they utter. There are, moreover, among the dialects of Maclay Coast a number of Malayo-Polynesian words. J. C. GALTON

(*To be continued.*)

JAMES R. NAPIER, F.R.S.

MANY cultivators of science, both at home and abroad, more especially those engaged in engineering and shipbuilding, will deeply regret to learn of the decease of Mr. James R. Napier, F.R.S., the eldest son of the late Mr. Robert Napier of Shandon, the eminent pioneer of the shipbuilding and marine engineering industries of the Clyde. The sad event occurred on Saturday, the 13th ult., at his house in Glasgow, after an illness which had confined him to his room for about three weeks. His health had been very unsatisfactory, however, for a number of years, and, with the view in a great measure of securing a better bodily condition, he had travelled a good deal—to Australia, twice to America, several times up the Mediterranean, wintering once at Malta, and on another occasion at Madeira, where he had the melancholy satisfaction of having as a brother invalid the late Prof. W. K. Clifford.

Born in the year 1821, and educated at the High School of Glasgow, Mr. Napier studied mathematics under Dr. James Thomson (Sir William Thomson's father), natural philosophy under Dr. W. Meikleham (Sir William's immediate predecessor), and practical astronomy under the late Prof. J. P. Nichol.

When quite a young man he was installed in his father's shipbuilding yard at Govan in a responsible position, having had, however, an excellent practical training in the workshop under the late David Elder, a man who did much to train the present race of mechanics who have since secured prominent positions in their profession. By and by the firm of Robert Napier and Sons was constituted, the sons being the deceased and his brother John; and the firm eventually attained a position in connection with marine engineering and naval architecture that has never been excelled in the annals of steam navigation. About twenty years ago Mr. James R. Napier retired from the firm, and for a time he conducted a shipbuilding business of his own, when he availed himself of the opportunity of putting into practice a number of his most advanced notions in ship construction. But it would seem as if he was not destined to shine as a man of business, being very unlike his father in this respect. During his subsequent career he occasionally executed a number of commissions in connection with matters in which his special knowledge could be profitably turned to account, and much of his time was devoted to scientific pursuits.

From time to time Mr. Napier communicated many interesting papers to learned societies with which he became connected. One of those bodies was the Philosophical Society of Glasgow, which he joined in the year 1850, when its presidential chair was filled by Dr. Thomas Thomson, F.R.S., the eminent chemist and mineralogist. In 1855 he became a life member of the British Association, on the occasion of its second meeting in Glasgow, and he long took a deep interest in its affairs, by serving on special committees, and otherwise. He was one of the founders, and subsequently president, of the Institution of Engineers in Scotland (now Institution of Engineers and Shipbuilders), the birth of which took place in 1857, with Prof. Rankine as the first president. When the Institution of Naval Architects was formed in the year 1860, he became a member, and was honoured by a seat in its first council.

Following the example of Prof. Roscoe in Manchester, a number of people of scientific proclivities, a few years ago, originated the Glasgow Science Lectures Association, the first lecture of which was, appropriately, delivered by Roscoe himself. The movement in Glasgow met with very hearty co-operation from the deceased. His sympathy with scientific progress was shown in a great variety of ways; and as an inventor who had often to apply to the Patent Office, he was leagued with Sir William Thomson and others in the recent movements for bringing about a comprehensive reform of the patent laws.

One of the leading features of Mr. Napier's career was the unbroken intercourse, personal and professional, which was maintained between him and Prof. Rankine. They had numerous joint undertakings in experimental investigation, and each was of very great service to his fellow, and in the end to science. As might well be understood, to no person was Rankine's too early decease a greater loss than to James R. Napier. JOHN MAYER

FERTILITY OF HYBRIDS FROM THE COMMON AND CHINESE GOOSE

IN the "Origin of Species" I have given the case, on the excellent authority of Mr. Eyton, of hybrids from the common and Chinese goose (*Anser cygnoides*) being quite fertile *inter se;* and this is the most remarkable fact as yet recorded with respect to the fertility of hybrids, for many persons feel sceptical about the hare and the rabbit. I was therefore glad to have the opportunity of repeating the trial, through the kindness of the Rev. Dr. Goodacre, who gave me a brother and sister hybrid from the same hatch. A union between these birds was therefore a shade closer than that made by Mr. Eyton, who coupled a brother and sister from different hatches. As there were tame geese at a neighbouring farm-house, and as my birds were apt to wander, they were confined in a large cage; but we found out after a time that a daily visit to a pond (during which time they were watched) was indispensable for the fertilisation of the eggs. The result was that three birds were hatched from the first set of eggs; two others were fully formed, but did not succeed in breaking through the shell; and the remaining first-laid eggs were unfertilised. From a second lot of eggs two birds were hatched. I should have thought that this small number of only five birds reared alive indicated some degree of infertility in the parents, had not Mr. Eyton reared eight hybrids from one set of eggs. My small success may perhaps be attributed in part to the confinement of the parents and their very close relationship. The five hybrids, grandchildren of the pure parents, were extremely fine birds, and resembled in every detail their hybrid parents. It appeared superfluous to test the fertility of these hybrids with either pure species, as this had been done by Dr. Goodacre; and every possible gradation between them may be commonly seen, according to Mr. Blyth and Capt. Hutton in India, and occasionally in England.

The fact of these two species of geese breeding so freely together is remarkable from their distinctness, which has led some ornithologists to place them in separate genera or sub-genera. The Chinese goose differs conspicuously from the common goose in the knob at the base of the beak, which affects the shape of the skull; in the very long neck with a stripe of dark feathers running down it; in the number of the sacral vertebræ; in the proportions of the sternum;[1] markedly in the voice or "resonant trumpeting," and, according to Mr. Dixon,[2] in the period of incubation, though this has been denied by others. In the wild state the two species inhabit different regions.[3] I am aware that Dr. Goodacre is inclined to believe that *Anser cygnoides* is only a variety of the common goose raised under domestication. He shows that in all the above indicated characters, parallel or almost parallel variations have arisen with other animals under domestication. But it would, I believe, be quite impossible to find so many *concurrent and constant* points of difference as the above, between any two domesticated varieties of the same species. If these two species are classed as varieties, so might the horse and ass, or the hare and rabbit.

The fertility of the hybrids in the present case probably depends to a limited degree (1) on the reproductive power of all the Anatidæ being very little affected by changed conditions, and (2) on both species having been long domesticated. For the view propounded by Pallas, that domestication tends to eliminate the almost universal sterility of species when intercrossed, becomes the more probable the more we learn about the history and multiple origin of most of our domesticated animals. This view, in so far as it can be trusted, removes a difficulty in the acceptance of the descent-theory, for it shows that mutual sterility is no safe and immutable criterion of specific difference. We have, however, much better evidence on this head, in the fact of two individuals of the same form of heterostyled plants, which belong to the same species as certainly as do two individuals of any species, yielding when crossed fewer seeds than the normal number, and the plants raised from such seeds being, in the case of *Lythrum salicaria,* as sterile as are the most sterile hybrids.

Down, December 15 CHARLES DARWIN

[1] Charlesworth's "Mag. of Nat. Hist.," vol. iv., new series, 1840, p. 90. T. C. Eyton, "Remarks on the Skeletons of the Common and Chinese Goose."

[2] "Ornamental and Domestic Poultry," 1848, p. 85.

[3] Dr. L. v. Schrenck's "Reisen und Forschungen im Amur-Land,' B. i. p. 457.

CLOUD CLASSIFICATION[1]

THE work of a meteorologist who has devoted himself with great diligence for many years to the study of the structure, forms, and movements of the clouds, possesses a strong claim on the attention of all who are interested in this difficult branch of science. Independently of the importance of the challenge which Prof. Poëy offers to an existing system of nomenclature, his book contains numerous facts and suggestions of very considerable scientific value. In the present enlarged and revised edition the author has endeavoured to satisfy the requirements of our advancing knowledge on the subject of which he treats; a task which ought, unfortunately, to be one of no great difficulty, owing to the small amount of progress which has been made in this, as compared with other departments of meteorology, since the appearance of the second edition.

The history of cloud-nomenclature has been to a great extent a record of wrecks and casualties, because classification has, by an unfortunate necessity, preceded the knowledge of the physical structure of the objects classified. Prof. Poëy was one of the first to appreciate the importance of the fact that the terminology of the clouds must, ultimately, be based not simply upon the varieties of the forms of clouds, but upon those physical conditions to which these varieties are related. But our knowledge of the physical conditions which determine the development of the modifications of cloud is at the present time so limited that no classification founded thereon can as yet be unreservedly adopted. A great deal of questionable hypothesis necessarily enters into the construction of Prof. Poëy's scheme, as he would, we believe, with the candour which distinguishes him, be the first to admit. There is of course a strong *prima facie* desirability that cloud observers should possess some definite system of nomenclature; and at present nearly all of them, not of the lazy class, complain that cloud-classification is still in a state of chaos. Yet it may be doubted whether, for some years to come, a Meteorological Congress will be able to establish an absolutely fixed system of classification which will be universally accepted. Of the ground on which such a system should be built science has hitherto explored but a small portion; and even where we have the materials for observational and experimental research in this direction, very inadequate use has been made of these materials. The immediately practical problem which is raised by the study of this book is this:—In the provisional adaptation of our cloud classification to the status of our knowledge, is it desirable that Prof. Poëy's terminology be adopted in lieu of that of Howard, or should the still prevailing nomenclature be retained, with such modifications as the observations of Poëy and of other students of the subject have as yet shown to be necessary? To this problem we shall venture in the present article to suggest an answer.

As might be expected from the condition of the subject the critical portion of Prof. Poëy's treatise is more successful than the constructive. Several of Howard's terms have had from the first an ill-fated career. To

[1] "Comment on observe les Nuages pour prevoir le Temps." Par André Poëy. Third Edition. (Paris: Gauthier-Villars, 1879.)

FIG. 1.—"Cumulus" with "Fracto-cumulus."

FIG. 2.—"Stratus" with "Fracto-stratus."

begin with, the name "stratus," which has ever been the object of Poëy's especial animadversion, was unluckily applied by Howard himself to ground fog. The result has been a curious condition of anarchy among the followers of Howard's system up to the present day. The predicament in which these observers have found themselves is this. One of the three primary cloud-names which Howard introduced is never, if his system be rigidly followed, to be applied to any object which most people call a cloud at all. It must be admitted that a fog and a cloud are, in structure, one and the same thing: a cloud is a fog viewed from without, and a fog is a cloud viewed from within. But it is precisely because a fog is, in this sense, a cloud, and not a particular kind of cloud, that it is objectionable in practice to apply to a fog a specific cloud name. An observer may be for hours together enveloped in a fog of the form of which he can discover nothing, except that the under surface necessarily follows the contour of the earth's surface. In a classification having reference to the shapes of clouds, it is undesirable to give to such a phenomenon a technical name distinctive of a special form of cloud. Prof. Poëy pertinently says "aucun observateur consciencieux ne voudra enregistrer sous le nom de 'stratus' un phénomène de brouillard." On the other hand, a very large class of clouds, occurring in every part of the globe, and in some parts actually the predominant type, have possessed in Howard's terminology no appellation at all, viz., the clouds, neither cumulus nor cirrus, which extend themselves in a bed or layer, whose vertical dimensions as compared with its horizontal are very small. A certain number of observers have freely applied the term "stratus" to this type of cloud. Others,

Fig. 3.—"Mammato-cumulus."

perhaps more conservative, have created endless confusion by bestowing the name "cirro-stratus" on all clouds of the description to which we refer, while others again have wrought similar havoc by a corresponding misapplication of another of Howard's compounds "cumulo-stratus." Finally, Prof. Hildebrandsson is driven to the revival of the "strato-cumulus" of Kaemtz, as the title for the prevailing winter-cloud of Northern Europe. Prof. Poëy's remedy for this state of things is to abolish the term "stratus," and to apply to all clouds which lie in beds the title "pallium." The effort has already proved partially successful, for, owing to the defect in Howard's system, "pallium" and its compounds have to some extent replaced, at least among American meteorologists, the "stratus" of Howard and its compounds. Ice-clouds disposed in a sheet or layer are to receive the name "pallio-cirrus"; water-clouds the name "pallio-cumulus." We think Prof. Poëy's objection to the word "stratus" as applied to a bed or layer of cloud somewhat ill-directed. The term (signifying "levelled," or "laid flat") is in itself quite as expressive as "pallium" (which does not so much involve the idea of the horizontal); and, however it may have been misapplied, we suspect that it will yet prove possessed of too much respectability to be summarily ejected. Prof. Poëy would retain, inconsistently as it appears to us, the compound name "cirro-stratus," but we have always found it extremely difficult to understand precisely what kind of cloud he means to describe under this name, or to recognise with any distinctness what is his idea of "nuage stratifié," the clouds which he terms "stratified" being rather what most persons would call "striated." Whenever cirrus becomes sufficiently extended to form a veil or sheet, it is to receive the name "pallio-cirrus." "Cirro-stratus" is something which floats at a higher level than "pallio-cirrus." Looking at one of the figures in which "cirro-stratus" is portrayed, we recognise only cirrus, tending slightly to the form cirro-cumulus (Plate 3, Fig. 1). Some of the other representations convey the idea of clouds which would certainly be at a lower level than the usual veil or bed of extensive sheet-cirrus. Some readers may however be more fortunate than we have been in recognising the form of cloud which the author intends to designate as "cirro-stratus." His theory of the formation of the varieties of clouds of the cirrus types is perhaps as clearly expressed in the following as in any passage in the book. "Voici exactement ce qui se passe dans la nature : lorsque les cirrus s'abaissent, ils se transforment en cirro-stratus. Les aiguilles glacées de ce dernier nuage inférieur sont plus compactes et abondantes, plus définies et mieux géométriquement distribuées que les particules moins abondantes et plus isolées des cirrus supérieurs. Quand les cirro-stratus s'abaissent à leur tour, ils se transforment en cirro-cumulus : la structure neigeuse remplace la structure glacée par l'effet de la hausse de la température. Les cirro-cumulus en s'abaissant eux-mêmes, se transforment en pallio-cirrus ou en une couche neigeuse" (p. 29).

The compound "cumulo-stratus" Prof. Poëy would get rid of. We believe that Howard had himself a clear idea of a distinct object when he employed this word; but up to the present time, owing to indistinctness of verbal description, to ill luck as to illustrations, and to other accidents, the word has had a desperately unfortunate history, and Prof. Poëy's objections to it consequently come with great force. It is no exaggeration to say that while we have seldom found two observers really agreed as to the object denoted by this word, we have known the word applied to every existing description of cloud, with the sole exception of unmistakable cirrus.

Poëy's word "tracto-cirrus," the use of which he advocates whenever the cirrus-clouds arrange themselves in parallel bands, is an expressive term. But it is often extremely difficult to decide whether the cirri are or are not arranged in bands. And in treating the "tracto-cirrus" as if it always occupied a lower level in the atmosphere than cirrus, and the "pallio-cirrus" as floating at a still lower level, the author appears to be straining physical fact in order to strengthen the basis of his classification. There is, so far as we are aware, no evidence to show that whenever cirrus adopts, as it does in a majority of cases in most regions of the globe, the band form, it sinks in the atmosphere, and that a further subsidence takes place whenever it spreads itself into a veil or sheet.

The word "nimbus" is to share the fate of stratus and cumulo-stratus. Here again we think the author would have been more successful if he had preferred reform to abolition. That two distinct beds of cloud, the one at a high, and the other at a low level, frequently exist when rain is falling, there is abundant evidence to show, and perhaps this is especially the case during extensive intra-tropical rains. But observers are at least equally agreed as to the fact that a bed of cirrus may coexist with a layer of low cloud, either with or without one or more intermediate layers, without the occurrence of rain or snow. And it is equally certain again that the majority of passing showers are produced in a single mass of cloud, not necessarily, and perhaps never, homogeneous in structure in the portions near the earth and in those which extend into the higher regions of the atmosphere, but certainly not divided into two ocularly distinguishable strata. These facts seem to be ignored by the author when he substitutes "pallium" for "nimbus," and then makes the rainy "pallium" to consist in all cases of "pallio-cirrus" superimposed upon "pallio-cumulus."

As regards the term "pallio-cumulus," we are again obliged to hesitate in accepting it as a thoroughly descriptive title for a layer of low cloud, which has little in common with cumulus except that it occupies much the same level in the atmosphere.

Another of the author's terms, "fracto-cumulus," which he employs for those fragments of low cloud, which, though not themselves hemispherical, are nascent or potential cumuli, seems a useful word (perhaps only open to the slight objection that the affix would be liable, if Poëy's system were adopted, to be confounded, especially in MS. reports, with his other affix tracto). His French equivalent "nuage venteux" is, however, not sufficiently comprehensive, and is open to the same objection as the English word "scud," which involves the idea of rapid motion. The low cloud-fragments are not necessarily either the concomitants or the precursors of wind.

A highly interesting section is devoted to the clouds which have been in England denominated "pocky clouds." The fact that this name has been applied to several distinct varieties of clouds is certainly not unduly pressed by the author; in truth he scarcely appears adequately to realize the amount of misapprehension which has existed on the subject of these clouds. A Latin affix would certainly have the desirable effect of obliging the observer to give attention to the generic form of cloud from which hang the characteristic bladder-like protuberances; thus clouds of the cirrus and of the cumulus type, presenting this peculiarity, would no longer be registered under a single title. But Poëy's proposed affix "globo" does not appear satisfactory, for there is reason to suspect that some observers would be likely to apply it to any spherical or apparently spherical masses of cloud. How easily, in cloud terminology, misapprehension arises from the mere sound of a name the author himself in this very section illustrates, when he mistakes the "roll-cumulus" of the English Meteorological Office for ill-developed pocky cloud.

Beset with difficulty as all questions of cloud classification must necessarily be, we yet believe that at the present time, and for the present, a useful and unobjectionable compromise might be made between the systems of Howard and of Poëy.

Stratus might, without dissolution, leave the surface of the earth, as it already has done in numerous meteorological records, and be applied to all clouds, not of the cirrus type, which arrange themselves in a horizontal bed. *Cirro-stratus* would then form the descriptive title of the ice-clouds of the higher regions whenever these are disposed in a bed, sheet, or veil. The terms *cumulus* and *cirro-cumulus* may remain undisturbed. If the title *cumulo-stratus* have not received mortal injury from abuse, it might be applied to those peculiar descriptions of "mackerel cloud" or "nuage pommelé," which are only at a moderate elevation, and are not in physical structure cirro-cumuli, a class of clouds which much need a distinctive title. If *nimbus* is to be retained, it might be subdivided into its two essentially distinct varieties, the massive local shower-cloud, and the extensive bank of composite rain-cloud; and for these varieties the titles *cumulo-nimbus* and *strato-nimbus*, or some equivalent expressions, might come into use. The expressive *fracto-cumulus* should have its place secured; and this affix of Poëy's may have further applications; detached pieces of those clouds which tend to arrange themselves in horizontal beds (pieces which are in no sense the nuclei of cumulus clouds), may conveniently be termed *fracto-stratus*, while to the little wavy or broken shreds of ice-cloud which Poëy seems to designate "cirro-strati," the term *fracto-cirrus* might perhaps be applied. For the bizarre "pocky clouds," which, though not nearly so rare as is usually suposed, are certainly not common, an affix, if descriptive, would be none the worse for being somewhat outlandish, and possibly "*mammato*," or even "papillato," might be acceptable. If the course suggested in the present article be adopted, no very serious changes will have to be made in the application of Howard's terminology, and no terms will have either to be coined or to be introduced from other systems of classification into that of Howard, with the exception of the affix "fracto," and the affix "mammato" (or one equivalent to it). We have thought it desirable to give illustrations of the types of cloud to be distinguished by these last names. In the first sketch "cumulus" is shown with "fracto-cumulus"; in the second "stratus" with "fracto-stratus"; in the third the characteristic base of "mammato-cumulus"; and in the fourth that of "mammato-cirrus."

We are not without hopes that Prof. Poëy will be induced to give his aid to proposals of moderate reform in the direction above indicated. We are convinced that he will find it easier to modify, by limitations and expansions, a long existing terminology, wherever the terms are essentially truthful and expressive, than to sweep it away and introduce another in its place.

To return to the book under notice. "How to classify the Clouds" would be a more descriptive title than that which it possesses. However, the reader who wishes to learn the art of cloud observation, with the view of learning to forecast the weather, will obtain valuable information from the descriptions which the author founds upon his own observations, as well as from those which he quotes from other observers, *e.g.* the exquisitely truthful description of cirrus quoted from Bravais (pp. 64 and 65). Some of the remarks on the azimuthal rotation of the clouds in Havanna, and on other phenomena, are well worthy of the attention of meteorologists. Here, *e.g.* is an observation, which, taken in conjunction with the inclination of the axes of cyclones and anti-cyclones in-

Fig. 4.—"Mammato-cirrus."

dicated by cloud-observations in Europe, and also with the recent conclusions of Prof. Loomis as to the sequence of winds at the American mountain observatories, may point to an important general law; "dans le plus grand nombre de cas, le vent anticipe sur les fracto-cumulus, ceux-ci sur les cirro-cumulus, et ces derniers sur les cirrus, c'est-à-dire de bas en haut, au lieu d'être de haut en bas. Ce fait paraît contredire l'hypothèse que les courants supérieurs déterminent, de proche en proche, le passage, sous le même parallèle, des courants inférieurs jusqu'aux vents de surface" (p. 127).

One who writes on a generally neglected subject, to which he has himself devoted much attention, is often tempted to accept too readily as grist anything that comes to his mill, and Prof. Poëy is not altogether free from this tendency, especially in those parts of his works in which he launches out into very questionable hypotheses both on the theory of winds, and on the action of heat and of electricity upon the clouds. Still more to be regretted is a certain looseness, not so much of language as of conception, which occasionally leads him to make some surprising statements, as well as to employ inaccurate expressions.

He usually speaks of the water-clouds as composed of aqueous vesicles, sometimes of vesicular vapour. In one passage, speaking of frozen clouds, he talks of the "vesicular vapour passing from the state of particles of ice to those of snow" (p. 77).

A protest is necessary against his often repeated definition of cumulus as a "cloud of the horizon." He says (p. 23), "Nous pouvons assurer que, sous toutes les latitudes du globe, les cumulus sont spécifiquement des nuages d'*été*, de *jour*, et de l'*horizon*." And again (p. 104), "Ils demeurent toujours confinés à l'horizon, et ne traversent jamais la région zénithale qu'ils n'atteignent même pas. Cette seule circonstance distingue profondément les cumulus des fracto-cumulus." Truly a profound distinction! We had supposed that in regard to clouds, as in some other matters, "one man's horizon is another man's zenith." Are cloud-classifiers really driven to such extremities? What would be thought of the botanist who appended to his description of the *Ulmaceæ* the statement that "the trees belonging to this family are objects seen upon the horizon," and then proceeded to meet the reasonable objection of the surprised reader by the remark that certainly the elm trees around his (the botanist's) residence, were all seen near the horizon? Yet this is how (p. 24) the author handles his descriptions of cumulus. (The fact of course is that the characteristic form of cumulus is not readily discernible when the cloud is near the zenith.) A somewhat similar remark, made by the author in explanation of the fact that a belt of cirrus, clearly visible towards opposite points of the horizon, is frequently invisible, or nearly so, overhead, a fact of which the optical explanation is obvious, is so strange that we must quote it. "Nous l'attribuons à l'extrême degré de froid que nous avons toujours observé dans la région zénithale, relativement aux autres azimuts. Sous cette basse température et cette extrême sécheresse, la vapeur d'eau se maintient à l'état élastique, et se précipite difficilement sous la forme de filaments extrêmement déliés. C'est pour cela que les cirrus sont plus rares, moins denses et passagers vers la région zénithale," (p. 69).

It is with reluctance that we notice statements of this kind in a work the general idea of which we admire, and in the aim of which we cordially sympathise.

W. CLEMENT LEY

THE PLANETS OF THE SEASON

MARS

IF the two great leaders of the planetary system have filled us with astonishment at their magnitude and velocity, and with perplexity in the contemplation of arrangements so incomprehensibly unlike our own, they have not exhausted all the resources of the season. There yet remains a much nearer and more intelligible neighbour, who possesses a peculiar interest for an opposite reason—his similarity to ourselves. This especial character of the ruddy planet has long been known to astronomers, and will naturally make him an object of careful study before we leave him too far behind; and though the opposition of this year does not diminish his distance so much as that of 1877, yet his almost startling brilliancy has been alone enough to prove it among the favourable ones; for English astronomers, at least, it is far more propitious than the last, from his greatly-increased elevation. Much had been expected at that last opposition from the broad expansion of his disk, but the indistinctness of detail was a general source of disappointment here, though the success of Schiaparelli at Milan and Green at Madeira showed that the fault lay chiefly—perhaps not exclusively—in the English sky. My own impression certainly then was that, besides the want of clear outline inseparable from so low an altitude, there was a deficiency in decidedness of form and strength of tone as compared with previous observations, the cause of which may have lain in the atmosphere of the planet, affected possibly by especial proximity to the sun in an orbit of considerable excentricity. At any rate, we may reasonably hope to find the present season more favourable for exploration than the last; for though at nearest approach we have only had 23″ of disk instead of 29″·4 in 1877, success depends, with equal instrumental sharpness, much more upon altitude and steadiness of air than on increase of visible surface. Schiaparelli was enabled to obtain his most valuable results after opposition, when the diameter had decreased to 20″ or even 16″, and he asserts that he was able to continue his researches with advantage even till it came down to less than 6″.

We have alluded to the special interest of this planet arising from its supposed close correspondence with the earth, and it may not be out of place on this occasion if we bestow a little pains in examining the ground of that supposition. This we may conveniently do by imagining what would be the telescopic aspect of our own globe at a distance not equal to that of Mars, as we should then appear about twice as large, but such as to reduce our apparent diameter to equality with his in a favourable opposition.

There is every reason to believe that our surface would then appear mapped out by a distinct separation into oceans and continents, the fluid being darker than the solid masses, and preserving their bluish-green tinge but little affected by distance. Except in very shallow parts, their darkness would be uniform from the rapid absorption of incident light, and their contour would be sharply defined. The general hue of the land would be lighter; and at a distance where its variegated patches of colour would be separately undistinguishable, the result would be a grey resulting from the mixture of many tints, except where tracts such as the great deserts or prairies might subtend a sufficient angle to preserve their natural hue, or where extensive forests might rival seas in depth of tone. In many places, too, brilliant streaks and patches would show where mountain masses were capped with dense clouds, or surpassed the level of perpetual snow; but our largest rivers, except possibly at some great *embouchure*, would be totally imperceptible.

Such, in its general lineaments, would be the distant aspect of our globe, if the whole lay at once distinctly before the eye. But this would never be the case. The formation and transference of masses of vapour would produce incessant and most uncertain changes. In some regions and at certain times of year there would be unbroken clearness; in other tracts the outlines and colouring of land and sea would be indistinct, or concealed, at times for short, but occasionally for very lengthened, periods. And the interposition would doubtless be always of a white aspect, since such is the character of our clouds wherever they are illuminated by the sun. Towards our polar regions this whiteness would be permanent in the form of great spots, excentric as regards the axis of rotation, increasing through and after the winter, with a corresponding diminution after the summer solstice. There would always be, however, a large unmelted area, even at the warmest period, and its outlines would probably be often irregular and extended from the presence of great masses of frozen clouds. Now, if these would be the probable features of the earth, presented to us at a distance of seventy or eighty millions of miles, in what respects shall we be able to trace the resemblance on Mars? We are soon brought to the conclusion that, according to the general rule already referred to, there is more analogical than identical correspondence: the inclination of axis, the excentricity of orbit, the duration of day and night, the respective length of the seasons—from the relative similarity but not identity in these particulars, we are prepared to meet with the same kind of proportion throughout. As far as aspect goes, a solid and fluid condition may be thought to divide each superficies; but if so, the land there is in a much larger ratio to the water; and if the colour of our oceans is repeated on Mars, we have little to correspond with the orange-yellow tinge which, since it leaves unaffected the polar snows, cannot arise from atmospheric absorption. The so-called seas, too, though in some places apparently deep and dark, frequently shoal off and show subaqueous markings in a way that perhaps would be scarcely paralleled in our own.

In atmospheric conditions, indeed, we find great approach to identity; yet even here there are discrepancies; the polar snows of the earth would probably not be distinguishable from the upper surfaces of terrestrial clouds floating in any latitude, while on Mars such peculiar whiteness, though sometimes vividly brought out in certain localities, is by no means universally concurrent with the local indistinctness and confusion that so often puzzle the areographer. The action of solar heat on the polar deposits seems identical, and yet it may be a question whether our Arctic snows are marked out by as regular a contour as those of Mars, and still less would they show what has often been observed there—a strongly-marked border of darkness. And however striking and suggestive may be the fact that in either globe the thermal axis is not that of rotation, we have the discrepancy that on Mars the glaciation is reduced in a much greater ratio, so that the pole, according to Schiaparelli, was, in 1877, entirely free. This observer, who is fully impressed with the terrestrial theory, admits that the vertical sunlight, instead of producing clouds, as on the earth, appears to clear the sky of Mars, and thinks the atmospheric changes there of a more simple nature. That the southern hemisphere would be subject to greater extremes of temperature than the opposite, as shown by the variation in size of the white caps, might have been expected as a direct consequence of the elliptical form of its orbit greatly surpassing our own.

A passing reference will be sufficient to the brighter zone, which, according to some observers, distinguishes the edge of the disk, but which others, including myself, have never detected; or to the bluish or greenish patches sometimes noticed on the limb. Such appearances may be mere results of contrast; at any rate they may be left on one side as not directly affecting our present comparison. But there is one consideration which cannot be thus disposed of, and which, obvious as it is, seems to have been taken little into account—the very different amount of solar radiation on the two planets. The heat derived from the sun on Mars is only from $\frac{1}{3}$ to $\frac{1}{2}$ of that received by ourselves. And thus we seem reduced to the alternative of either abandoning to a considerable extent the supposed closeness of resemblance in material and constitution, or of maintaining it by the hypothesis of a supply of heat on Mars derived in some other way. No ice such as ours would be so reduced by the unaided action of that distant sun—no terrestrial continents could remain so long unclothed with snow. The dilemma is a curious one. It may not be incapable of explanation, but it certainly requires more special and careful consideration than it has yet received.

We have been looking at the subject much as though a supposed view of the earth at a suitable distance might be fairly paralleled with a corresponding representation of Mars as drawn by the best observers. But it must be added, with much regret, that such is not yet the case. As to certain main features of that planet, there is indeed a very satisfactory agreement; but with regard to others, and as to details in general, we feel, as a first impression, some extent of disappointment. It may be fairly admitted that the disk is after all not large, and its markings often feeble; and there is great diversity in instruments, and eyes, and hands, and aptitude for the work. Yet still an exhaustive survey, of which we cannot even indicate the materials in this place, but which we trust will be carried on, as it has been most ably commenced, by Dr. Terby of Louvain, would show much unexplained, and some things unsatisfactory. Mädler laid the foundation of definite areography; but his successors, while enlarging, have not always confirmed his results, and, to say nothing of others who have bestowed much pains upon the subject with more or less mutual agreement, our own keen-eyed and accomplished Dawes—at least as represented by Proctor—is found to differ in some parts materially from Lockyer, Kaiser, and Secchi. At the last opposition in 1877, the subject was taken in hand with especial zeal and perseverance by Schiaparelli at Milan with an exquisitely sharp Merz object-glass of 7·15 inches aperture and 10 feet 8 inches focus, and by Green, who went out purposely to Madeira with a 13-inch mirror by With, the perfect polish and critical definition of which are sufficiently guaranteed by the maker's name. Each did his best; each was far in advance of the other observers of the season; and yet at first sight there is more apparent difference in their results than might have been expected. It is not surprising that in the case of minute details each should have caught something peculiarly his own; but there is a general want of resemblance not easily explained, till, on careful comparison, we find that much may be due to the different mode of viewing the same objects, to the different training of the observers, and to the different principles on which the delineation was undertaken. Green, an accomplished master of form and colour, has given a portraiture, the resemblance of which as a whole, commends itself to every eye familiar with the original. The Italian professor, on the other hand, inconvenienced by colour-blindness, but of micrometric vision, commenced by actual measurement of sixty-two fundamental points, and carrying on his work with most commendable pertinacity, has plotted a sharply-outlined chart, which, whatever may be its fidelity, no one would at first imagine to be intended as a representation of Mars. His style is as unpleasantly conventional as that of Green indicates the pencil of an artist; the one has produced a picture, the other a plan. The discordance arising from such opposite modes of treatment would naturally be less real than apparent; still, a good deal remains that it is not easy to harmonise. Let us hope that during the present favourable opportunity, much may be effected towards clearing up the obscurities that still rest upon the study of Mars. Every contribution may prove of use, provided it is the result of that conscientious spirit that will show only what it sees, and take care to show it well.

A suggestion may be permitted that observations in the twilight might obviate the unpleasant glare arising from the vivid light of the disk, or that a screen-glass might be advantageously employed for the same purpose at a later hour.

Meanwhile the nomenclature of the spots—a point of increasing importance for identification—is in a state of pitiable confusion. This ought to be remedied at once; and its revision could be more suitably intrusted to no one than to Dr. Terby, who so thoroughly knows its difficulties, and is so competent to decide upon some system that may be adopted with the general concurrence of observers.

With regard to the satellites, we have entered into so much detail about the primary, that little space remains for them. Yet we must express our hope that, once discovered, they may be more easily caught in our larger instruments, and that the magnificent reflector of Mr. Common may, as is very possible, increase their recognised number. Those already discovered are certainly among the most wonderful objects in the whole solar system. So disproportionally minute, according to our limited ideas of proportion; so speedy in their revolution that the innermost rises in the west and sets in the east, and compasses the whole heavens more than three times in a Martial day; so close that the same attendant ranges at less than 4,000 miles from the surface of his primary; so much of their time invisible in total eclipse; so powerless to influence any fluid mass beneath them; one might call them exceptions, while yet they are among the strongest illustrations of the great principle of identity of character combined with the extremest variety in detail, in the inscrutable work of the Creator.

T. W. WEBB

RECORDING SUNSHINE[1]

SO far as I have seen there is in use at present but one form of apparatus which effects an automatic registration of the duration and the times of sunshine, and that is the instrument of Campbell, in which a sphere of glass is so disposed as to burn a piece of wood or paper by the concentration of his rays when the sun may chance to shine. During the past few years I have devoted some attention to this matter and devised a number of appliances having the same object for their end but differing materially both in their construction and in the manner of their use from the apparatus I have named.

One of these, with your permission, I will now describe. It is an arrangement which places a lead pencil on a sheet of paper and writes down therewith when and for how long the sunshine lasts.

It consists essentially of a differential thermometer with a long horizontal stem, in which latter is contained throughout the greater portion of its length some fluid intended to operate by its weight. This thermometer is attached to a scale beam or some equivalent device which also carries the pencil by means of which the record shall be made.

The whole is so arranged that in its normal state it rests gently—upon that side to which the pencil is *not* attached—on an embankment provided for that end.

Close beneath the pencil point a disk of metal rotated at the proper speed carries a paper dial whereon marks and figures are engraved corresponding with the hours at which the sun may shine.

When using this instrument I have it inclosed within a box which permits one bulb only of the thermometer—that most distant from the clock—to be affected by the radiance of the sun, which when it shines expands the air contained therein, forces the fluid along the tube and by altering the equilibrium of the beam brings some portion of its weight to bear upon the pencil point, and so the record is commenced.

When the sun becomes obscured, the air expanded by his rays contracts, the fluid in the tube returns, the normal equilibrium is restored, and the pencil ceases to produce its mark.

In the instance of the instrument I use the stem of the thermometer is 18 inches long and the eighth of an inch or thereabouts in bore.

Mercury in consideration of its weight is the fluid I employ, and in conjunction with it some sulphuric acid is inclosed, because of the mobility which is thereby gained. I am aware that in these circumstances mercuric sulphate is very slowly formed, but after two years' lapse of time no inconvenience has been caused thereby and the mobility of the mercury remains.

The bulbs of the thermometer are 2 inches in diameter or thereabouts, and that they may be more rapidly affected the glass thereof is thin. Both are blacked, and the one intended to receive the radiance of the sun projects above the box in which the apparatus is contained into a dome of glass.

[1] Paper read at the Literary and Philosophical Society of Manchester by David Winstanley, F.R.A.S., November 18, 1879.

NOTES

W. HEPWORTH DIXON died very suddenly early on Saturday morning. He was best known to us as a brilliant writer and speaker, and but comparatively few knew how profoundly, and with what patient determination he would sift the truth, alike of even the most well attested, as of the most apparently trivial fact, before making use of it in his work. Only those within the circle of his more intimate friends were aware how well he followed and how easily he grasped the progress of scientific thought. In this circle were several with whom and about whose labours he delighted to converse, and none could listen without benefiting by the practical views his vigorous intellect suggested, the more so as they were possibly induced by quite other claims of thought. These columns have called attention to the ethnological value of his researches in America. His travels, especially those in the Far West, in the wilder parts of Russia, in the Holy Land, and in Cyprus, attended at times with personal risk, are full of suggestive interest to the scientific mind, and we may shortly to call attention to some of the salient facts connected with natural science which they contain. In his early days he studied astronomy and kindred subjects, and it almost seemed at one period of his life that his bent would have led him more deeply into these researches. That this early inclination never forsook him, even those who knew him least, may gather from his attendance at the meetings of the British Association, his unremitting labours as chairman of the Palestine Exploration Fund, and his presence at numerous anniversary meetings of our learned societies. His surviving son, Harold, is already known as a teacher of natural science at Oxford University.

THE death, on December 18, is announced of Prof. Franz Boll, who has filled the Chair of Physiology and Comparative Anatomy in the Roman University; he was only thirty years of age. Born at New Brandenburg in February, 1849, he studied at Berlin and took his Doctor's degree in medicine and surgery in 1869. When little more than twenty years old, he became assistant to Dubois-Reymond in his physiological laboratory at Berlin. Having been obliged on account of his health to seek the warmer climate of Italy, he was in 1873 offered an appointment in the Roman University, and in 1877 was, by the unanimous decision of the Commission of Examiners, elected to the chair he has since held. His researches regarding the arterial circulation of the retina are recognised as a most valuable contribution to physiological science.

GENERAL surprise is naturally expressed that Dr. William Farr has not been appointed to succeed Major Graham as Registrar-General. Dr. Farr's qualifications for the post are known to all the world; but it has been conferred upon Sir Brydges Henniker, Bart., for what reason we have failed to discover. It must be regarded as an almost national misfortune, though it will surprise no one, that Dr. Farr has resigned his post as head of the statistical department.

THE *Hannoversche Courier* announces that Leibnitz's long-lost calculating machine has been recovered. Leibnitz invented and constructed this machine in 1672, during his stay in Paris. It can add, subtract, divide, and multiply, and was the wonder of the time. This machine became the property of the Hanover public library, but long ago disappeared from among its treasures. All that was known about its disappearance was that it had once been sent to an instrument maker at Göttingen to be repaired. It has now turned up again in the Göttingen library, and through the efforts of Dr. Bodemann, the librarian of the Hanover public library, has again come into the possession of the institution.

IT is only about a year since we gave some account (NATURE, vol. xviii. p. 361) of the railway bridge which spans the Firth of Tay at Dundee, and on Sunday it was the scene of one of the most terrible railway accidents on record. With the details of this sad occurrence our readers are no doubt familiar; for accurate information as to the prime cause we must await the searching inquiry which will no doubt be instituted. The structure appears to have been subjected to the most rigid tests before being opened to traffic, but we fear there must have been more than one screw loose somewhere. Upwards of 3,000 feet of the high girders are reported to have been swept away. One conjecture is that the train had got well upon the girders when a gust of greater strength had caught the structure. There would thus be, in addition to the ordinary vibration of the train, an enormous lateral pressure from the wind. The carriages of the train would also, of course, feel the full force of the blast, and once the weakest part yielded the whole would go with a sudden crash. In a letter to the *Glasgow Herald*, Prof. Grant states that the storm of Sunday was the most violent in Scotland for thirty years, and that the rate of the wind about 7 P.M. was upwards of seventy miles per hour, equal to a pressure of forty-two pounds per square foot. No doubt there were frequent sudden gusts reaching a rate of ninety miles per hour. A Commission of Investigation has already been appointed.

THE *Times* correspondent describes a visit he made to inspect Mr. Edison's new electric light at Menlo Park. Two of the lights had been burning continuously for ten days without injury to the baked cardboard horseshoe in the little glass globe which furnishes the light. Cardboard, he states, seems sufficiently durable, successfully resisting quite rough usage, such as dropping, shaking, turning the current on and off thousands of times, and raising the intensity of light to that of 400 candles. All the arrangements are simple. Mr. Edison will put about 800 lights at Menlo Park, while the inventions immediately go into practical operation in New York city. The globe containing the horseshoe is exhausted to one-millionth of an atmosphere by the Sprengel pump, measured by the M'Leod gauge. By successfully dividing the electric current Mr. Edison gets individual lamps of 16-candle power, each lamp having 100 ohms resistance. Light is turned on or off, and the current regulated with the same ease as gas is, while the current can be transmitted on wire as small as No. 36. The central regulator contains an even current, while the meters accurately measure the supply furnished to each consumer. Mr. Edison finds that the best generators are of five to seven horse power, each one-horse power maintaining eight lamps. Each lamp costs about one shilling to manufacture, while a supply equivalent to 10,000 feet of gas can be produced for tenpence or less. Mr. Edison calculates the cost of furnishing light thus:—the consumption of 3 lb. of coal in a steam engine will maintain eight to ten lamps one hour. Mr. Edison's system also furnishes electric power for small industries, such as running sewing machines. Mr. Edison's light is bright, clear, mellow, regular, free from flickering or pulsations, while the observer gets more satisfaction from it than from gas. Mr. Edison lights at Menlo Park, dwellings, offices, desks, street-lamps, also laboratory and workshop, making it available for every lighting purpose for which gas is used.

PROFESSORS C. A. F. PETERS (director of Kiel Observatory) and Albert von Kölliker (Würzburg) have been decorated by the King of Bavaria with the Maximilian Order for Art and Science.

THE death is announced of Dr. Alexander Sadebeck, of Kiel, professor of mineralogy and geology at Kiel University, on December 9, 1879, at the early age of thirty-six years.

THE Emperor of Austria has presented the Austrian Gold Medal for Arts and Sciences to Herr Wilhelm Hoffmann, of Dresden, in recognition of his merits in advancing the art of photography.

ON January 2, 1882, the University of Würzburg will celebrate the 300th anniversary of its foundation. The Bavarian Government had intended to set aside a sum of 2,000*l*. to defray the expenses of the celebration. The Finance Committee of the Bavarian House of Deputies have, however, declined to allow the sum in question.

THE two first parts of an interesting work, "Bibliotheca Belgica: Bibliographie générale des Pays Bas," have just been published. The editor is M. Ferd. van der Haeghen, librarian of Ghent University. The work will contain (1) the description of all works printed in the Netherlands during the fifteenth and sixteenth centuries, as well as of the principal ones printed between 1600 and 1879; (2) a description of all works whose authors are born Netherlanders, as well as of all works printed abroad which refer to the Netherlands; (3) a list of all the works printed by Netherlanders who settled abroad.

A HIGHLY interesting discovery has recently been made on the Russian peninsula of Kertch. The director of the Kertch Museum discovered a tomb dating from the third century B.C., and from the reign of Persidas II., King of the Bosphorus. The tomb is situated on the road from Temruk and near the Sennaja Station. In it were found (1) a thick gold necklace, with a lion's head at each end; (2) a gold crown of about one inch in breadth, the exterior part being formed of intertwisted rings, and ornamented with fine stones; (3) several pairs of gold earrings; (4) two gold chains, of which one is ornamented with figures; (5) two gold bracelets; (6) a round gold brooch, and a gold pin representing Venus and Cupid; (7) four gold leaves; (8) a pearl necklace, some amulets, and three small gold rings; (9) a phial, an urn, a vase, a spoon, &c.—all these of silver.

THE opening meeting of the Epping Forest and County of Essex Naturalists' Field Club will be held on Saturday evening, January 10, at the rooms of the Buckhurst Hill Art Classes, 3, St. John's Terrace, at seven o'clock. The objects of the club, as set forth in the proposed rules, are as follows:—"The investigation of the natural history, geology, and archæology of the County of Essex (special attention being given to the fauna, flora, geology, and antiquities of Epping Forest), the publication of the results of such investigations, the formation of a library of works of local interest and other publications, and the dissemination amongst its members of information on natural science and antiquities." Excursions, under skilful direction, to various localities of interest to the naturalist and antiquary, will also be a main object of the Club. The Club will strongly discourage the practice of removing rare plants from the localities where they are to be found or of which they are characteristic, and of risking the extermination of rare birds and other animals by wanton persecution; it will also endeavour to use its influence with landowners and others for the protection of the same, and to dispel the prejudices which are leading to their destruction. In like manner the club will endeavour to cultivate a fuller knowledge of local antiquities, historical, popular, and idiomatic, and to promote a taste for carefully preserving the monuments of the past from wanton injury. Considering the fine field offered to the biologist in Epping Forest and the surrounding country, it is certainly a matter of surprise that a society similar to that now in process of formation was not long since founded. We trust the club will meet ample support.

THE latest news from the St. Gothard Tunnel states that the thickness of the soft strata recently encountered was only ten metres, and that the boring machines are again at work on solid and firm rock.

AN earthquake is reported from Agram. It occurred during the night of December 8, 1879, and lasted three seconds. Another phenomenon of the same nature was observed at Seisenberg (Carniola) on December 4, at 6.45 A.M., lasting two seconds. The direction of the shock was from north to south. Ten minutes later a second shock was felt. The intensity of the shocks was alarming. A smart shock was felt at Geneva on December 30, at 12.15 P.M. Several shocks were felt on December 26, at Lyons, where the winter has been exceptionally severe.

THE *Times* correspondent describes an eruption of Vesuvius on the night of December 18, 1879. The mountain has been in an uneasy state for several years, and slight eruptions have constantly taken place; but the climax seemed to have been arrived at on the 17th, when Vesuvius changed its mantle of snow for one of fire. As the wind blew furiously from the north-east, the lava descended in the direction of Portici, covering a large portion of the cone and presenting a magnificent spectacle. On the 18th there was less disturbance; but even in its state of greatest activity the mountain made none of those awful efforts which form a grand eruption. There were some local shocks, and a heavy breathing from the furnace, but there was no tremendous explosion. The cup was full, and it flowed over. This flowing over, however, if continued to great excess, may produce far greater disasters than a roaring discharge which finishes the whole business. Prof. Palmieri's reports of Mount Vesuvius state that the present modest eruption has lasted since 1875. It commenced at the bottom of the vast and deep crater left after the eruption of 1872, and was therefore only visible to those who ascended to the summit of the mountain. But now this crater is filled up by the new lava which flowed at successive periods, and therefore the fresh streams which issue from the eruptive cone flow down the external parts of the mountain, generally on the side towards Naples. The new eruptive cone has gradually increased in height until it now protrudes about fifty feet above the edge of the old crater.

WRITING to the *Western Daily Press* under the date of December 22, 1879, Prof. Silvanus Thompson says:—I had the opportunity about half-past ten this morning of witnessing from Clifton Down a phenomenon which enjoys the repute of being very rare. The entire gorge of the Avon was filled with mist, so that the river in the bottom and the Leigh Woods opposite were quite obscured. Standing on the western extremity of the Observatory Hill, I observed a dim gigantic figure apparently standing out through the mist upon one of the lower slopes of Clifton Down, where it runs down in undulating ridges from the promenade towards the river. A moment's glance sufficed to show me that it was my own shadow on the mist, and as I waved my arms about the gaunt spectre followed every movement. A gentleman who stood beside me likewise saw his spectre, but not mine, as we ascertained by the movements executed; nor could I see his, unless we stood so close together that the spectres seemed combined into one. The analogy presented by these spectres with the famous *Spectre of the Brocken*, seen by travellers in the level rays of the morning sun from the summit of that celebrated mountain, and described by Sir David Brewster in his "Letters on Natural Magic," is very striking.

A PRIZE of 200*l.* has been offered by the Rev. E. Wyatt Edgell, through the Sanitary Institute of Great Britain, for the best essay that may be sent in by August 1 next, on "The Cause of Hereditary Tendencies in Health and Disease." The subject is of first importance in its bearings not only on personal but on natural health, and the Council of the Institute expects to receive many valuable contributions in competition. It only regrets that the generous donor, who for a long time has filled the office of Honorary Treasurer of the Institute, is obliged to resign office owing to a state of impaired health, which demands for a time residence abroad. The Chairman of Council of the Institute, Dr. Benjamin W. Richardson, F.R.S., and Dr. W. Farr, F.R.S., are appointed adjudicators of the prize.

PROF. F. W. HUTTON, of Dunedin, New Zealand, has been appointed to fill the new Chair of Biology in the Canterbury College at Christchurch. In consequence of this move the Chair of Natural Science in the Otago University is vacant. We have not heard what steps are being taken to fill it.

A REMARKABLE anthropological discovery has recently been made at Sypniewo, near Marienwerder (Prussia), by Herr Wilckens. In a bronze cauldron which was imbedded in the ground several feet deep, were found calcined human bones (apparently both male and female), a golden hoop, an open necklace with hook and eye, two square sticks of greenish glass with marks on them, similar to the eyes of dice, twenty button-like ball segments without holes, four bronze plates, and fragments of some metal implements evidently burnt with the bodies. The articles seem to be of old Etruscan or Phœnician workmanship, and are now in the hands of the Historical Society of Marienwerder.

"WATER ANALYSIS," by Prof. Frankland, a long-promised contribution to an important question, will be published during January, by Mr. Van Voorst.

IN reporting the reception of Prof. Nordenskjöld and the staff of the *Vega* at Nagasáki, the correspondent of the *North China Herald* notes that there was not a single case of scurvy during the whole voyage. This, he learns, was owing to the free use of a curious little berry that springs out of the eternal ice and snow during the short summer; it bears profusely, and has a taste like the raspberry, but more acid. The fruit is dried, and then mixed with the milk of the reindeer, and it can be carried in a frozen state for thousands of miles. There was also used a curious kind of food made from the whale's hide, which is pickled and eaten freely during the winter.

THE additions to the Zoological Society's Gardens during the past week include a Yellow Conure (*Conurus solstitialis*) from Guiana, received in exchange; a Vulpine Phalanger (*Phalangista vulpina*), a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens.

GEOGRAPHICAL NOTES

THE eminent Russo-German traveller, Dr. Wilhelm Junker, well known by his successful tours in the Nile districts, left Cairo for Chartum on December 1. He travels *viâ* Suez and Suakin, and hopes during the present winter to reach the Upper Nile districts beyond Chartum. This time the Monbuttu land will form the basis of his operations, and he intends to penetrate into the interior in the direction of the Congo or the Schari rivers.

DR. GERHARD ROHLFS has arrived at Rome on his return from North Africa.

THE expedition charged with the investigation of the question whether it is possible to conduct the waters of the Amu Daria into the Caspian Sea has started from St. Petersburg. General A. J. Gluchowski is commander of the Expedition, and M. Holmstrem acts as chief engineer. MM. Bole, Svichtchoff, and Macsimovich are assistant engineers. Prince Gedroitz takes part in the expedition in the capacity of geologist. These gentlemen will be joined by Capt. Roop, from Turkestan, and by Engineer Hellmann, from the Caucasus. The company will first proceed to the delta of the Amu Daria, and then begin the investigation of the river's course and of the surrounding territory, with regard to elevation, geology, &c., &c. It is considered that two or three years will be necessary for collecting the materials to finally decide the question.

PROF. BASTIAN has arrived at Batavia. He has made important ethnological and anthropological researches in Assam, and has also brought together a valuable collection of illustrative specimens. He then continued his studies in the Padang Islands, and will now do the same on the island of Java.

THE Geographical Society of Hamburg has elected the well-known author of numerous descriptions of travels, cities, and countries, Herr Ernst von Hesse Wartegg, as a corresponding member.

THE Archbishop of Algiers has received from Zanzibar favourable reports of the eighteen missionaries who left Algeria last June and had reached Ugogo, as also of the missionaries sent out last year for Tanganyika. The latter had lost their superior, Père Pascal, but had arrived at Ujiji and had been well received there by the English mission and the Arab chiefs. They had explored Urundi, a rich region, which they depict in altogether different colours from Stanley, and by invitation of the Sultan of Bikari they had established a station, commencing operations by rescuing abandoned infants. The Abbé Debaize, on the other hand, had been twice deserted by his porters, had been plundered of a great part of his outfit, and had returned sick and discouraged to Ujiji, where the Algerian and English missions were nursing him. It was not known whether he would recommence the exploration intrusted to him by the French Government.

THE death is announced of Prof. Wappæus, of Göttingen, an industrious German geographer.

THE newly-established Geographical Society of Rochefort has just issued the first number of their *Bulletin*, the more noteworthy contents of which are a paper by M. L. Delavaud on the Portuguese in Central Africa before the seventeenth century, and another by M. Silvestre on Indo-China.

ON THE HETEROSTYLISM OF "MELOCHIA PARVIFOLIA"

MELOCHIA PARVIFOLIA, H.B.K. (nova gen. et spec., pl. v., 325) is a very common plant on the dry plains in the neighbourhood of Carácas, where it flowers nearly all the year round, and not only in the month of January, as Kunth says in his description, which in all other respects is a very complete and good one. I was led to notice the heterostylism of this plant when comparing carefully Kunth's words with a specimen I had brought home. Humboldt's specimen belonged to the long-styled form, for Kunth says:—*Stamina petalis dimidio breviora, Styli longitudine petalorum.* Mine was short-styled, so that I found these proportions to be inverse. I searched immediately our *sabanas* (or plains) for long-styled plants, and came at once across a considerable number of both forms. A comparison of their flowers gives the following result:—

Short-styled Flowers.	*Long-styled Flowers.*
1. Stamens as long as the petals.	1. Stamens half as long as the petals.
2. Styles scarcely half as long as the stamens.	2. Styles as long as the petals.
3. Stigmata with few and short papillæ.	3. Stigmata with many and rather long papillæ.
4. Styles without stellate hairs.	4. Styles with stellate hairs.
5. Pollen grains:—	5. Pollen grains:—
a. Dry, globular, diam. 0·044 mm.	*a*. Dry, elliptical, obtusely triangular in cross-section, diam. 0·044 × 0·024 mm.
b. In water, globular, diam. 0·060 mm.	*b*. In water, globular, diam. 0·052 mm.
c. In alc. abs., globular, diam. 0·036 mm.	*c*. In alc. abs., elliptical, diam. 0·040 × 0·028 mm.

(My measurements were made with a glass micrometer by Oberhäuser, five divisions of which are equal to 0·02 millimetres for the enlargement I used.)

It would appear that the protoplasm of the pollen-grains of the short-styled form contains a larger percentage of water, their size shrinking more in alcohol than that of the pollen-grains of the long-styled form.

Although the heterostylism of *Melochia parvifolia* might be fairly admitted from the stated morphological differences, I was desirous to try by experiments whether there was also a functional difference, as Darwin and Hildebrand have done in the case of other heterostyled plants.

Both forms of *Melochia parvifolia* seem to be equally common in our flora. This I ascertained in the following manner:—On the *Sabana de San Lázaro*, where this plant constitutes all the higher vegetation, together with *Turnera ulmifolia*, *Pavonia cancellata*, and *Hyptis suaveolens*, all the plants of *Melochia* were examined in a square, the side of which was 100 steps. There were altogether forty-two plants, twenty with long-styled flowers, and twenty-two with short-styled ones. In one single plant of the former two short-styled flowers were discovered, in all the rest each plant had only one kind of flower. I collected seeds from both forms, and began last year my experiments by sowing them in cases placed in one of the yards of my house in town. This circumstance was perhaps of some consequence, the yard being surrounded by walls 12 feet high, so that there could be next to nothing of the influence of the wind, just the reverse as in the open field.

Ten seeds taken from plants with long-styled flowers produced eight plants, which this year flowered, all the flowers being long-styled ones.

Ten seeds of the short-styled form gave nine plants; two of these perished before setting flowers; the remainder produced in due time a large number of short-styled blossoms.

The last summer was very rainy, thus not at all favourable to experimental research connected with artificial fecundation. However, I tried my best, and obtained the results given in the following table, which is constructed according to Darwin's models in his "Forms of Flowers":—

Nature of union.	Number of flowers fertilised.	Number of capsules produced.	Average number of seeds per capsule.	Percentage of capsules in reference to flowers.
a. Long-styled form by pollen of short-styled	12	12	5[1]	100
b. Long-styled form by own-form pollen, from a distinct plant	10	8	3·5	80
c. Long-styled form by pollen from the same flower[2] ...	6	1	5	16·6
d. Short-styled form by pollen of long-styled	12	12	5	100
e. Short-styled form by own-form pollen from a distinct plant	10	9	3·3	90
f. Short-styled form by pollen from the same flower[3] ...	8	6	4	75
Cases *a* and *d* together (legitimate unions)	24	24	5	100
Cases *b* and *e* together (illegitimate unions)	20	17	3·4	85
Cases *c* and *f* together (illegitimate unions)	14	7	3·6	50

I think the favourable influence of cross-fertilisation is evident, as in no other case the *average* number of seeds per capsule reached the *normal* number, although there were some few capsules in the other crops which also contained five seeds.

In the open field the flowers of *Melochia parvifolia* are visited by large numbers of small hymenoptera, which fly about during the hottest hours of the day, when these flowers are open. They have no particular smell, and fade very soon; on cloudy or rainy days they do not open at all, so that not a few wither before getting fertilised, which accounts for the considerable number of seedless capsules to be found on nearly every plant.

The seeds of my crop appeared to be of good quality (their specific weight being greater than that of water). I have sown them already in separate lots, in order to find out how far they will germinate and produce strong and healthy plants, and which forms of flowers these latter will have. A. ERNST

Carácas, November 2

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Next term, at Cambridge, practical anatomy in the dissecting-room will commence on January 17. The professor of anatomy is to be assigned (as to his fellowship) to King's College, and not to Caius, as originally proposed; it was thought more advisable not to assign two professorial fellowships in medical science to Caius, but rather to divide the association. Prof. Paget is especially fitted to receive further honour from Caius College, and we trust he will ultimately attain the mastership.

Prof. Newton announces that his lectures will recommence on February 2; and the demonstrator will take an advanced class on Sauropsida, beginning on the same day.

[1] Normal number of seeds in *Melochia parvifolia*.

[2] The plant was left to itself, foreign pollen being excluded by a fine muslin-bag tied around it. The numbers show that self-fertilisation was difficult in this case; though in the open field, where the wind has its full sway, it may be much easier, and perhaps more frequent.

[3] The plant was treated as stated in the foregoing note. Self-fertilisation is no doubt easier in this case, but the result of the crop was not very good.

Candidates for the natural science scholarship at Clare College are to be examined in chemistry and chemical physics, without restrictions in age.

At King's College any candidates for honours are now received, a great improvement on the old exclusiveness. The Vintner exhibition for natural science is worth 90*l*. a year, but only candidates under twenty, and British subjects, may compete, also undergraduates of the College in their first or second year. The scholarships are to be held till M.A. standing, or until election to a fellowship. Candidates in natural science must notify before March 1 in what branches of natural science they wish to be examined.

Every encouragement is now offered to selected candidates for the Indian Civil Service.

It having been decided that there should be a memorial to Prof. Clerk Maxwell, it might be suggested that a Maxwell university scholarship in experimental and molecular physics would be a great benefit, as there are scarcely any mathematical or natural science competitions open to the University. Let it be given for a specified research, rather than spend it on a posthumous bust or portrait.

MANCHESTER.—Mr. J. E. A. Steggall, B.A., scholar of Trinity College, Cambridge, mathematical master at Clifton College, Bristol, has been appointed to the Fielden lectureship in mathematics in the Owens College, vacant by the appointment of Mr. A. T. Bentley, M.A., to the principalship of the Firth College, Sheffield. Mr. Steggall graduated as second wrangler in January, 1878, and subsequently gained the First Smith's Prize. There were twenty candidates.

WE have received a very favourable report from the Liverpool School of Science, which now numbers 800 students. Before long it is hoped that a central college may be established in Liverpool, from which all existing branches with extensions may be worked.

THE Kaiser Wilhelm University at Strassburg is seemingly becoming popular in Germany. During the last term the number of students rose to 810, this being the largest number reached since the University was inaugurated.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 11, 1879.—This opens with a valuable contribution by Herr Hagenbach in support of Stokes's law, the validity of which has been somewhat controverted recently. The author regards Lommel's division of fluorescent bodies as based on no essentially different behaviour of them.—Some curious experiments on electric perforation of glass are described in papers by Herren Mach and Doubrava, and Herr Waltenhofen; the latter considers the phenomenon as "a mechanical work taking place at cost of the *vis viva* of the colliding air-molecules at the part perforated, and this transformation of energy is evidently more easily effected the stronger the molecular motions; which, when they meet an obstacle, are suddenly checked." Herr Doubrava also writes on the motion of plates between the electrodes of the Holtz machine.—A series of experiments, by Herr L. Weber, with electricity of high tension used in the telephone, seem to clear up some sources of error in like observations by other physicists, to give new proof of the availability of the telephone for observing weak periodic discharges of a conductor, and to illustrate the conception of Helmholtz and others as to electric movements in an induction circuit and electrolytes inserted in it.—The relations between velocity of rotation, resistance, current strength, and electromotive force, in the Gramme machine, are set forth by Herr Meyer and Herr Auerbach.—Other papers:—On the true theory of Fresnel's interference phenomena, by Herr F. Weber.—On the relation between galvanic resistance and specific heat, by Herr Auerbach.—On extra currents in iron wires, by Herr Herwig.—Experimental researches in determination of the indices of refraction of liquefied gases, by Herr Bleekrode.—Influence of temperature on tuning-forks, by Herr Kayser.—On galvanic conduction of metallic alloys, by Herr Elsässer.—On phosphorescence-phenomena, by Herr Stürtz.

Gazetta Chimica Italiana, fasc. x. 1879.—Researches on cobalt and nickel, and methods for distinguishing them when mixed, by Dr. Papasogli.—On the constitution of ellagic acid, by S. Schiff.—On determination of acetyl by means of magnesia, by the same.—Ozone with some noble metals, by Prof. Volta.—On paraoxymethylphenyl-cinnamic acid, and on oxymethylstilbene, by Dr. Oglialoro.—On the action of perchloride of phosphorus on molybdic anhydrides, by S. Piutti.—On some derivatives of naphtols, by S. Marchetti.—Researches on the diffusion of copper in the animal kingdom, by Dr. Giunti.—On amines corresponding to a toluic alcohol, by Dr. Spica.—On the preparation of hydroxylamine, by Dr. Bertoni.—Transformation of hydroxylamine into nitrous and nitric acid, by Dr. Bertoni.—On an easy and rapid process for determining at any time the nitrogen, sulphur and chlorine, in organic substances, by Dr. Spica.

Bulletin de l'Académie Royale des Sciences de Belgique, Nos. 9 and 10.—M. Montigny here describes a case of supernumerary rainbows which were only visible at the lower extremities of the principal bow (a phenomenon overlooked in works on meteorology).—M. van Mensbrugghe shows how the ventral and nodal appearances of liquid veins may be explained on principles he lately enunciated.—Dr. Jorissen contributes a note on the employment of chloride of zinc as reagent for certain alkaloids, glucosides, &c.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 18, 1879.—"Chemico-Electric Relations of Metals in Solutions of Salts of Potassium," by G. Gore, LL.D., F.R.S.

In this investigation the author has determined the chemico-electric positions of about twenty-four elementary substances in a number of solutions, of various degrees of strength, and both cold and hot, of chloride, bromide, iodide, and cyanide of potassium, and has drawn from the results of the experiments various general conclusions. The results are exhibited in a series of tables. The experiments were made with the intention of also determining by means of a capillary electrometer the quantitative differences of electromotive force between each two consecutive elementary substances of the entire series; but after making many attempts the author was unable to construct such a form of that instrument as might be relied upon for accurately measuring such differences.

Chemical Society, December 18, 1879.—Mr. Warren De La Rue, president, in the chair.—The following papers were read:—On the specific volume of water of crystallisation, by T. E. Thorpe and J. J. Watts. Some years ago Playfair and Joule pointed out that the volumes of certain highly hydrated salts, for example, sodium carbonate with ten molecules of water, are equal to that of the water, considered as ice, which they respectively contain. This law does not hold good for salts less highly hydrated. The authors of the present paper have determined the precise relations between the specific volumes of various sulphates of copper, magnesium, zinc, nickel, cobalt, iron, and manganese, and their respective degrees of hydration. They conclude that in the case, at least of the so-called magnesian sulphates, the volume occupied by the several molecules of water varies with the degree of hydration. The first molecule occupies less bulk than any other, its mean relative value is 10·7, the value of the second molecule being 13·3, of the third 14·5, the fourth 15·4, the fifth 15·6, the sixth 15·7, the seventh 16·2. These results accord with the fact that the different molecules of water in a hydrated salt are held with various degrees of tenacity. The authors point out the importance of estimating the amounts of heat resulting from the combination of successive molecules of water.—Note on the formation of ozone during the slow oxidation of phosphorus, by H. McLeod. The active substance formed during the slow oxidation of phosphorus is probably either ozone or peroxide of hydrogen. Air in which phosphorus is slowly oxidising, was drawn through a U-tube 9½ inches long (filled with fragments of glass containing in succession sodic carbonate, a mixture of potassic bichromate and sulphuric acid, and potassic permanganate), the U-tube was at the temperature of the air or at 100° C., in both cases the gas which passed through rendered blue a solution of potassic iodide and starch, hydroxyl under these circumstances would be completely decomposed. In another series of experiments the gas was passed through a narrow U-tube heated to 150° to 200° C., but no water was formed. It is extremely improbable that ozone and hydroxyl are simultaneously formed, as these substances decompose each other. The author therefore concludes that the gas obtained during the slow oxidation of phosphorus possesses the properties of ozone and not those of hydroxyl, the only known peroxide of hydrogen.—On the analysis of organic bodies containing nitrogen, by W. H. Perkin. The author proposes to substitute for the freshly reduced metallic copper, which has severa disadvantages (such as being hygroscopic, occluding iron, &c.), roughly powdered or granulated potassic chromate. About 4 to 7 inches of this substance are placed in the front of the combustion tube and maintained at a low red heat. All nitrous fumes are completely absorbed, whilst no effect is produced on the carbonic acid determination. The salt can be readily dried. It also absorbs sulphurous acid completely.

Linnean Society, December 18, 1879.—Prof. Allman, F.R.S., president, in the chair.—Mr. B. Daydon Jackson exhibited series of the various editions of Dillenius's "Historia Muscorum," Oxford, 1741, and its reprint, Edinburgh, 1811, in illustration of the following communication.—The Rev. J. M. Crombie read a paper on the lichens of Dillenius's "Historia Muscorum," as illustrated by his herbarium. This latter collection is preserved in the Botanic Gardens at Oxford, and the specimens, though well nigh 150 years old, are still in a fair state of preservation. The intrinsic value of Dillenius's material rests in the fact of the earlier writers on cryptogamic botany referring constantly, in their synonomy and nomenclature, to his descriptions; hence the importance of an accurate knowledge of the collection, to judge from a present standard, in how far his descriptions and figures agree with the specimens themselves. No systematic examination has hitherto been made, though some old writers have compared certain of the forms. While the Dillenian lichens identified are, as a whole, now found to bear considerable accuracy with his descriptions and figures, yet serious mistakes have crept in. Mr. Crombie gives technical data and details of the series, and adds a conspectus for reference to workers on lichens who have not Dillenius's volumes and figures at hand.—Prof. Allman then gave a description of what appears to be true sense-organs in the hydroids. In one form the organ in question is a bulb, with rod-like structures and a series of radiating filaments. These latter terminate in conical bodies containing filaments which resemble thread-cells, though differing physiologically. Another form is met with in a Medusa (*Gemmellaria*), where free, club-topped filaments constantly in motion are attached to the tentacles, and possess sacs with thread-cells, but incapable of being exserted. Prof. Allman suggests the term *Podocysts* for these, and says, from his observations in *Myriothela* and other genera, they have a wide extension among the hydroids.—Mr. H. Seebohm was elected a Fellow of the Society, and Messrs. A. D. Bartlett (Zool. Gard.), N. E. Brown (Kew Herb.), and F. H. Waterhouse (Librarian, Z.S.) were balloted for and elected Associates.

Entomological Society, December 3, 1879.—J. W. Dunning, F.L.S., vice-president, in the chair.—Mr. Howard Vaughan exhibited a series of extreme varieties of *Lycæna corydon* which had been taken at Dover.—Mr. W. L. Distant exhibited a hitherto unrecorded variety of *Danais plexippus* (commonly known as *D. archippus*) received from Antigua.—Mr. T. R. Billups exhibited some rare British beetles, and a specimen of *Carabus auratus* taken in the Borough Market.—Mr. C. O. Waterhouse communicated some interesting details as to tenacity of life in *Curculio cleonus*.—The Rev. H. S. Gorham read a paper entitled "Materials for a Revision of the Lampyridæ." Mr. Bates, in connection with the light-emitting power of this family, remarked that certain species of Longicorns mimicked Lampyrids with great exactness, the light-giving segments of the latter being perfectly represented in the Longicorns, although destitute of phosphorescent power.—Mr. J. W. Slater communicated a paper on certain minute characters of insects with reference to the theory of evolution.—A communication was received from Mr. P. H. Gosse, on *Papilia homerus*, its ovum and larva, and a paper from Mr. Roland Trimen, on some hitherto undetermined butterflies inhabiting Southern Africa.

Geological Society, December 17, 1879.—Henry Clifton Sorby, F.R.S., president, in the chair.—James Booth, Edgar S. Cobbold, D. M. Ford Gaskin, John Farran Penrose, Stephen Seal, Thomas Tate, and Richard Taylor were elected Fellows of the Society.—The following communications were read:—A contribution to the physical history of the cretaceous flints, by Surgeon-Major G. C. Wallich, M.D. The author described the origin, the mode of formation, and the cause of the stratification of the chalk flints. Taking as the basis of his conclusions the fact brought to notice by him in 1860, namely, that the whole of the protozoan life at the sea-bed is strictly limited to the immediate surface-layer of the muddy deposits, he pointed out in detail the successive stages of the flint-formation, from the period when the chief portion of the silica of which they are composed, was eliminated from the ocean-water by the deep-sea sponges to the period when it became consolidated in layers or sheets conforming to the stratification of the chalk. In relation to this subject the author claimed to have sustained the following conclusions:—1. That the silica of the flints is derived mainly from the sponge-beds and sponge-fields, which exist in immense profusion over the areas occupied by the globigerine or calcareous "ooze." 2. That the deep-sea sponges, with their environment of protoplasmic matter, constitute by far the most important and essential factors in the production and stratification of the flints. 3. That whereas nearly the whole of the carbonate of lime, derived partly from foraminifera and other organisms that have lived and died at the bottom, and partly from such as have subsided to the bottom only after death, goes to build up the calcareous stratum, nearly the whole of the silica, whether derived from the deep sea sponges or from surface protozoa, goes to form the flints. 4. That the sponges are the only really important contributors to the flint-formation that live and die at the sea-bed. 5. That the flints are just as much an organic product as the chalk itself. 6. That the stratification of the flint is the immediate result of all sessile protozoan life being confined to the superficial layer of the muddy deposits. 7. That the substance which received the name of "*Bathybius*," and was declared to be an independent living Moneron, is, in reality, sponge-protoplasm. 8. That no valid *lithological* distinction exists between the chalk and the calcareous mud of the Atlantic, and *pro tanto*, therefore, the calcareous mud may be, and in all probability is, "a continuation of *the* chalk-formation."—Undescribed fossil carnivora from the Sivalik Hills, in the collection of the British Museum, by P. N. Bose. This communication contained descriptions of nine species of carnivora from the ossiferous Sivaliks, together with an introduction, in which the age of the Sivalik fauna, and several matters of general interest, were briefly discussed. The species described were: *Machærodus sivalensis*, *M. palæindicus*, *Felis grandicristata*, *Hyæna sivalensis*, *H. felina*, *Viverra bakerii*, *Lutra palæindica*, *Canis curvipalatus*, and *C. cautleyi*. *Canis curvipalatus* is so named on account of the curvation of the palate. *C. cautleyi* is closely allied to the wolf, as is *Viverra bakerii* to the civet. The form of the forehead is peculiar in *Lutra palæindica*. In the form of the skull, the dimensions of the upper tubercular, &c., *Hyæna sivalensis* approximates to the living Indian hyæna (*H. striata*); but, in the absence or extremely rudimentary character of the postero-internal cusp in the lower carnassial, as well as in the entire absence of the anterior accessory cusps in the upper and the first two lower premolars, the Sivalik species comes closer to *H. crocuta*. *H. felina* differs from all other species of hyæna, living or extinct, in the absence of the upper premolar 1. *Felis grandicristata*, which was of about the same size as some of the larger varieties of the Royal Tiger, had the sagittal crest even more prominent than the *F. cristata* of Falconer and Cautley. *Machærodus sivalensis* was of about the same size as the jaguar. One of the specimens, on which this species is based, shows two molars in the deciduous dentition instead of three (as in the genus *Felis*). *M. palæindicus* was considerably larger than *M. sivalensis*. Both differ from all other known species of *Machærodus* in the form of the lower jaw, &c.

PARIS

Academy of Sciences, December 15, 1879.—M. Daubrée in the chair.—The following papers were read:—On some applications of elliptic functions, by M. Hermite.—Researches on the substance designated hydride of copper, by M. Berthelot. The amorphous substance precipitated in the reaction of hypophosphorous acid with sulphate of copper is not a true hydride; it contains constitutional water, oxygen, and phosphorus in considerable quantity.—On the cold of December and its influence on the temperature of the snow-covered ground, by MM. Becquerel. Snow alone does not preserve the bodies it covers from frost. It acts, indeed, as a screen, preventing radiation, and gives water at 0°, which filters through the ground; but under 0° it undergoes, like other bodies, by its conductivity, variations of temperature, and may transmit them, attenuated much, however, by reason of its thickness. But the presence of straw or the like under the snow may preserve organic bodies in the ground.—M. Pasteur stated that the bacteridium of anthrax, and the organism which produces the cholera of fowls, could both resist a temperature of 40° below zero.—On the variations of the vertical, by M. D'Abbadie. In his observatory near the Pyrenees he has found the place of the vertical vary in only six hours, from 7″·4 to 2″·4, and he thinks the changes there do not depend on temperature (as M. Plantamour explains the phenomena he noted). The desirability of all astronomers publishing their observations on this subject is referred to.—Craniology of Australian races, by MM. Quatrefages and Hamy. The eighth volume of their "Crania Ethnica" completes the study of the Australians, and treats partly of the African negro races. The Australian continent seems to contain only two indigenous races, one forming the Australian race proper, the other distinguished as *neanderthaloid*, and represented by a small number of homogeneous and disappearing tribes. The craniological characters are indicated. The male natives of the interior have considerably larger cranial capacity than those of the coast, but the women have slightly less.—Observations during a voyage in Equatorial America, by M. Crévaux. The River Iça (one of the affluents of the Amazon) is navigable for 800 geographical miles, as far as the outliers of the Andes.—New æroplane, moved by a compressed air-engine; experimental determination of the work necessary to make it fly, by M. Tatin. The apparatus resembled that of Henson's (1843), except in dimensions, a sort of kite moved by screw propellers. It rises and describes a curve in the air, coming to the ground again. The horse-power was about 1 per 50 kg.—Reply to M. Balbiani, on the presence of the winter egg of phylloxera in the ground, by M. Boiteau.—A head of jacquez grafted on a French vine, by M. de Lafitte.—On a class of functions connected with the functions of M. Heine, by M. Appell.—On measurement of the intensity of absorption lines and dark lines of the solar spectrum, by M. Gouy. The problem is reduced to making a pure spectrum, and measuring the intensity of different portions of it.—On a curare of the unstriped muscles, by MM. Couty and De Lacerda. This kills by lowering the arterial tension, and consequent cessation of the circulation. The effects were got with preparations from *Strychnos gardnerii* and *S. triplinervia*.—Alterations of the cutaneous nerves in a case of vitiligo, by MM. Leloir and Chabrier.—Researches on vaso-dilator nerves contained in various branches of the fifth pair, by MM. Jolyet and Laffont.—On the chemical composition of bones in arthropathy of the ataxic, by M. Regnard. Fat becomes abundant, and phosphate of lime is greatly diminished.—Researches on the mode of formation of the spinal fissure, by M. Dareste.—On a new form of vesicular worm found in a jerboa, by M. Mégnin.—New remarks on the Orthonectida, by M. Giard.—On the reproduction of marine algæ (Bryopsis), by M. Cornu.—On the influence of forests on rain-currents traversing them, and the affinity of pines for vapours, by M. Fautrat. On an average the weight of aqueous vapour contained in 1 cub. metre above pines is 8·66 gr., and on bare ground at the same height 7·39 gr.; showing 1·27 gr. in favour of the pines. Above leafy trees the corresponding numbers are 8·46 gr. and 8·04 gr.; difference in favour of leafy trees 0·42 gr.—On a very intense hoar-frost observed at Angers on December 12 and 13, by M. Decharme. The temperature was − 8°·8 to − 6°·4; pressure 779 mm.; wind weak. The numerous long opaque needles of ice were all placed on one side of the branches, that opposite to the direction of the wind.—M. Jobert proposed a large celestial reflector, giving, in a dark chamber which might hold as many as a hundred observers, an enlarged image of heavenly bodies.

December 22, 1879.—M. Daubrée in the chair.—M. Faye presented his "Cours d'Astronomie nautique." His method is to bring all questions to two or three fundamental equations (which ever recur). The study of chronometers is treated with special care. The graphic solutions of Douwes's problem are expounded from a new standpoint.—Reply to M. St. Claire Deville's remarks on the temperature of decomposition of vapours, by M. Wurtz.—Observations on M. Berthelot's note entitled "Researches on the Substance named Hydride of Copper," by M. Wurtz. He adheres to his formula, Cu_2H_2. The presence of a small quantity of copper and phosphate of copper in the product explains at once the existence of small quantities of oxygen and phosphorus, and the deficit in hydrogen.—On a new hydride of silicium, by M. Ogier. He submitted some siliciuretted hydrogen to the electric *effluve*. After some time the gas is wholly destroyed; a yellow coat forms on the walls of the tube, and the gaseous volume (pure hydrogen) increases to a sensibly constant limit. The composition of the deposited matter (arrived at from comparing the volume of the siliciuretted hydrogen and the resulting hydrogen), appeared to be Si_2H_3. The body is thus a sub-hydride of silicium corresponding to sub-oxide of carbon, or to crotonylene. (Its properties are specified.) Similar effects are got with the *effluve* acting on arseniuretted hydrogen; a solid hydride As_2H is formed, corresponding to solid phosphide of hydrogen, P_2H.—Comparative studies on ptyaline and diastase, by M. Defresne. These two bodies are not identical physiologically. Ptyaline saccharifies starch in the mixed gastric juice as well as in the mouth; it is only paralysed an instant in pure gastric juice, and recovers its action in the mixed juice and in the duodenum. Diastase or maltine is destroyed immediately in chlorhydic solutions or in pure gastric juice, and after having passed into the mixed juice, it is profoundly altered, for, if again dissolved with starch, it no longer saccharifies it.—M. Debrun submitted a new capillary electrometer, a modification of Lippmann's, a microscope being dispensed with, and the mercury surface whose displacements are observed being in a graduated tube inclined at an angle of 10° to the horizon. The change of level is about 75 mm. for a variation of one volt (giving, with a Vernier, a sensibility of at least $\frac{1}{150}$ of a volt).—On the determination of the elements of a vibratory movement; measurement of periods, by M. Mercadier. Two very fine styles are fixed (parallel, and one behind the other, and very near it, in a horizontal plane) to the two vibrating bodies; and their shadows with light coincide on a vertical screen. When the bodies vibrate vertically, a certain number of lines result in the projection, some of which are broader than others, and seem fixed. (These effects are investigated).—Researches on nitrification, by MM. Schlœsing and Muntz. The conditions affecting the production of nitrates are set forth; temperature, access of oxygen, humidity, weak alkalinity, presence of various organic matters, &c. *Nitrites* are formed in general when the conditions of temperature and aëration are not advantageous.—On dioxyethylmethylene, and on the preparation of chloride of methylene, by M. Greene.—On two substances, palmelline and characine, extracted from fresh-water algæ, by Mr. Phipson. It is characine that gives plants of the *chara* genus their marshy odour; it is formed by the plant during life, and is not a product of decomposition. It is lighter than water, and is a species of camphor, forming very thin pellicles on the water surface, but dissolving very little in it.—Habits and parthenogenesis of *Halictus*, by M. Fabre. These animals have two generations annually, one in spring, and sexual, from mothers which, fecundated in autumn, have passed the winter in their cells; the other in summer, and due to parthenogenesis.—On tubercular inflammation of the internal coat of the vessels in tubercular meningitis, by M. Cornil.—On the structure of the bark and wood of *strychnos*, by M. Planchon.

CONTENTS

THURSDAY, JANUARY 8, 1880

THE TECHNICAL UNIVERSITY QUESTION

THE correspondence which has appeared during the month of December in the columns of the *Times* concerning the question of a Metropolitan Technical University, has revived a question upon which we have more than once spoken in these columns, and of which we shall hear more hereafter. It is quite evident that the promoters of the City and Guilds of London Institute for the Advancement of Technical Education meet with many great and unforeseen difficulties in the way of pushing into execution their laudable project for applying some of the vast funds they have inherited from the Trade Guilds of the past to the purpose of promoting the elevation of trade by science. It is equally evident that they will not abandon their projects without a very considerable effort, especially now that the pressure of public opinion is beginning to bear upon the question and to aid them in their demand. No one probably denies or doubts the legal right of the City Companies to the funds which have thus come down to them. Probably also no one denies or doubts that the law-making power which gave them these legal rights can take them away and can force them to hand over, if need be, to the advancement of Technical Education at large, the wealth which they have ceased to apply to the advancement of Technical Education within their own borders. Two years ago a very definite scheme in this direction was launched by the provisional Committee appointed by some of the Guilds. Recognising the moral obligation upon them to use their funds for the advancement of their respective industries, some dozen out of the eighty City Companies agreed to devote a certain yearly sum for this purpose. They even went so far as to invite a number of distinguished men of science to write reports on the best way of attaining the ends in view, and eventually they embodied their suggestions in a report which was characterised by two main propositions: firstly, to establish local technical schools which should be accessible to artisans; secondly, to found a central institution, chiefly for training technical teachers and scholars of exceptional promise. This was two years ago; and in the mean time so little has been done, that some of those who have taken an active part in the earlier stages, begin to be impatient at the little substantial progress made.

A note of dissatisfaction of this nature was heard at the beginning of the month of December, and gave rise to the discussion in the *Times*, to which we have alluded. To understand the merits of the controversy it will be necessary to go back to the beginning. The correspondence arose out of some remarks made by Prof. Huxley when presiding at the meeting of the Society of Arts on December 3, at which a paper on apprenticeship was read by Prof. Silvanus Thompson, of Bristol, and to which a paragraph was devoted in NATURE, vol. xxi. p. 139. Prof. Thompson's paper, which appeared in the *Journal* of the Society of Arts for December 5, and which has been reprinted in pamphlet form, was devoted to a discussion of the relation between apprenticeship and technical education; and after laying down the general principles of a scientific and rational system of apprentice training, pointed out that the "lower technical," or "industrial" training which is needed for the forming of good workmen, cannot exist in any effective degree until there is some provision made for the higher technical training analogous to that of the great technical schools of Germany and France, which would qualify a superior class to become on the one hand foremen and masters, and on the other teachers in technical schools. In short, Prof. Thompson's argument was that there could be no growth of technical schools for the artisan without a central technical university to train teachers for such schools.

In the discussion which ensued Prof. Huxley made some pungent remarks upon the delays which had arisen over the project of the Guilds and Companies of the City of London, who had consulted him some time back concerning their proposal to found a Central Institution or Technical College, and who, two years ago had empowered him to make known their good intentions. It was time, he thought, that those good intentions bore fruit. It would be an utter scandal if one shilling were asked for out of the general revenue for this purpose, at least so far as London was concerned, for the Livery Companies were in possession of the enormous funds inherited along with the ancient traditions of the crafts from the old Guilds of London, which were established to aid their respective trades—funds which they were morally, if not legally, bound to apply to the advancement of Technical Education.

Prof. Huxley's remarks were not, however, suffered to pass unchallenged. In the *Times* of December 9 Mr. J. H. Crossman condemned Prof. Huxley and those who act with him as somewhat impatient and hasty in their proposals.

To this letter Prof. Huxley replied a few days later in a most admirably conceived and no less successfully worded letter. What had been proposed was simply the establishment of local technical schools accessible to the artisans, and a Central Institution chiefly for the training of teachers and of scholars of exceptional capacity; and he added the very pertinent query: "Do the Livery Companies of London intend to carry out any general scheme of Technical Education such as that adopted by their own Committee, or do they not?"

Mr. Owen Roberts, one of the Honorary Secretaries of the City and Guilds Institute, replied to the point raised by Prof. Huxley's letter, asking whether he was aware of the negotiations which had been going on between the City and Guilds Institute, and the Lords Commissioners of the Exhibition of 1851, for a piece of land on the South Kensington estate as a site for a central institution, and stating that the only reason why these negotiations had not been definitely concluded, was that lately the Commissioners had put forward certain requirements, as a condition of their grant of a site, which the Livery Companies have not considered to be consistent with their independence of action. Hence the repeated delays, which had not, however, debarred the Institute from proceeding with one very important section of its work, namely, the promotion of local schools for artisans.

Following hard on Mr. Roberts's letter, there appeared in the *Times* of December 27 a communicated article giving a careful and detailed history of the various schemes considered by the City and Guilds Institute, which may be broadly stated as being three in number. The first of these schemes, proposing to build a central institution upon a site on the Corporation lands on the Thames Embankment, has been dismissed as essentially too costly. The second, the proposal to obtain a site from the Commissioners of the South Kensington Estate, is in abeyance since the ancient free "spirit" of the Companies leads them to regard as distasteful either that the Commissioners should be directly represented on the managing body of the Central Institution, or that, as an alternative, the chief scientific bodies of the nation should have the right of being represented on it. The third scheme, which apparently does not stand a much better chance of success than its predecessors, though having many points in its favour, was a proposal to buy the palatial mansion built by Baron Grant at Kensington, with its seven acres of ground, and convert it into a building for a Central Institution by slight but suitable alterations in its interior arrangements, thus obtaining capital laboratories and lecture theatres. But the unreasoning outcry raised against the site simply because it was in the west, and not in some equally inaccessible situation in the north or in the east, has been so loud in its tones that we believe the project has virtually been abandoned. At least so the semi-official article in the *Times* would lead us to imagine. Prof. Huxley has, however, had a last word on the matter. He cannot quite agree in the view that the guarantees asked by the Lords Commissioners are so unreasonable as the Livery Companies think them. In his second letter of the 29th ult. he says that if he is rightly informed, they amount to being guarantees firstly of sufficiency and permanency of endowment, and secondly of proper government; the desire of the Commissioners in reserving the right of nominating two or three members of the governing body being merely that they may insure the presence amongst the representatives of the city magnates that small number of "educational experts." To which Mr. Roberts quietly rejoined that educational experts differed considerably in the advice they tendered, and that the principal point of objection lay in the proposal that the two or three persons nominated by an exterior authority should be the only permanent members of a governing body the majority of whom were continually going off by rotation.

It is not our place to pronounce judgment upon the conflicting views which have been maintained concerning the conditions imposed by the Commissioners in their offer of a site. If Prof. Huxley's information is correct, it is hard to see how or why the independence of the Guilds, or of the Institute they have founded, should be impaired by the presence on the governing body of such men as, say, Mr. Lyon Playfair, or Mr. Mundella, or perhaps even Prof. Huxley himself. If, on the other hand, the Livery Companies have some further knowledge or insight than Prof. Huxley has, it would certainly be well if they would explain what it is that is incompatible with their ancient liberties, and would suggest some alternative course, which, while reserving them all reasonable liberty of action, should attain the ends for which guarantees are desired.

The most painful aspect of the whole controversy is one which does not come to the surface in this correspondence, but which is nevertheless a very real one. There is a large section of the outside public who take a deep and increasing interest in the question of technical education, and who have watched the present scheme from its first inception with something more than curiosity. They cannot understand that any body of men really intending to carry out a project such as that which was made public two years ago could permit such endless delays, such interminable cross-purposes, such haggling over different schemes, as have been lately witnessed. They begin to fear that all these things are done with a purpose, and that the delays are interested, and the rival schemes manufactured to serve some less noble end. Whether such persons are right or wrong, all these whispers would be at once silenced by a few unmistakable signs of real progress, such as we have looked for in vain. The public knows well enough that the organisation of the City Guilds *as they are* is a blot upon an intelligent community; that they have ceased in all but name to represent the trades for the sake of which and out of which they arose. It knows full well that their unfathomed funds are not applied to the purpose of elevating and improving their respective crafts, whatever else they may be applied to. And it is quite prepared to say with emphasis when the moment arrives that if reform does not come from within it must come from without. The first step, if such measures must come, will doubtless be the appointment of a Royal Commission of Inquiry. What the second might be he must be bold who would predict.

The announcements made two years ago were hailed as a note of progress, indicating the probability that wiser counsels would prevail, and that the needed reform was to be brought about quietly and harmoniously from within. But the project for founding a Central Technical College is as far from realisation as ever, and the hopes raised have been sorely disappointed. Men of scientific habits and of business aptitudes are alike getting tired of the endless delays and fruitless negotiations that have taken place. And there are, we suspect, many who, on learning how one scheme after another has fallen through for want of unanimity of purpose to carry it out, will be quite ready to think that it was not without good cause that Prof. Huxley asked: *Do the Livery Companies of London intend to carry out any general scheme of Technical Education such as that adopted by their own Committee, or do they not?*

OSTEOLOGY OF MAN

Catalogue of the Specimens Illustrating the Osteology and Dentition of Vertebrated Animals, Recent and Extinct, contained in the Museum of the Royal College of Surgeons of England. By William Henry Flower, Conservator of the Museum. Part I. *Man.* (London: David Bogue, 1879.)

IT is now twenty-five years ago since Prof. Owen, the then Conservator of the Museum of the Royal College of Surgeons, completed the last volume of the catalogue of the osteological collection. Since that time the additions to the Museum have been so numerous and valuable that the original catalogue has ceased to fulfil the requirements of the collection, and the preparation of a new catalogue has become necessary.

Prof. Flower, the present Conservator, has undertaken this task, and the first fruit of his labours is now before us. In this volume he has catalogued the specimens, 1,312 in number, which illustrate the development of the human skeleton, the osteology of adult man, the dentition of man, and the crania and other parts of the skeleton illustrating the osteological characters of the various races of men. This volume is, therefore, from the extent and variety of the collection, and from the methodical way in which the numerous measurements are recorded, an important contribution to physical anthropology.

In the introductory chapter Prof. Flower describes the method he has pursued in obtaining the measurements of the crania, and he explains the meaning of a number of terms, mostly introduced by Paul Broca, into craniology. The measurements which he records are taken with especial reference to the determination of the circumference of the cranium, its length, breadth, and height and the relations of these to each other; the length from the anterior margin of the foramen magnum, on the one hand to the fronto-nasal suture, and on the other to the most projecting part of the upper alveolar arch, from which the alveolar index is deduced; the height and width of the nose; the height and width of the orbit; and the cubic capacity of the cranium. The capacity is expressed in cubic centimetres and the other measurements in millimetres.

In measuring the length of a skull craniologists are in the habit of taking the longitudinal diameter between the prominence at the root of the nose called the glabella, and the most projecting part of the occiput behind, a measurement which has the advantage of giving the absolute length of the cranium between its two most extreme points. Prof. Flower, however, does not follow this method, but prefers to take the length from the most projecting part of the occiput behind, to a point situated immediately above the projection of the glabella, to which Broca has given the name ophryon. This point is in the centre of a line drawn across the narrowest part of the forehead, which separates the face from the cranium. He has selected this point anteriorly, in preference to the glabella, on the ground that the glabella is properly a part of the face, and that it may vary much in development, without occasioning any alteration in the essential form of the cranium. Similarly in taking the horizontal circumference of the cranium he passes the tape line, not over the prominence of the glabella, as is customary with craniologists, but above it, around the supra-orbital line. Mr. Flower therefore entirely excludes this well-known prominence from his measurement of the cranium.

But in excluding the glabella from the cranium, on the ground that it belongs to the face, he does not appear in his measurements of the face, to have made provision for including th glabella, so that in these measurements a feature which gives a very decided character to the anterior region of the head is left out of consideration. This seems to us to be a defect, for if such a mode of mensuration were generally adopted, skulls possessing great projections in the glabellar and supraciliary regions, such as the well-known Neanderthal skull and the crania of the generality of the Australian aborigines would not have, what undoubtedly constitutes one of their most salient and characteristic features, represented in a table of their dimensions, and the relations of their extreme length and breadth to each other, as expressed by the latitudinal cephalic index, would not be fully brought out.

It may, however, be argued that, by including the glabella in the longitudinal diameter and in the horizontal circumference, a portion of the cranial wall which lies superficial and owes its extent of projection to a subjacent air-containing space—the frontal sinus—and not to the brain cavity, is made to appear as if it were an essential part of the box containing the brain, and that the size of the cavity of that box is made to seem therefore to be greater than it really is. But to this it may be replied that the capacity of the cranial box, as capable of being deduced from external measurements, is affected, even when the glabella and supraciliary ridges are left out of consideration, by other causes, such as variations in the thickness of the diplöe and the development of ridges for muscular attachment.

The only reliable mode of ascertaining the capacity of the cranium is by actual measurement of what it can contain, and not by calculations based on the external dimensions of its walls. The longitudinal diameter of the cranium ought in our judgment to express the actual length of the skull between its two extreme anterior and posterior points, to whatever cause it may be due. The special mode of taking the length of the cranium, adopted in this Catalogue, is to be kept in mind in comparing, not only the length of the crania but their latitudinal and altitudinal indices, with the corresponding measurements recorded by those craniologists who take the length of the skull between its two most extreme points.

The several measurements have been made and recorded with that care and precision which characterises all the anatomical work done by Prof. Flower. To obtain reliable evidence of the cubic capacity, one of the most difficult and important measurements to procure, many thousands of experiments have been made to ascertain the best process, and some of the crania have been gauged several times over. The material used has been mustard seed, with which the brain cavity has been filled to its maximum and the quantity of the seed has then been taken with the choremometer designed and constructed by Mr. Busk.

In addition to the measurements recorded of the individual crania, the author has given a valuable table in which he summarises the general results that have been obtained from the examination of the skulls of the different races. This table shows clearly that after making allowance for variations in individual skulls, yet that the different races of mankind possess in the configuration and dimensions of their skulls certain tangible characters which may be expressed by distinctive terms. Thus, to select a few examples adduced by the author, from the races which are probably unmixed. The Veddah race of Ceylon is dolichocephalic, orthognathous, with the orbital and nasal apertures moderately wide in proportion to the height (*mesoseme* and *mesorhine*), and with the capacity of the cranium small (microcephalic). The Australian race, again, whilst dolichocephalic, and microcephalic as regards the dimensions of the cranium, is prognathous, platyrhine, and microseme in the measurements of the face. The now extinct Tasmanian race was, like the Australian, prognathous, platyrhine, microseme, microcephalic, but in the relations of the length to the breadth of the cranium not dolichocephalic but mesaticephalic, *i.e.*, between dolichocephalic and brachycephalic. The Bushmen, whilst mesaticephalic, platyrhine, microseme, microcephalic, are, as regards the upper jaw, not prognathous, but orthognathous. The Bush crania differ in an important manner from their near geographical neighbours the Kaffirs and Zulus, which, though platyrhine in their nasal relations, are dolichocephalic and megacephalic in their cranial dimensions, mesognathous as regards the projection of the upper jaw and mesoseme in their orbital dimensions. The skulls of the African Negroes are dolichocephalic, mesocephalic, prognathous, platyrhine, and mesoseme; whilst the Andamanese, of which the Museum possesses a remarkably good series, are brachycephalic, microcephalic, mesognathous, mesorhine, and megaseme. As regards the Australian and the dark races with frizzly hair dolichocephalism and prognathism, with small or moderate cranial capacities prevail, except in the Bushmen and the Andamanese. The prevailing characteristics of the races inhabiting Europe, North Africa, and South-West Asia are a moderate latitudinal index, a moderate orbital index, a low alveolar index, a low nasal index, and a high cerebral capacity. In the Mongoloid races again the orbital index is usually high, the cranial capacity variable, whilst in its dimensions the skull ranges from brachycephalism in the Siberians and Peruvians to extreme dolichocephalism in the Eskimo. The jaw may be either orthognathous or prognathous.

The study of this Catalogue is essential to all who are interested in physical anthropology, but more especially to those who may be engaged in working with the craniological collection in the Museum of the Royal College of Surgeons of England.

OUR BOOK SHELF

The Village Life. (Glasgow: Maclehose, 1879.)

THIS is a volume of poems intended to picture various phases of Scottish village life. It is beyond our province to criticise the quality of the poetry, but it deserves some notice at our hands for the prominence given throughout to the most recent scientific doctrines, especially that of evolution. With the latest teachings of science in this direction the author appears to be thoroughly acquainted, as is evidenced especially in the two poems on "The Schoolmaster" and "The Doctor." It seems to us a noteworthy fact in the progress of science that its latest developments should form so prominent a feature in a work so purely literary, as a series of poems. The author himself, while he has evidently a tenderness for the old beliefs and bygone customs, still, cannot help showing how strong is his leaning to the revelations of the science of to-day. We venture to think that the anonymous author's presentation of the latest results of scientific investigation ought to reassure those who dread that science and poetry cannot co-exist, that the spread of science and the increase of scientific knowledge will leave no room for the exercise of the poet's fancy. If ignorance is a necessary condition for the exercise of this function, it is quite safe to predict that there is no chance of the poet's occupation ever being gone. Let us suggest to the author of the "Village Life," as a subject to try the mettle of his fancy and the extent of his knowledge, the "Lake Dwellers." We think the present volume is likely to afford a quiet pleasure to many readers, and as a specimen of the versification and to show how clearly and musically the author can put a puzzling problem, we give the following quotation from the poem on "The Doctor":—

"Search as we may, no trace is found
Of how the man-ape was transformed
Into the man with speech and creed;
We know not how he shed his hair,
Or shortened his fore limbs and rose
On back-bone straight, with head thrown back,
With archèd foot, and supple knee;
Or by what process came the hue
Of his now soft and hairless skin,
Its brown, its red, its jetty black,
Its yellow, and the tints between;
Or how the straight and flattened nose,
Developed from the monkey's face,
The jaw prognathous, square or thin;
And above all how speech began—
How first the inarticulate,
Long-armed, broad-chested, roaring clan
Of men-apes, out of shouts and cries,
Formed syllables and meaning words;
How, from the jarring harsh discords
Of brutal sounds there broke instead,
Liquid utterances, replies,
Sweet conversation, grave debate?—
A vast development, so great
And splendid that the tail-less ape
At once became the planet's lord,
A god in reason, as in shape.

The Doctor hoped that searchers keen,
Might find before the glacial age
Some traces of an earlier stage—
Man Pliocene or Miocene—
A skull, or skeleton that showed,
The type improving from the ape;
Some form revealing how a broad
Divergence intellectual,
May come from trifling change of shape;
That showed complete, a reason why
The glorious art of speech arose;
How shortened arm, and thickened thigh,
Deepened the chest, enlarged the lung;
The larynx and the mouth and nose
Transforming with the breast and brain,
Became sonorous, and the tongue
Shaped simple words, they grew amain
To language musical, and song.
But though the search is deep and long,
And evolutionists await
With eager hope, the early 'brave'
Emerging from the brutal state;
He comes not from his ancient grave;
His grave is lost; his fossil bones
No geologic era owns."

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.*]

Artificial Diamonds

THE fate of the Glasgow diamonds, as recorded in NATURE, vol. xxi. p. 203, reminds me of an adventure of my own that happened about ten years ago, and is likely to be repeated by others. For showing the popular class-room experiment of burning phosphorus in oxygen, I was in the habit of using a little cup of chalk made deeper and with smaller rim than the brass cups usually made for the purpose. The object of this was to limit the too rapid outburst of combustion. I noticed that a cup which had been used several times was coated on the inside with a hard, glassy enamel, which I supposed to be phosphate of lime. To test this, the cup was thrown into some hydrochloric acid and dissolved bodily, but I found at the bottom of the beaker an insoluble residue of crystalline particles. What were these? Could it be possible that the carbonic acid driven off by heating the chalk had, on reaching the heated phosphorus, become dissociated, its oxygen combining with the phosphorus, and its carbon thrown down as veritable diamond? To test this startling theory, I collected the particles and rubbed them between a glass pestle and mortar. They appeared hard enough to scratch the glass, but were too small for further examination. To obtain a better supply, I dissolved some phosphorus in bisulphide of carbon, pounded some chalk and made it into a paste with the solution, then filled a porcelain crucible with this and fired the mass by heating it over a Bunsen burner. It blazed magnificently, throwing out eruptive jets of flame. Here, in the absence of surrounding oxygen, the carbonic acid had every opportunity of becoming dissociated or reduced by the heated phosphorus. The residue was treated with hydrochloric acid, and this time I found at the bottom of the beaker quite a respectable quantity of crystalline grains. These left unmistakable scratches on the glass pestle and mortar, and seemed to make some fine scratches on an agate pestle and mortar. I next examined them under a microscope, and found that they were more like pebbles than crystals, so much so as to suggest another theory of their composition and origin, viz., that they were miniature chalk flints formed by the fusion and aggregation of the siliceous cuticles of fossil diatoms, or such-like organisms of which chalk appears to be in some degree made up.

To test this, I precipitated some pure carbonate of lime, soaked it with the solution of phosphorus and fired as before, then treated with hydrochloric acid; when, alas! my *Eldorado* of dissociated carbonic dioxide melted into thin air as the effervescent liquid gradually cleared itself and showed no traces of crystalline residue. W. MATTIEU WILLIAMS

Stonebridge Park, Willesden

Solar Phenomenon

ON the afternoon of the 18th ult., in company with Herr Lohse, of this observatory, I was occupied in adjusting a spectroscope attached to the 15-inch refractor. The sun was disappearing behind the ridge of the hill of Fare, about five miles distant. To utilise the last rays of the sun, I was directing the telescope on the gradually lessening segment of the sun's disk, while Herr Lohse was looking through the spectroscope. Under these circumstances it will be understood that we were both standing near the inner vertical surface of the drum-shaped dome, close to where it was lit up by the sunlight coming through the opposite vertical opening, which is 40 inches wide. It may be well to add that the dome is made of corrugated iron, painted slate-colour, the corrugations of the wall being vertical.

Under the impression that the sun had wholly disappeared, I looked at the inner wall of the dome to see if it was actually shaded by the distant hill.

To my great surprise, the still illuminated surface was crossed by a number of distinct, horizontal, black lines, which ascended at a uniform pace about a foot and a half in a second. The lines were, on an average, about $\frac{1}{4}$ inch thick, while the intervals may have been mostly some $2\frac{1}{2}$ inches, but I do not think that the intervals were uniform. Herr Lohse, on turning from the spectroscope, also saw the lines; but while he feels sure that some of them terminated in points, I am under the impression that all the lines crossed the entire illuminated space.

The lines had a distinct quivering motion, which, combined with their uniform ascent, gave the whole phenomenon a most beautiful appearance. We both independently estimated the number of lines seen at about thirty, and the duration of the phenomenon at half a minute from the time when we first saw it. It was, however, certainly fully developed when first caught sight of. These lines seem to be closely allied to those repeatedly seen at the beginning or end of the total phase of a solar eclipse. See particularly *Astronomische Nachrichten*, Nos. 1,921 and 1,922, and "Le Soleil" (German edition), p. 301, *et seq.*

Some of the observers referred to speak of the lines as undulating; in this case it is difficult to say if the lines were quite straight or not, because of the corrugations of the surface on which they were thrown. My own impression is that they were straight except in so far as they were affected by the quivering before mentioned.

It would be remarkable indeed if this is the first time they have been seen at the daily disappearance or reappearance of the sun. RALPH COPELAND

The Observatory, Dunecht, Aberdeen, December 23, 1879

Carbon and Water Figures

THE separation of clear water from a uniformly diffused mixture with soot is so remarkable that it seems worth attention, especially in connection with the behaviour of charcoal powder in water, which is always streaky after any amount of shaking.

For some months I have observed and recorded these figures, as shown in a large white basin of sooty rain water, which is left undisturbed for twelve to twenty-four hours; they only appear occasionally, perhaps once in a week, are not constant when formed, and are entirely destroyed by stirring or mixing the water. They always consist of lines, planes, or patches of *clearer* water, sometimes not containing certainly more than a quarter of the proportion of soot around them; no aggregation of sooty water, or soot, has ever been seen. These quasi-vertical planes are very thin, sometimes the clearest part as little as $\frac{1}{50}$th inch wide, and the extreme thickness $\frac{1}{20}$th, the other dimensions being $\frac{1}{2}$ to 1 inch deep, and 1 to 5 long. Most usually only one plane appears, the azimuth of which is quite irregular; occasionally it is curved; sometimes a row of quasi-parallel planes or lines appear—once as many as six, at irregular intervals averaging ·8 inch; once a clear circular spot about $1\frac{1}{2}$ inch across appeared.

The last form I found was by far the most complex, and is here given from a careful sketch.

The lines were not as thin as usual, only one or two being as little as $\frac{1}{30}$ inch wide. They were very bright, probably not containing $\frac{1}{4}$ of the average soot around them; the water was unusually dark. The central semicircular space was 3·6 inches long × 1·7 inch; when first seen this space was uniformly grey, but in a few minutes, after slightly disturbing the water, the bright sharp plane across it appeared, inclined at about 5° to vertical. Some of the other planes were inclined 15°. The most striking point was the sharp definition of the central space, all the lines ending abruptly at its regular outline.

The depth of these figures bears strongly on their cause. They are never at the surface, but usually on the bottom. The water is about 2 inches deep, and the upper limit of these planes is $\frac{1}{4}$ to $1\frac{1}{2}$ inch from the top. In the above figure the lines or planes appeared to lie on the bottom, and to turn upwards at the edge of the central space, leaving it untouched, thus forming a bright edge to it. I have also, on disturbing water, seen apparently that a clear layer existed below a uniformly sooty surface.

The conclusions are, that water tends to separate from the finely divided carbon, in a clear bottom layer (or lines) of uncertain thickness (though lamp-black sinks if diffused in water), and that parts of this layer are (by convection?) turned upward and form quasi-vertical planes. The points still to be settled are:—1. Why these layers when turned up should not re-mix with the general mass, if their separation is due only to gravity, especially when as thin as $\frac{1}{50}$ inch, or $\frac{1}{100}$ of their length? 2. Why a particular sharply-defined space in the above figure should be avoided by the lines? 3. Are the causes the same as those preventing the uniform diffusion of charcoal dust in water?

These figures are not due to any form of caustic curves, though mistaken for such at first sight, and therefore neglected.

W. M. FLINDERS PETRIE

Velocity of Light

IF you can spare the space please state that the corrected result for the velocity of light (NATURE, vol. xxi. p. 94) is—

299944 ± 50 kilometres,
or 186380 ± 33 miles per second.

A. A. MICHELSON

328, Fifth Avenue, New York, N.Y., December 17, 1879

The Word "Telegraph"

I HAVE recently had occasion to ascertain the period when the word "Telegraph" first came into use; the following may be of interest to your readers:—

It is not mentioned in Johnson's Dictionary, 1810, but it occurs in the edition of 1818. In that valuable work, Rees's "Encyclopædia," 1819, vol. xxxv., we find:—"The word telegraph, which is derived from two Greek words, τῆλε, at a distance, and γράφω, to write, was brought into use about 1793 or 1794, when the French Directory established machines of this kind for communicating intelligence between Paris and all the principal towns in France. The British Government soon after adopted the same measure, and it has since become very general." So that telegraph and semaphore are both of French origin.

In the grand French "Encyclopédie" of Diderot—1778—the word telegraph does not occur.

WARREN DE LA RUE

73, Portland Place, W., December 31, 1879

The Lophiomys

As the oft-repeated statement (which originated with M. Alphonse Milne-Edwards) *that the roofed-in temporal fossa of the Lophiomys finds its parallel in certain reptiles alone* reappears in the pages of Messrs. Cassell's excellent "Popular Natural History" (see NATURE, vol. xxi. p. 137), it is high time that it should be modified in accordance with more recent anatomical investigations, which show that two *amphibian* genera, Pelobates and Calyptocephalus, participate in this singular abnormality.

Beddington Park PAUL HENRY STOKOE

Scorpion Suicide?

MR. F. GILLMAN'S note (vol. xx. p. 629) in favour of scorpion suicide carries with it its own refutation, as will be seen by examining the details of his cruel experiment. Given the "circle of glowing charcoal embers a foot or so in diameter," and the inference is that the central temperature of that circle would be well nigh "glowing" too; dropped into this fire-bound ring, the poor scorpion would at once be scorched nigh unto death, and to escape the ensuing agony, why does it not, then and there, commit suicide? No, "after vain attempts to get away," in each of which it is more and more scorched, if not absolutely burned in its head, its vital powers fail, and its last instinctive throe is to gather its limbs together as much as possible, away from the heat. The heat has killed it, and I defy Mr. Gillman, or any one else to prove that, in this experiment, the scorpion "pierces its head with its sting and dies" in consequence.

As our winter has set in, and the crickets had gone into winter quarters, I determined upon giving my scorpions an opportunity of doing the same, so, taking them into the garden, I emptied them into a hole. I only mention this to illustrate my remarks on change of colour in lizards, for, taking my scorpions into the sun, out of a comparatively dark room, each individual distinctly assumed a lighter hue on the way to the hole.

Peshawar R. F. HUTCHINSON

Strange Incubation in Fishes

Apropos of my note on strange incubation in fishes, I send you, *quantum valeat*, an extract from Mrs. Yelverton's *olla podrida* of travels, "Teresina Peregrina," vol. ii. pp. 15, 16: "His Highness (the Tumangong of Johore) had a splendid collection of orchids, which it seemed to gratify him to point out to me. I recognised many of them as my old friends, the acanthus-shaped denizens of the Cambogian forests, from whose urn-like leaves my people used to bring me down the little fish. This *bouleversement* of natural history may sound like a traveller's tale, but the explanation is simple.

"The aquatic birds often drop the spawn of the fish into the calixes (*sic*) of these beautiful parasites, which the next shower of rain turns into basins or pools of water, wherein the little fish first opens his eyes and receives its consciousness, probably believing firmly that it is the proper thing for a fish to live in a tree (so strong are early impressions), while all the rest of the world, fish, flesh, and fowl, view him with amazement.

"Many of our beliefs have not one whit more solid foundation than this fish's belief in the cornucopia of the orchid being a real fish-pond, because a few accidental fish got there through the slavering of some ill-mannered water-fowl." ! ! !

Peshawar, December 2, 1879 R. F. HUTCHINSON

FURTHER NOTES UPON THE PAPUANS OF MACLAY COAST, NEW GUINEA[1]

II.

OBJECTS *of Art.*—Specimens down to the simplest and commonest ornament were collected, or, at any rate accurately copied by M. Maclay, for the reason that the natives of Maclay Coast were still in the "Stone age"—a period which will soon belong to the past, and of which the relics are yearly becoming rarer and rarer. The implements as yet discovered by the Papuans, and upon which artistic skill has been expended come under two categories. 1. Fragments of flint, shells, and bones. 2. Chipped stones in the form of axes. The ornaments themselves may be divided into three classes. (*a*) Ornaments properly speaking, engraved, or drawn on their own account solely, and serving none other than a decorative purpose. (*b*) Ornaments and drawings demonstrating the first beginning of the figurative or ideal style of writing. (*c*) Ornaments, sketches, and carvings, which stand in relation to the superstitions and dark stage of religious ideas among the Papuans.

1. *Ornaments in the strict Sense of the Word.*—The salient character of most Papuan ornaments is that they are for the most part rectilinear, and for the reason that bamboo and reed, from which the majority of their utensils are made, are best adapted for such style of decoration, for it is, as Maclay has practically convinced himself, difficult to draw or scratch round and circular designs upon the substance, while straight lines, on the contrary, can be made with ease, the tools being sharp fragments of flint or shell. It is upon the bamboo receptacles for lime for betel chewing, but more especially upon the large comb which is worn by all men that their decorative skill is principally expended. That style of ornament which of necessity was adopted for articles of bamboo, is also applied to such as are of other material, *e.g.*, wood or clay, for the Papuan, in general with the rest of mankind, is influenced by laziness, for he lacks the energy to make trial of such designs as would be more suitable for the latter kind of material. Some of the designs, however, upon wood are of a curved and circular character, but these are difficult to make with such primitive tools as the Papuan possesses. A slight scratch with a piece of flint suffices to mark a line upon the epidermis of bamboo, while in the case of wood, strong pressure and tedious scraping or scratching are necessary to produce a superficial design. More trouble, moreover, is expended upon things made of wood, such as drums and canoes (*praus*).

That the want of variety in subjects of decoration does not proceed from lack of inventive power and skill is shown by the fact that directly after use was made of the

[1] Continued from p. 206.

sherds of glass bottles collected near Maclay's hut new refinements and variations were introduced into their wood ornamentation. As regards the pottery ware, since this is made by the women, and as the latter are wanting in artistic sense or in interest in their work, it is quite devoid of ornament.

2. *The Origin of the Development of Symbolic Characters.*—M. Maclay believes that he discovered by accident the use of an ideograph ("Ideenschrift") by the Papuans in a very rudimentary form. He noticed upon the façade of the *buambramra* of a neighbouring village a row of shields formed from the leaf-bladders of the sago-palm, on which rude figures, *e.g.*, fish, snakes, suns, and stars were painted in various combinations. Their meaning puzzled him for a long time, and from insufficient knowledge of the language he was for a long period unable to inquire about it. In the forests, too, he remarked similar enigmatical symbols carved upon the bark of the trees; also upon the sides of the praus which came from the Islands of Contentment. The riddle remained unsolved until the occasion of a feast, several months later, given in celebration of the launch of two large canoes on which the natives had been working for a long time, when a solution suddenly presented itself. Towards the end of the feast one of the younger guests jumped up, took a coal, and began to sketch a row of primitive figures upon a plank which lay near. These symbols had a great resemblance to those which Maclay had previously remarked upon the trees, canoes, &c., and were sketched in the following order. First came a representation of the two newly launched *praus*, drawn as though half upon the shore and half in the water; then followed a drawing of men carrying two pigs tied fast to a stake, victims doomed to be sacrificed for the feast. After these were represented, a row of large *tabir*, equivalent in number to the "covers" which had been served at the banquet, while the rear was brought up by a drawing of Maclay's canoe, conspicuous by its large flag, two large sailing canoes from the Archipelago of Contentment, and a number of smaller ones without sails, from the neighbourhood of Bili-bili. This group, which symbolised the various guests present at the feast, was drawn as a *souvenir* of the banquet, and Maclay saw it several months afterwards. Further observations have led M. Maclay to the conclusion that representations such as that just mentioned, are not to be regarded in the light of pictures or sketches, but as rudiments of a primitive ideograph — "primitive Ideenschrift" — a conclusion which has been borne out by later observations. M. Maclay was impressed with the variety in the representation of the commonest objects, which implies a very limited comprehension of drawing and renders it an utter impossibility for any other [than the artist?] to understand this primitive writing, or pictorial mnemonic medium. A man, for example, was actually represented by the same artist (1) as a rough human shape; (2) as a face with eyes and a large mouth; (3) as a comb[1] with a plume of feathers, and, lastly, as the "membrum virile," and it is very probable that there are many other symbols besides having an analogous signification. Besides the pictorial representations, the Papuans of Maclay Coast employ several mnemonic appliances to aid in remembering important events; for in every village may be seen suspended "in memoriam," various objects, such as bones, as a *souvenir* of a great feast, cocoa-nut shells, of a less important feast—no animal having been slaughtered on the occasion—a dry bunch of leaves or an empty basket, the former hung up by some friend in remembrance of a visit, the latter in which some present had been brought, being left behind as a hint for some gift in return. In every *buambramra* hang rows of the lower jaws of pigs and dogs, skulls of fish and of various marsupial animals, in remembrance of feasts, successful fishing and hunting parties, and visits of friends; serving thus as a veritable calendar of the events of past months and years.

1 "Kamm," a comb or crest.

3. *Sculpture in Wood.*—To this category belongs principally the fairly numerous quantity of carvings which, if not precisely as idols, may nevertheless be regarded as objects standing in a very intimate relation to the religious ideas of the Papuans. Such, under the common term, *Telum*, were seen by M. Maclay in nearly every village, and accurate drawings were made of no less than twenty-one of them, interesting as they were not only as specimens of the art of the stone age, but as affording many a guide to the relationship of the Melanesian races. A *Telum* consists of a human figure, of either sex, fashioned out of wood, or, more rarely, from clay. Nearly all wear peculiar head-dresses, and those of the male sex have the genitals of an enormous size. In a mountain village a *Telum* was discovered with the body of a man, but the head of a crocodile, for which a turtle served as a kind of cap, and in the same village another human figure was found which held with both hands a tablet covered with various symbols. In all figures the nose, as is the custom among the Papuans, is bored through, and every *Telum*, moreover, of which several may be found in each village, has its own special name. As for the significance of these wood-carvings, M. Maclay is not quite certain upon this point, although he is sure that they stand in some relation to the rudimentary religious conceptions (*Vorstellungen*) of the Papuans, for in some of the hill villages large stones even were seen to be honoured as *Telums*. If, on the other hand, we regard these representations from an æsthetic point of view, we shall be again forced to admit the artistic capabilities of the Papuans, their great perseverance, as well as the way in which simple decorations become transformed into bas-relief, and again from *alto relievo* into the complete figure; for in Papuan art of the "stone age," such a series of progressive steps is demonstrated in the completest manner.

Superstitions and their Resulting Customs.—With regard to "Tabu,"[1] this custom exists in New Guinea, but M. Maclay did not succeed in finding out any equivalent term for it in the Papuan tongue, though frequent examples of it could be recognised in the various restrictions put upon the actions of women in their relation to the men. For example they are forbidden to set foot within the *buambramra*, they are excluded from all feasts, and every dainty which they prepare for the latter, especially the principal drink, *Keu*, is forbidden to them as well as the children. The meeting places of the men, music, musical instruments, and even the mere hearing of the same is strict *Tabu* for the women, for as soon as the sound of one is heard in the neighbourhood, they and the children must instantly flee. To the repeated inquiry of Maclay as to the reason of the above exclusion of the women, the answer was invariably returned—"It would never do, for the women and children would fall ill and die."

Music and Song.—The performance on all instruments of music, which are collectively included under the term "*Ai*," is allowed to the men alone. They are as follows:—

The "*Ai-Kabrai*."—This consists of a bamboo, about two yards and more in length, and about fifty millimetres in diameter, from which all the septa between the internodes have been removed so that the whole consists of a single long tube. This instrument is put into the mouth, and through its large orifice the performer blows, shrieks, or howls, the sound being audible in still weather at a distance of from two to three miles. The word "*Kabrai*"

1 Accounts of "*Tabu*" will be found in "Tylor's Researches into the Early History of Mankind." London. 1865, and in Captain Cook's "Voyage to the Pacific Ocean," Vol. i.i., p. 163. London. 1784. "This word" (*loc. cit.* p. 164) "is used to express anything sacred, or eminent, or devoted. Thus the King of Owhyhee was called *Eree-taboo*; a human victim, *Tangata-taboo*; and in the same manner, among the Friendly Islanders, Tonga, the island where the king resides, is named *Tonga-taboo*."—J. C. G.

is (in the Papuan dialect), the name of a species of parrot, with a loud screaming voice.

"*Munki-Ai.*"—This equally simple and ear-splitting instrument is made out of the shell of one of the smaller kinds of cocoa-nut (*Munki*), in which a hole is bored both in the side and in the upper end; a shrill piping tone being produced by blowing through the upper hole, and alternately stopping and leaving free the side one by means of a finger. This instrument is often elaborately and artistically ornamented.

"*Hol'-Ai.*"—This is a curved or straight wind-instrument, of the character of a trumpet, made out of the root of a kind of *Lagenaria.*[1]

The three just described are not strictly wind-instruments, as compared with those of a European model, but are rather of the character of a ship's speaking-trumpet, in that they are only used for strengthening the human voice, though the tunes produced are of extreme variety.

"*Orban-Ai.*"—This consists of a handle from which a number of perforated Orban-nut shells hang, each at the end of a cord. When this is shaken the shells strike against one another, producing a kind of rattling sound, which at times resembles the rustling of foliage caused by a breeze.

"*Okam.*"—This is a kind of drum made from a hollowed tree stem, over the upper end of which the skin of a Monitor lizard is stretched, while the lower end remains open.

For purposes of signalling, a triton-shell perforated at the side is used, and by this means the arrival or departure of the *praus* which come from Bili-Bili or the "Archipelago of Contentment" is made known.

All the above-mentioned instruments of music are *Tabu* to the women and children, being, like the wooden carvings, regarded as something sacred, and this to such a degree that M. Maclay had great difficulty in obtaining from their owners specimens for his collection.

The songs of the Papuans of Maclay Coast are of the very simplest, being confined to a few words which are perpetually repeated, sometimes in solo, sometimes in chorus. They are almost always improvised, the composition being prompted by the advent of guests, some occupation or other, or the most trifling events.

Under the common term "*Ai*" are included the feasts which are celebrated by the Papuans from time to time. The guests are summoned from the surrounding villages by a number of beats on the *Barum*, repeated at prescribed intervals, while the *Malassi* bring out the various utensils and instruments of music from the *Buamramra*. Baskets full of the root of the Colocasia (*Bau*), and the fruit of the Dioscorea (*Ajan*) are brought, of which a certain quantity is contributed by each male guest, and added to the general heap, each fresh arrival being greeted with applause. At length there arrives, bound to a stake carried by two men, and greeted with cries of joy, the principal object of the feast, a pig, richly decked out with the red flowers of the *Hibiscus*. The victim is laid on the ground, and, after a long oration from one of the Tamos, is despatched by a thrust of a spear in the armpit. As for dogs, which are not unfrequently eaten at feasts, they are slaughtered by being swung round by the hind legs and the head dashed against a tree trunk. Fowls, rats, the cuscus, and smaller marsupials are killed in the same manner. After the pig has been killed and the hair singed off over a large fire, it is placed on a number of banana leaves spread on the ground. In all the details of preparation for the feasts the Papuans show a remarkable appreciation of division of labour, for everything is done without noise or confusion. While the cooking of the various portions of food is taking place, the guests set about the brewing of their two favourite drinks, the *Munki-la* and the *Keu*. In order to make the first, green cocoa-nuts, after they have been stripped of their fibrous outer coating, are split down the middle by a single blow from a long stone implement, and the watery contents collected in a *Tabir*. The halves of the nuts having been distributed, each guest sets to work to shred the kernel with his *Jarur* into the bowl until the latter is filled to the brim with a whitish, gruelly mess. The second drink is thus made:—The fresh leaves of the *Keu*[2] plant, together with the young twigs, are chewed without further preparation, while the old and hard roots are previously softened by bruising with a stone. For this end all the young men play the part of living masticatory machines, their teeth fulfilling the function of millstones set in motion by the action of the "masseter" muscles. If one of them is tired out before the mass is soft enough, he forthwith spits it out into his hand, rolls it into a ball, and hands it over to a neighbour to finish the process. After having been duly masticated, the *Keu* is filtered by means of an apparatus consisting of two halves of a cocoa-nut shell, the upper of which, having an aperture in the middle, covered with some finely crushed grass, serves for a filter, while the lower receives the filtrate. To this latter, which is of a greyish-green colour, some water is added, and it is then left standing. Every *Keu* drinker has his own bowl reserved for this purpose alone, and carefully kept in his pouch, or *gun*. It consists of the shell of a small cocoa-nut, the inner surface of which is of a uniform greenish-grey colour, a result probably of the custom forbidding all cleaning of the interior, while the outer is decorated with various devices and coloured with a black pigment.

At length there rings over from the village, two or three short *Barum* tones, as a signal that the banquet is ready, and the *Keu* drinkers assemble, surrounded by the younger men. Each then rests his bowl in a shallow hole made by a lance in an area of ground previously cleared for the purpose, and into it the thick fluid is poured from the large *Keu* bowl. After a preliminary coughing and spitting, in order to clear out the mouth, each, in the order of seniority, or social standing, drinks his portion with many a grimace, as the infusion is very bitter; and in some instances, passes urine at the same moment. After this the guests proceed to eat, and when their hunger is appeased, the grated cocoa-nut infusion, *Munki-la*, is served round. If the pig is too small for all to partake of, only the men are allowed to eat of it, it being *Tabu* to the "Malassi," or youths, who will then on no account touch it, as they have the firm belief that if this rule be violated either illness or some calamity will inevitably overtake them. The feast is brought to a close by smoking and the chewing of Betel nut, and the "Siri" leaf. If, as is sometimes the case, there are not enough eatables for the feast, a supplementary banquet is held, the materials for which have to be first procured by an improvised fishing party. In order to keep the women and children from disturbing the guests when feasting, the musical instruments are brought into play, which, as before stated, is an infallible means of keeping them at a distance. Finally, as a *memento* of the feast, the lower jaw of the pig or dog which has figured on the principal dish is hung up in the *Buamramra*.

During the month of November and December, when the Papuans are less occupied in the plantations, certain other kinds of feast take place, of which at the first, called "*Ai-mun*," only the men are allowed to be present, while at the second, the "*Sel'-mun*," held in the villages, the presence both of women and children is permitted. At the *Ai-mun* very curious masked processions are formed, and here the *Aidogan*, a kind of *telum* consisting of numerous figures carved one over the other out of one

[1] A genus belonging to the order *Cucurbitaceæ*.

[2] According to Dr. Scheffer, director of the Botanic Garden at Buitenzorg, near Batavia, to whom they were submitted, the *Keu* plants brought by M. Maclay from Papua belong to two distinct species of the genus *Piper*, but neither of the two is identical with the *Kava* plant of Samoa. It is, moreover, doubtful even if this latter is really the *Piper methysticum*.

tree stem, play a conspicuous part, after having been brought, fresh painted, from the village to the feasting place. Sometimes there is even a migration of the revellers into another village, which generally results in a kind of sham fight between the two parties.

With regard to Betel chewing and tobacco-smoking, both these habits are very prevalent, and freely indulged in by the people inhabiting Maclay coast. Nevertheless, the *Areca* palm[1] is by no means abundant on the coast, being, with the exception of the "Archipelago of Contentment" and a few other spots, but seldom found in the villages. The process of Betel-chewing is as follows: The Areca nut having been first partly masticated, is then mixed with a little powdered lime, which is carried in a special box formed from bamboo or a calabash gourd, and, after being rolled in a Betel[2] leaf or two, is placed between the teeth and chewed. Although the tobacco plant, here called *Kas'*, is much cultivated, and flourishes well along the whole coast, the American tobacco, pressed flat into cakes, which Maclay had brought with him, was so much liked and prized, that he contributed a portion at almost every *Ai* feast. This, after being separated into its component leaves, was dried over a fire, torn into little shreds, and then rolled into cigarettes in green leaves, also previously dried at the fire. A single cigarette makes the round of a number of smokers. In smoking the Papuans swallow the smoke, and blow the rest through the nose.

As the *Keu* has soporific qualities, the Papuans have devised a means of keeping any one who has succumbed to its influence in a wakeful condition. The victim to its power betakes himself to a friend, who with a stalk of grass tickles the cornea and conjunctiva of his eyes until they become full of tears. This is repeated until the patient declares that he feels no longer sleepy. This operation is regarded as a very pleasant one, but "whether it always succeeds," remarks M. Maclay, "is another question."

J. C. GALTON

EPIDEMICS[3]

WE are now entering on our thirtieth session, and, I trust, with reason to believe that our progress is satisfactory, and our work such as to prove that the Society is fulfilling the main object for which it was founded. Though not one of the largest, it is certainly not one of the least active or important among the medical societies of the metropolis, whilst the cosmopolitan range of subjects embraced within the scope of its inquiry renders its proceedings of far more than mere local interest.

The *raison d'être* of this Society is the investigation and development of our knowledge of disease in motion. It involves much, for any disease where it spreads, whether among the people of a house, a ship, a village, a city, a province, or a continent, is an epidemic, and comes within the scope of our inquiry. Dysentery and malarious fevers are typically *endemic* diseases, but in India they may and do at times assume a dangerously epidemic character. But it is not meant that our inquiries should be restricted to mere epidemicity alone; we cannot advantageously study one phase of the natural history of disease and exclude others. There is so much in etiology, semeiology, and pathology both human and comparative that concerns our department of research that we may not ignore the means by which we gain the most important of all information to the epidemiologist—namely, the means of discriminating one form of disease from another. Therefore, though our proceedings will naturally refer mainly to epidemic disease, we shall thankfully receive and carefully consider all information that may tend in any way to throw light on the causal relations, and on the influences exercised by climate, season, locality, food, and occupation on the genesis and dissemination of all diseases, not excluding those of the lower animals, nor even of plant life. I might illustrate this by referring to the importance of discriminating between the different forms of fever that occur in India. It is well known that the greatest proportion of mortality in India is ascribed to fevers. The highest death-rate[1] was registered in Bombay, where it equalled 20·82 per 1000; in Madras the deaths of 469,241 persons gave a death-rate of 10·08 per 1,000. Both here and at Bombay, however, the mortality recorded was greatly aggravated by famine.

There is no doubt that, under the heading Fever, many deaths from other causes are recorded, and we may probably refer a large proportion of them to diseases of an inflammatory character affecting the thoraic or other viscera, or to complications involving inflammatory action elsewhere. In a vast country like India, where the population is so extensive, and the means of registration of necessity limited, often not under medical supervision at all, it is not to be expected that greater accuracy can be ensured; but, were it possible to discriminate among the various forms of disease returned as causing the mortality by fever, we should have a very different result from the present. One can hardly refer to this subject without expressing admiration at the great progress that has been made of late years in registration under the direction of the sanitary authorities of India, and confidence that it will continue to improve, and render the statistics more valuable even than they are now. Of course, where the registration of death is not subject to medical definition discrimination between the various forms of fever or other death-causes could hardly be expected; and therefore the example I have just given is hardly so good an illustration of what I refer to as typhoid, for which we have accurate medical statistics of our European troops in India. It is within my recollection that attention was first called to the existence of this form of fever in India, and yet there can be, I suppose, no doubt that it has always been there. It soon became generally recognised as a new discovery in India, and people wondered how it had escaped observation hitherto, whilst some perchance regarded it as a new disease. But it was just this power of discriminating observation that is so rare and so valuable that had been wanting; it was this that, exercised by Budd, Jenner, Stewart, Murchison, and others after them, established a new era in the nosology of fevers in England; and it was this, that, a little later, in India, discriminated between certain forms of remittent and enteric (*i.e.*, between malarious and specific) fevers, and that will, I hope, ere long further discriminate and rearrange the nosology of fevers in India and the tropics.

Now typhoid or enteric fever is an important cause of mortality among our young European soldiers in India; and it raises or suggests questions of great importance in regard to them—such, for example, as the right age, time, and seasons for sending them to India; to say nothing of the hygienic questions as to sanitary measures arising out of its causal relations. The Sanitary Commissioner's Report of 1877 says that out of 233 cases of typhoid, 92, or 39 per cent., proved fatal; the admission rate being 4·1 per 1,000 of strength. It moreover appears that 2·45 per cent. occurred at or under twenty-four years of age; 1·55 at twenty-five to twenty-nine; 0·99 at thirty to thirty-four; and a few or none above that age; showing that the disease tells most severely on the younger men—in this respect resembling typhoid in England. Again, Bryden, in his Report of the Statistical History of the European Army in India up to 1876 (published 1878)

[1] *Pinang* in the Malay language.
[2] *Siri* in Malay.
[3] Abstract of Presidential Address at the Epidemiological Society, delivered on November 5, 1879, by Sir Joseph Fayrer, K.C.S.I., LL.D., M.D., F.R.S.

[1] *Vide* Report of Sanitary Commission of the Government of India for 1877.

says: "It has no geography; and it is a matter of popular observation that no regiment or battery escapes enteric fever *in the first year*, whatever cantonment of India may be selected." "Out of seventy-three bodies of men two regiments and seven batteries only returned no case of enteric fever in the first year." And he gives the following analysis of 368 deaths that occurred between 1823 and 1876:—

Ages.	Total deaths.
24 and under	255
25 to 29	90
30 to 34	17
35 to 39	4
40 and upwards	2

Seventy-five of these deaths occurred within three years after landing in India, and 94 per cent. of the total were among men under thirty years of age. In a memorandum received only a few days ago Bryden says, out of 132 deaths from enteric fever in 1878, 90 occurred in men who had been under twenty-two months in India. All this shows that youth and the first year of service in India are the great predisposing causes.

Now is this the same disease as that which might be contracted in London, Dublin, Windsor, or elsewhere in a town or barrack? from a watercloset, drain, sewer, well, or, it may be, from a milk-can? I have little doubt that very frequently it is exactly identical; but I believe also that perhaps as frequently, or more so, it is not; and this, I believe, not in regard to young European soldiers only, but of the whole population of India. In short, I am, and long have been, of opinion that a form of fever exactly like European typhoid, except in its etiology, exists in India and other hot and malarious countries; and that it is due to climatic causes, not to filth or specific causes such as give rise to it in England and elsewhere, and recent reports from India and other parts of the world seem to show that this view is gaining ground.

Be it clearly understood, however, that I do not for a moment dispute the existence of genuine *filth* typhoid in India. The official returns, which cannot be gainsaid, and my own experience alike leave me in no doubt about it. But I do believe that many cases now recorded, and rightly recorded, as typhoid in India, are not caused by the same specific agency as that which gives rise to typhoid here, and also in India, where the necessary conditions are present. There are, in fact, two, perhaps more, forms of typhoid, or perhaps, I should say, different causes for a disease presenting the same phenomena, one being specific, the other climatic; if so, it is obviously very desirable to discriminate between them —not merely as a matter of nosological or pathological interest, but in regard to the hygienic measures that are necessary in either case. This question is of great interest to epidemiologists, and is just one of those subjects that should come within the scope of our inquiry. A remarkable instance occurred near London lately, where an *epidemic* of typhoid was traced to its origin along the track of a particular water-supply by a distinguished member of our Society. Our lamented colleague, Murchison, also traced a similar outbreak to contamination of milk by polluted water. The explanations of these outbreaks were exactly in accordance with these views, no doubt rightly held in Europe. Typhoid in India, however, would not always be similarly explained.

We know but little of the nature of the causes of epidemics such as cholera, or of malarious diseases, but we know something of what may be expected in regard to them, when and how they will appear, and how sanitary work may be made most effectually to avert, prevent, control, mitigate, or remove them; nor is it too much to say that we hope, if not to banish or stamp out, at all events still further to mitigate their ravages. This, I think, is warranted by experience, for certainly the past twenty years have witnessed great progress, and we already see that not only is the value of life increasing, but that the virulence of, and mortality caused by, epidemic disease are being controlled, whilst the vexatious and purposeless restrictions and restraints of quarantine are diminished if not altogether removed, in our dominions at least. Science that has enabled us to reduce the death rate among our troops from 17·9 to 8·56 per 1,000 in Europe, and from 69 to 17·62 per 1,000 in India, speaks for itself, and were there no other result this alone is a triumph such as has been achieved by no other department of knowledge. Pray do not suppose that I claim all this for Indian workers. We all know that these great steps in social and sanitary progress began here, but I do say that the torch then lighted has since been worthily and firmly borne in Indian hands.

This Society, young as it is, can remember the commencement of systematic sanitary work in the East, and may claim some share in the origination of the good work; for among its earlier members were some who advocated the study of epidemiology and hygiene in India. I cannot now stay to dwell on this, but I may say briefly in regard to its progress and work that until the sanitary department was formed, less than twenty years ago, comparative, I might almost say complete, ignorance on the subject of epidemics, and of the diseases that prevailed among the people, existed. An epidemic might carry off thousands, but we knew not where it commenced, where it ended, or what area it occupied. Now, thanks to the continued and careful statistics, we know all that and more, with fair accuracy, and are gradually collecting facts which make the study of epidemiology possible. Before organised sanitary work in India began our knowledge of the general population—nay, even of the European troops and prisoners—was most imperfect. Now, thanks to that department, and especially to Bryden, whose name cannot be too prominently mentioned in connection with the subject, we have, in his most elaborate and valuable statistical reports, facts and figures, as well as deductions, which deserve the closest attention. We have, in short, the most complete details of sickness and mortality in all classes over the whole of India. It is impossible, however much any one may differ from his conclusions, not to recognise the great value of his work, for these reports contain a vast and continued array of authenticated facts which will serve as a mine of information to epidemiologists; and there is every reason for believing that it is but an earnest of more, for if, as Bedford said, the circumstances of India were such as to favour the acquisition of knowledge in 1850, when the precise conditions of life of the population generally, and even of our troops and prisoners were imperfectly known, what must it be now when a system of observation, carried out by a body of trained observers under a head such as he contemplated, is in full and daily improving operation? One can only wish that, considering the magnitude of the work, it were more extensive still, and that observations, already of the greatest value, could be rendered still more so by being concentrated on certain limited areas so as to enable the inquiry to extend to details with a precision that at present can hardly be practicable. The results of epidemiological knowledge and sanitary work are seen in the effect already produced in reducing the mortality from cholera and other epidemics, and from malarial fevers. For instance, among our European troops, the circumstances of which are well known, there has been the following alteration in the general death-rate:—

1861 to 1865	9·02 per 1,000.
1865 to 1870	6·98 ,,
1870 to 1875	3·23 ,,
1875 to 1876	2·3 ,,
1876 to 1877	·84 ,,

And it can be shown from the same source (Bryden) that there is a similar reduction in the death-rate among native troops; and that, during the great cholera epidemic that prevailed in 1876, the death-rate among the civil population being 12·12 per 1,000 (it was the famine year), that of the European troops was 1·75 and of the native army 2·2 per 1,000. Also that in the death-rate of that great scourge of India—fever—there has been an equally happy result, as shown by the death-rate of a period of nine years—from 1868 to 1877—in the Bengal and N.W. Provinces gaols, as against a mean, in nine years ending 1867, of 22·41.[1]

	Per 1,000.		Per 1,000.
1859	13·76	1868	2·84
1860	49·19	1869	4·57
1861	38·14	1870	6·20
1862	30·81	1871	5·81
1863	25·44	1872	1·92
1864	29·96	1873	1·56
1865	7·65	1874	2·67
1866	5·23	1875	3·50
1867	3·12	1876	1·26
Mean ...	22·41	Mean ...	3·29

In India, as elsewhere, the purpose of epidemiological study is to observe accurately and to interpret the import of the facts—*i.e.* if possible, to elucidate the laws of which they are the expression,—and thus to form a scientific basis on which to direct sanitary work, which itself is the practical outcome of such observation, and concerns itself but little with theories. Those who have to do with it know how difficult it sometimes is to obtain *reliable* observations, such is the difficulty of excluding the bias of preconceived theory of the nature of the subject under investigation. Our Society, however, must hold the balance, and deal with theories as well as facts. No doubt the explanations sometimes are conflicting. Happily, in the practical mode of dealing with the question, there is not much conflict, and it is remarkable how little different is the action of those who hold opposite opinions on the causation of disease. As to the different views that are held in regard to fundamental questions regarding the genesis and diffusion of disease let us hope that we may, perhaps, here contribute something towards their adjustment.

In illustration of the state and progress of epidemiology in India I might select the history of any of the great epidemics that have occurred of late years, but it would be impossible, in the short space of time at my disposal, to do this completely. I shall, therefore, confine myself to a few remarks on cholera, as it, though far from being the most destructive, is the epidemic to which most interest attaches.

The theory that cholera is purely of Indian origin, and that wherever it may appear it is to be traced back ultimately to the delta of the Ganges, is disputed by some who see in history evidence that it had long been existing in other parts of the world, and that it was described by the earliest writers—Sanscrit, Greek, and Arabian. I may here just remark that the name "haida," or "haiza," used by Rhazes nearly 1000 years ago in describing the symptoms of cholera, is the same as that applied to it now by every Hindustanee-speaking native of India. As to its presence in India, from earlier periods we have descriptions by Correa, d'Orta, Bontius, and others, beginning from 1503. An epidemic of it in and about Goa in 1543, for example, is described by d'Orta, giving all the characteristics that distinguish an epidemic now. He calls it "moryxy" and also "haiza." It is described by a continuous chain of writers as occurring in various parts of India, in the interior as well as on the coast, up to the seventeenth century, when, after being quiescent during the later part of the eighteenth and early part of the nineteenth century, it broke out with great virulence in Bengal, and has remained there ever since, in what Bryden calls its endemic area, whence it spreads according to certain laws, which are being worked out with admirable patience and intelligence by this distinguished statistician. I cannot now trace the history of cholera in either East or West, nor refer even to the numerous authors who have described it. For full particulars on this subject I refer you to Inspector-General Dr. J. Macpherson's learned work, "The Annals of Cholera."

I need hardly insist that cholera is not a new disease, or that it did not, as by some supposed, make its first appearance as an epidemic in Jessore, in Bengal, in 1813; though no doubt since that period it has been more closely investigated and described. All seems to show that it is the same now as formerly, and that though we have gained much knowledge of its natural history of late years, yet we are as ignorant as our predecessors of its real nature. We have, thanks to sanitary measures, disarmed it of some of its terrors, and have diminished the mortality it caused; but as to treatment we have gained but little, though the empiricism of to-day is more scientific than it was in former days. We do not now burn our patients on the soles of the feet, tie ligatures round their limbs, or have recourse to other senseless barbarities; for we find that simpler and more rational methods are of greater avail, more or less according to the period of the epidemic at, and the promptitude with, which the remedies are applied. But we have learned that local causes have a potent influence, and that cleanliness, good air, *pure water*, and free ventilation are all powerful opponents of cholera; that we can predict its appearance and avoid it in certain places; and that it is not to be controlled by quarantine or sanitary cordons. And from the earnestness and intelligence with which the subject of its etiology is pursued, it is not improbable that sooner or later it too will be made out. We shall then be in a position to say, not only what it does or will do, but what it *is*. Meanwhile we must go on observing and investigating. It is satisfactory to know that we are daily learning, practically, better how to deal with it, and how to modify its cyclical intensity and avoid its ravages. For my own part, until I know something more of the *nature* of the cause—be it a material poison, aërial or telluric, a miasm, or a dynamic agency that so perturbs the vital energy, I cannot see my way to formulate a definite theory either of the nature of its origin or the method of its diffusion. I find the highest authorities at complete variance on the subject, and reposing faith in theories diametrically opposed to each other. Some explain all the phenomena by contagion—*i.e.*, communicability in some way of a *materies* or germ from one person to another. Cholera, they say, is the result of infection by a poison derived from the intestines, and water or air, but especially water, is the channel through, by, or in which the infective material is intensified and conveyed. These arguments are supported by an abundant array of facts, and have been maintained by men whose very names carry conviction. Others reject altogether this explanation; they insist that local influences are all-important, and deny that the spread of cholera is due to human intercourse, that there is any poison transmitted by the excreta, or that the disease is in any way communicable from one person to another. They admit the existence of a poison of some sort—a miasm or an influence, though of its nature they are ignorant. It is a subtle thing that travels in certain directions in obedience to certain laws, is influenced by atmospheric and telluric conditions, and where it finds certain local conditions, and the people prepared by them to submit to it, there cholera will prevail. They deny the efficacy of any enteric or specific poison in the water to produce it, though they attach the greatest importance to the purity of water from *all* organic contamination, impure water being one

[1] Bryden's Report (1876), p. 157.

of the local conditions which, if added to crowding, filth, or other insanitary conditions and want of proper ventilation, is that *of all others* which favours cholera. Such are the principal theories of the disease as they are supported by fact and argument which appear convincing. Europeans, Americans, and some authorities in India maintain the contagious view, whilst high authorities in India adhere to the opposite theory, and declare roundly that the facts of cholera, in India at least, are altogether opposed to the contagion theory.

On the question of importation of cholera in the Punjab epidemic (1875-6) and its spread by human agency, Dr. Bryden, in his report, p. 308 (1876, published 1878), says:—"The assertion amounts to this. The Punjab is divided into thirty-two districts. Cholera was introduced into seventeen of these in 1875, and therefore it spread. Cholera was *not* introduced into fifteen districts, and therefore did not appear, or, if it was introduced, influences of which we know nothing stopped its propagation in these districts. Unknown causes prevailing in the one-half of the area are presumed to influence the human system so that it is capable of receiving cholera, and in the other to act universally as an antidote even to a cholera poison when introduced. This is what is offered as antagonistic to the theory which asserts that cholera is air-borne and is as far-flying as are the limits of natural areas. Primarily, these theories cannot be reconciled; the one or the other is false. If cholera is spread only by the human being, the theory which shows it to be air-conveyed is untrue; if cholera is spread solely as an aërial miasm, then the theory which recognises only the effects of human intercourse is unfounded. The most that is admitted by the advocates of the human theory is, that the subjection of cholera to meteorological agencies is absolute, and that these influences can, and do operate so as to do away altogether with the effects of the poison, although imported. They do not recognise the entity *minus* the human being. The antagonistic theory, while holding, as opposed to demonstrable fact, the statement that cholera moves only by human agency, may, if necessary, be extended in its scope so as to embrace the other; that is to say, the inquiry is left open as to whether or not the cholera entity, after being aërially distributed, may be subsequently propagated or spread by man. In the theory which connects cholera solely with man there is no such extensibility. Human intercourse must explain every fact of spread and propagation, and nothing is left to the play of natural agencies. Human intercourse, giving the widest scope to the signification of the term, cannot pretend to account for any fundamental phenomenon displayed during the progress of epidemic cholera; and, therefore, I assert the theory to be radically untrue as applied to the behaviour of cholera in India. I do not say that the above statement will hold true all over the world; and, even as applied to India, the theory does not preclude the possibility that cholera may be conveyed by the human being. Naturally the recoil is to the opposite extreme. The bold statement that cholera is never spread over an area unless human agency intervenes, is apt to be met by the equally dogmatic statement that cholera is as pure a miasm as malaria, and as little amenable to the control of man.

In the present state of our knowledge we can only be guided by the inferences from well-ascertained facts and such laws as we have ascertained to be in constant operation, watching and carefully observing until we may, were it only by a process of exclusion, arrive at some deeper knowledge still. "So far," says the chief sanitary authority in India, "the history of cholera is full of enigmas and seeming contradictions, and though we have of late years collected many valuable data, and understood the importance of studying them on a broad basis, we know no more of the exact cause of the disease than our grandfathers did. We know that, whatever the cause may be, it flourishes in the midst of insanitary conditions of dirt and overcrowding, and especially of impure water, impure from whatever cause; we know that it is liable to occur under certain conditions, and at certain times and seasons, and we should endeavour to extend that knowledge, and hope, as we do so, to arrive at the precise nature of the disease itself." But it may be well to remember that "expenditure of public money must take place only on observed facts and experience," not in accordance with theories. "It would be prejudicial to real sanitary work if opinions which have been promulgated in some parts of India, as to the cause of cholera being due *solely* to the state of the water-supply, were to take root."

It is most important that we should arrive at some definite conclusion as to the real nature of the disease, for it is impossible but that our conceptions on this subject must influence the sanitary measures that deal with it, and I believe the question must find its final solution in India, where the disease is always present in its endemic and seldom absent from the epidemic areas. The highest authorities—for both I have the greatest respect—differ *toto cœlo* on this subject. Is it that they are both right, though seemingly so opposed in their views? Like the knights who fought about the silver and golden sides of the shield, will they not change places, and find why they differed?

I would venture to suggest that in India the inquiry might be pushed with more detail in regard to individual cases and outbreaks in certain limited areas; and that, on the other hand, one or more epidemiologists of European fame should be deputed to visit India and study cholera with the eminent men who have devoted so many years of close attention to it there. It might be, I believe it would be, that mutually they would gain from each other, and that those who went out would find their own views confirmed as to the disease in Europe—modified as to what they deemed it to be in India. Of one thing I am convinced, that simple truth is the object of their search; and I feel sure that from such combined action the greatest benefit would result.

POPULAR NATURAL HISTORY[1]

JUDGING by the continuous stream of popular "Natural Histories," the demand for such books must be great. Messrs. Cassell have already published many volumes of the kind, some dealing with the whole animal kingdom, some with a single class; they are now bringing out a series of volumes under the editorship of Dr. Martin Duncan, and in the mean time they present us with a single volume of a still more popular character by Dr. Perceval Wright. This book, as we are told in the preface, is intended for that large class of readers who, while they take an intelligent interest in the study of natural history, have but little taste for the technical details which would naturally form the bulk of a scientific manual on the subject. For this reason the space devoted to the several orders is roughly proportioned to the amount of interest generally felt in them. The mammalia occupy more than a third of the volume, the remaining orders of the vertebrata about an equal space, while the whole of the invertebrates are compressed into the space that remains—about one-fourth of that occupied by the vertebrates. The author tells us that his aim has been "to compile a story-book about animals, and at the same time in some degree to write a scientific manual." This is undoubtedly a difficult thing to do, and to do it thoroughly and in the best style would be a fitting life-work for a great naturalist. It would have to be done as a labour of love, not to the order of a publisher; and the

[1] Animal Life: being a Series of Descriptions of the Various Sub-kingdoms of the Animal Kingdom. By Perceval E. Wright, M.A., M.D., &c., Professor of Botany in the University of Dublin. With Illustrations. (Cassell, Petter, Galpin, and Co., London, Paris, and New York.)

illustrations should be of the very best kind, so as fully to exhibit the beauty, the variety, and the intricacy of nature.

The present volume lays no claim to such completeness; yet it is far superior to the mere popular natural history, inasmuch as it gives a considerable amount of accurate information both on the anatomy and physiology of the chief types of the animal kingdom, and on the geographical distribution of the chief families and genera of the higher animals. It also deserves great credit for the completeness of its review of the vertebrata, every well-established family group being referred to, and its more prominent characteristics usually described; so that, so far as this sub-kingdom is concerned, the book is a compendium of information well worthy of a place in the library of every natural history student. With the invertebrata a very different plan has had to be followed, only the more important orders being noticed, and a few typical forms selected for description and illustration; yet even here we are glad to meet with some account of the most recent discoveries among marine animals, and some illustrations which offer a welcome relief from the usual stereotyped forms of most popular works.

We shall best exhibit the character of Dr. Wright's volume by laying before our readers a few passages with their accompanying illustrations.

Under the mouse family (Muridæ) we have twenty species described or noticed, and these are illustrated by eight excellent figures. The beautiful illustration of the harvest-mouse nest building accompanies the following descriptive passage:—

FIG. 1. Harvest Mouse and Nest.

"The Harvest Mouse (*Mus minutus*) is found probably all over Europe. It is not common in England, and is more frequent in Belgium. White, of Selborne, in writing to Pennant, says: 'They build their nests amidst the straws of the corn above the ground, and sometimes in thistles. They breed as many as eight at a litter, in a little round nest composed of the blades of grass or wheat. One of these I procured this autumn, most artificially platted, and composed of the blades of grass or wheat, perfectly round, and about the size of a cricket-ball, with the aperture so ingeniously closed that there was no discovering to what part it belonged. It was so compact and well-filled that it would roll across the table without being discomposed, though it contained eight little mice that were naked and blind. As this nest was perfectly full, how could the dam come at her litter so as to administer respectively a teat to each? Perhaps she opens different places for that purpose, adjusting them again when the business is over, but she could not possibly be contained herself in the ball with her young, which, moreover, would be daily increasing in bulk. This wonderful procreant cradle—an elegant instance of the efforts of instinct—was found in a wheat-field suspended in the head of a thistle.' The food of this little mouse consists of corn and grass seeds, insects, and earth-worms. Of insects it is very fond."

Of the ravages of another British species we have the following interesting account:—

"The Short-tailed Field Mouse (*Arvicola arvalis*) is found throughout Europe to Siberia. Small and insignificant as this animal appears to be, there is scarcely a species among the rodents more destructive to our fields, gardens, and woods. In the corn-field, the rick-yard, the granary, and in extensive plantations, its depredations are often severe, and even calamitous. Of the damage effected by a multitude of these animals we give a single instance. In the year 1814 the whole, both of Dean and New Forest, appeared to be largely stocked with mice; at least wherever the large furze-brakes in the open parts had been burnt their holes and runs covered the surface. Hayward Hill, a new plantation of about 500 acres in the Forest of Dean, was particularly infested. This inclosure, after being properly fenced, was planted with acorns in 1810, and in the following spring about one-third came up, the rest of the seed having been destroyed principally by mice. The young shoots of the natural hollies of the district, which had been cut down to favour the plantation, were not attacked by the mice in the following winter, though their runs were numerous. In the autumn of the succeeding year a large quantity of five years old oaks and chestnuts, with ash, larch, and fir, were planted in the inclosure. In the winter the destruction began, and numbers of the hollies, then two, three, or more feet in height, were barked round from the ground to four or five inches upwards, and died. In the succeeding spring a number of the oaks and chestnuts were found dead; and when they were pulled up it appeared that the roots had been gnawed through two or three inches below the surface of the ground; many were also barked round and killed, like the holly-shoots, whilst others, which had been begun upon, were sickly. The evil now extended to the other inclosures, and becoming very serious both in Dean Forest and the New Forest, cats were turned out, the bushes, ferns, rough grass, and other plants were cleared off to expose the mice to beasts and birds of prey; poisons in great variety were laid, and seven or eight different sorts of traps were set for them, some of which succeeded very well. These were, however, superseded by the plan of a ratcatcher, who, having been employed to capture the mice, had observed, on going to work in the morning, that some of them had fallen into wells or pits accidentally formed, and could not get out again, many of them dying from hunger or fatigue in endeavouring to climb up the sides. Such pits were therefore tried on his recommendation. They were at first made three feet deep, three long, and two wide; but these were found to be unnecessarily large, and after various experiments it appeared that they answered best when from eighteen to twenty inches deep, about two feet in length, and a foot and a half in width at the bottom, and only eighteen inches long and nine wide at the top, or so wide as would allow of the earth being got out of a hole of that depth, for the wider they were below and the narrower above the better they answered their purpose.[1] They were made about twenty yards asunder, or, where the mice were less numerous, thirty yards apart. Nearly 30,000 mice were speedily caught by this method in Dean Forest, and in the New Forest about 10,000 more. It was believed that a far greater number had been taken out of the holes either alive or dead by stoats and weasels, or by kites, owls, crows, jays, and magpies."

The following account of the Angler (*Lophius piscatorius*), a curious large-headed fish belonging to the family of the Lophiidæ, or fishing-frogs, and a native of our seas, is short, but clear and instructive:—"This curious fish has the head wide, and the mouth nearly as wide as the head; the eyes are large; the lower jaw, which is the longer, is bearded or fringed all round the edge, and both jaws are armed with numerous teeth; the body is narrow compared with the breadth of the head, and tapers gradually to the tail. The colour of the upper surface of the body is uniform brown, the under surface white, and the tail almost black. On the top of the head are three long filaments; of these, two are seated just above the muzzle, the other rises from the back of the head. These filaments are movable in all directions, especially the first, which, tapering like the finest fishing-rod, ends in broad, flattened, silvery tips.

"The angler is insatiably voracious, but it is a slow swimmer; it is formed, in fact, for taking its prey in ambush. It reposes on the soft mud or sand, in some favourable lurking-place, and, stirring up the mud with its pectoral fins, thus obscures itself in a murky cloud, beyond which appear its long filaments, and, especially the first, with its glittering tip, offering an attractive bait to other fish. Thus stationed, the creature quietly expects its victim. On rove the shoals of fish, eager in quest of food. They pass one after another in succession, till at length one espies the bait. Forward the fish darts, either to examine or seize the expected prize; but at that instant, aided by its broad, feet-like pectoral fins, the watchful angler springs up and captures its prey."

FIG. 2.—Angler (*Lophius piscatorius*).

The fishes are generally very well illustrated, and a large number of interesting species are described.

Passing on to the invertebrates, we come first to the insects, which form the weakest part of the volume; but this is perhaps of less importance as none but specialists feel any interest in the bulk of the forms; while their immense numbers and endless variety, their strange habits, and marvellous instincts can only be adequately set forth where ample space can be afforded them. We pass on therefore to the lower marine animals, and select as an example of the way they are treated a rare British species allied to the sea cucumbers, and named *Synapta duvernea*. It was discovered in the English Channel by M. Quatrefages, who thus describes it:—

"Imagine a cylinder of rose-coloured crystal as much as eighteen inches long and more than an inch in diameter, traversed in all its length by five narrow ribbands of white silk, and its head surmounted by a living flower whose twelve tentacles of purest white fall behind in a graceful curve. In the centre of these tissues, which rival in their delicacy the most refined products of the loom, imagine an intestine of the thinnest gauze, gorged from one end to the other with coarse grains of granite, the rugged points and sharp edges of which are perfectly perceptible

[1] This is the form adopted for the tiger-pits made by the Chinese in Singapore.

to the naked eye. But what most struck me at first in this animal was that it seemed literally to have no other nourishment than the coarse sand by which it was surrounded. And then when, armed with scalpel and microscope, I ascertained something of its organisation, what unheard-of marvels were revealed! In this body, the walls of which scarcely reach the sixteenth part of an inch in thickness, I could distinguish seven distinct layers of tissue, with a skin, muscles, and membranes. Upon the petaloid tentacles I could trace terminal suckers, which enabled the Synapta to crawl up the side of a highly-polished vase. In short this creature, denuded to all appearance of every means of attack or defence, showed itself to be protected by a species of mosaic, formed of small, calcareous, shield-like defences, bristling with double hooks, the points of which, dentated like the arrows of the Carribeans, had taken hold of my hands. If one of these Synapta is preserved alive in sea-water for a short time, and subjected to a forced fast, a very strange phenomenon will be observed. The animal, being unable

FIG. 3.—*Synapta duvernea.*

to feed itself, successively detaches various parts of its own body, which it amputates spontaneously."

Although most of the illustrations in this volume are very good, and some are good works of art, there are also several which are very poor, and quite unworthy of the text. This is especially the case among the smaller birds, several of which are unrecognisable. A few also have been wrongly named, representing very different creatures from those they are said to be. The most prominent defects of this kind are the figure of the Leucoryx antelope, which is named *Saiga tartarica*, and that of two humming-birds, which do duty for sun-birds. These oversights, which no doubt occurred in the London office, since they are far too gross to be imputed to the author of the book, should be corrected in another edition; and if the publishers will substitute better figures for those of the stone-chat, hedge-sparrow, dipper, Java-sparrows and some others which are barely recognisable, the work will be one of permanent use and interest, both as an illustrated manual of the families of the vertebrata and a popular introduction to general natural history.

A. R. W.

ON THE SECULAR CHANGES IN THE ELEMENTS OF THE ORBIT OF A SATELLITE REVOLVING ABOUT A PLANET DISTORTED BY TIDES[1]

THE investigation which forms the subject of this paper is entirely mathematical, and is therefore not of a kind to be easily condensed into a short account.

This paper is the fifth of a series (of which notices have from time to time appeared in NATURE) in which I have endeavoured to trace the various effects on the configuration of a planet and satellite, which must result from tidal friction—the tides in the planet being either a bodily distortion or oceanic. The investigations are, I think, not without interest as a branch of pure dynamics, but this side of the subject is too complicated to be made intelligible without mathematical notation, and it would occupy too much space to explain the methods of treatment.

There is, however, another side of the subject, which must, I think, attract notice, or at least criticism, and this is the applicability of the results of analysis to the history of the earth and of the other planets.

[1] An account of a paper by G. H. Darwin, F.R.S., read before the Royal Society, on December 18.

We know that no solids are either perfectly rigid or perfectly elastic, and that no fluids are devoid of internal friction, and therefore the tides raised in any planet, whether consisting of oceanic tides or of a bodily distortion of the planet, must be subject to friction. From this it follows that the dynamical investigation must be applicable to some extent to actual planets and satellites. For myself, I believe that it gives the clue to the history of the system, but of course an ample field for criticism is here opened.

The investigation is intended to be more especially applicable to the case of the earth and moon, and therefore, instead of planet and satellite, the expressions earth and moon are used.

The effect of tidal friction upon the eccentricity and inclination of the lunar orbit here affords the principal topic. The obliquity of the ecliptic, the diurnal rotation of the earth, and the moon's periodic time were considered in a paper read before the Royal Society on December 19, 1878, and which will appear in the *Philosophical Transactions* for 1879.

The present paper completes (as far as I now see) the main investigation for the case of the earth and moon, and therefore it is now possible to bring the various results to a focus.

It appears then that, when we trace backwards in time the changes induced in the system of the earth and moon by tidal friction, we are led to an initial state which is defined as follows:—

The earth and moon are found to be initially nearly in contact; the moon always opposite the same face of the earth, or moving very slowly relatively to the earth's surface; the whole system rotating in from two to four hours, about an axis inclined to the normal to the ecliptic at an angle of 11° 45′, or somewhat less; and the moon moving in a circular orbit, the plane of which is nearly coincident with the earth's equator.

This initial configuration suggests that the moon was produced by the rupture, in consequence of rapid rotation or other causes, of a primeval planet, whose mass was made up of the present earth and moon. The coincidence is noted in the paper, that the shortest period of revolution of a fluid mass of the same mean density as the earth, which is consistent with an ellipsoidal form of equilibrium, is two hours twenty-four minutes; and that if the moon were to revolve about the earth with this periodic time, the surfaces of the two bodies would be almost in contact with one another.

The rupture of the primeval planet into two parts is a matter of speculation, but if a planet and satellite be given in the initial configuration above described, then a system bearing a close resemblance to our own, would necessarily be evolved under the influence of tidal friction.

The theory postulates that there is not sufficient diffused matter to materially resist the motions of the moon and earth through space. Sufficient lapse of time is also required. In a previous paper I showed that the minimum time in which the system could have degraded from the initial state, just after the rupture into two bodies, down to the present state, is fifty-four million years. The time actually occupied by the changes would certainly be much longer.

It appears to me that a theory, reposing on a *vera causa*, which brings into quantitative correlation the lengths of the present day and month, the obliquity of the ecliptic and the inclination and eccentricity of the lunar orbit, must have considerable claims to acceptance.

It was stated that the periodic times of revolution and rotation of the moon and earth might be traced back to a common period of from two to four hours. In a previous paper the common period was found to be a little over five hours in length; but that result was avowedly based on a partial neglect of the sun's attraction. In this paper certain further considerations are adduced, which show that, while the general principle remains intact, yet the common period of revolution of the earth and moon must initially have been shorter than five hours to an amount which is uncertain, but is probably large. The period of from two to four hours is here assigned, because it is mechanically impossible for the moon to revolve about the earth in less than two hours, and it is uncertain how the rupture of the primeval planet took place.

But if tidal friction has been the agent by which the earth and moon have been brought into their present configuration, then similar changes must have been going on in the other bodies which make up the solar system. I will therefore make a few remarks on the other satellites and planets.

In the first place it is in strict accordance with the theory, that the moon should always present the same face towards the earth. Helmholtz, was, I believe, the first who suggested tidal friction as the cause of the reduction of the moon's axial rotation to identity with her orbital motion. It is interesting to note in this connection that the telescope seems to show that the satellites of Jupiter, and one at least of the satellites of Saturn, also have the same peculiarity.

The process by which tidal friction brings about the changes in the configuration of a planet and satellite is a destruction of energy (or rather its partial conversion into heat within the planet, and partial redistribution), and a transference of angular momentum from that of planetary rotation to that of orbital revolution of the two bodies about their common centre of inertia.

Now a large planet has both more energy of rotation and more angular momentum; hence it is to be expected that large planets should proceed in their changes more slowly than small ones.

Mars is the smallest of the planets, which are attended by satellites, and it is here alone that we find a satellite revolving faster than the planet rotates. This will also be the ultimate fate of our moon, because after the joint lunar and solar tidal friction has reduced the earth's rotation to an identity with the moon's orbital motion, the solar tidal friction will continue to reduce it still further, so that the earth will rotate faster than the moon revolves.

Before, however, this can take place with us, the moon must recede to an enormous distance from the earth, and the earth must rotate in forty or fifty days instead of in twenty-four hours. But the satellites of Mars are so small, that they would only recede a very short way from the planet, before the solar tidal friction reduced the planet's rotation below the satellite's revolution. The rapid revolution of the inner satellite of Mars may then, in a sense, be considered as a memorial of the primitive rotation of the planet round its axis.

The planets Jupiter and Saturn are very much larger than the earth, and here we find the planets rotating with great speed, and the satellites revolving with short periodic times. The inclinations of the orbits of Jupiter's satellites to their "proper planes" are very interesting from the point of view of the present theory.

The Saturnian system is much more complex than that of Jupiter, and it seems partially in an early stage of development and partially far advanced.

The details of the motions of the satellites are scarcely well enough known to afford strong arguments either for or against the theory.

I have not as yet investigated the case of a planet or star attended by several satellites, but perhaps future investigations may throw further light both on the case of Saturn, and on the whole solar system itself.

The celebrated nebular hypothesis of Laplace and Kant supposes that a revolving nebula detached a ring, which ultimately became consolidated into a planet or satellite, and that the central portion of the nebula continued to contract, and formed the nucleus of the sun or planet.

The theory now proposed is a considerable modification of this view, for it supposes that the rupture of the central body did not take place until it was partially consolidated, and had attained nearly its present dimensions.

I do not pretend, in these remarks, to have thoroughly discussed the cases of the other planets, and have only drawn attention to a few salient features; in the paper itself the subject is considered at greater length. It will, however, I think, be admitted that the theory agrees with some remarkable facts in the solar system.

G. H. DARWIN

THE SEXUAL COLOURS OF CERTAIN BUTTERFLIES

DR. SCHULTE, of Fürstenwalde, has called my attention to the beautiful colours which appear on all four wings of a butterfly, the *Diadema bolina*, when looked at from one point of view. The two sexes of this butterfly differ widely in colour. The wings of the male, when viewed from behind, are black with six marks of pure white, and they present an elegant appearance; but when viewed in front, in which position, as Dr. Schulte remarks, the male would be seen by the female when approaching her, the white marks are surrounded by a halo of beautiful blue. Mr. Butler, also showed me in the British Museum an analogous and more striking case in the genus Apatura, in which the sexes likewise differ in colour, and in the males the most magnificent green and blue tints are visible only to a person standing in front. Again with Ornithoptera the hind wings of the male are in several species of a fine golden yellow, but only when viewed in front; this holds good with *O. magellanus* but here we have a partial exception, as was pointed out to me by Mr. Butler, for the hind wings when viewed from behind change from a golden tint into a pale iridescent blue. Whether this latter colour has any special meaning could be discovered only by some one observing the behaviour of the male in its native home. Butterflies when at rest close their wings, and their lower surfaces, which are often obscurely tinted, can then alone be seen; and this it is generally admitted, serves as a protection. But the males, when courting the females, alternately depress and raise their wings, thus displaying the brilliantly coloured upper surface; and it seems the natural inference that they act in this manner in order to charm or excite the females. In the cases above described this inference is rendered much more probable, as the full beauty of the male can be seen by the female only when he advances towards her. We are thus reminded of the elaborate and diversified manner in which the males of many birds, for instance the peacock, argus pheasant, &c., display their wonderful plumage to the greatest advantage before their unadorned friends.

The consideration of these cases leads me to add a few remarks on how far consciousness necessarily comes into play in the first acquirement of certain instincts, including sexual display; for as all the males of the same species behave in the same manner whilst courting the female, we may infer that the display is at least now instinctive. Most naturalists appear to believe that every instinct was at first consciously performed; but this seems to me an erroneous conclusion in many cases, though true in others. Birds, when variously excited, assume strange attitudes and ruffle their feathers; and if the erection of the feathers in some particular manner were advantageous to a male whilst courting the female, there does not seem to be any improbability in the offspring which inherited this action being favoured; and we know that odd tricks and new gestures performed unconsciously are often inherited by man. We may take a different case (which I believe has been already advanced by some one), that of young ground birds which squat and hide themselves when in danger immediately after emerging from the egg; and here it seems hardly possible that the habit could have been consciously acquired just after birth without any experience. But if those young birds which remained motionless when frightened, were oftener preserved from beasts of prey than those which tried to escape, the habit of squatting might have been acquired without any consciousness on the part of the young birds. This reasoning applies with special force to some young wading and water birds, the old of which do not conceal themselves when in danger. Again a hen partridge when there is danger flies a short distance from her young ones and leaves them closely squatted; she then flutters along the ground as if crippled, in the wonderful manner which is familiar to almost every one; but differently from a really wounded bird, she makes herself conspicuous. Now i is more than doubtful whether any bird ever existed with sufficient intellect to think that if she imitated the actions of an injured bird she would draw away a dog or other enemy from her young ones; for this presupposes that she had observed such actions in an injured comrade and knew that they would tempt an enemy to pursuit. Many naturalists now admit that, for instance, the hinge of a shell has been formed by the preservation and inheritance of successive useful variations, the individuals with a somewhat better constructed shell being preserved in greater numbers than those with a less well constructed one; and why should not beneficial variations in the inherited actions of a partridge be preserved in like manner, without any thought or conscious intention on her part any more than on the part of the mullusc, the hinge of whose shell has been modified and improved independently of consciousness. CHARLES DARWIN

Down, December 16, 1879

NOTES

WE are much pleased to be able to announce that the Committee of the British Association for the Exploration of Socotra have secured the services of Dr. I. B. Balfour, Professor of Botany at Glasgow, as naturalist. Besides many other qualifications for the post Dr. Balfour has recently taken part in the execution of a similar piece of work as one of the naturalists attached to the station for the observation of the Transit of Venus at Rodriguez. Dr. Balfour will leave for Aden on the 9th inst., and proceed thence to Socotra.

M. PERRIER, the head of the French Survey, has been appointed a Member of the Academy of Sciences. It may be remembered that M. Perrier is a commander on the staff, and has just accomplished one of the greatest geodetic feats on record, the connection of the South of Spain with the Algerian province of Oran. M. Perrier is a supporter of M. Roudaire's scheme, and his appointment is considered likely to accelerate the work of the survey for the great Saharan Railway.

WE are pleased to see that a movement is on foot to erect an educational natural history museum in Perth, as a memorial to the late Sir Thomas Moncrieffe, president of the Perthshire Natural History Society. From a statement sent us by Dr. Buchanan White, we notice that the organisers have a rational idea of what such an institution should be, and their scheme is a comprehensive one, having in view the education of the citizens of the ancient burgh, as well as the collection of objects of natural history connected with the county. A generous citizen of Perth, Mr. Robert Pullar, offers 500*l*. of the 2,000*l*. which it is estimated the building will cost.

M. E. LEVASSEUR, a well-known French geographer, has invented an amusing and instructive geographical game, to which he gives the name of "Tour du Monde." It is played on a large terrestrial globe divided into 232 spherical rectangles, each of which has a number, corresponding to a number on a list, indicating gains or losses, in accordance with the nature of the rectangle to which it belongs. The game is played with eighteen flags corresponding to the principal States of the world, from China, the most populous, down to Holland, the least populous. A brass slip, from pole to pole, contains eighteen holes, into which the flags are successively placed by the players at each revolution, commencing at the south pole and moving northwards. The gains and losses correspond with the nature of the facts indicated in the space above which a flag may stand when the globe stops revolving. Thus London counts thirty, Paris twenty, and so on, according to population. A coal-mine, a Manchester cotton factory, a grain centre, all count for gains; while meeting a Zulu or a lion in Africa, a storm in Atlantic or Pacific, a crocodile in the Nile, being caught in the Polar ice, &c., count for losses. Thus it will be seen, the new game is calculated to afford considerable excitement as well as instruction.

DR. B. W. RICHARDSON has been re-elected Assessor of the University Council of St. Andrew's University. This will be Dr. Richardson's third term of office.

WE last week referred to the new appointment to the Registrar-Generalship and the resignation of Dr. Farr. The following is Dr. Farr's dignified and temperate letter to Major Graham, the retiring Registrar-General:—"December 23.—Sir,—Having now heard from you that Sir Brydges Henniker is to be the new Registrar-General, and thus having lost all chance of being your successor, I shall be glad if the Lords of Her Majesty's Treasury will allow me to resign my appointment, and will grant me superannuation allowance to the extent of my full pay. I have served under you nearly forty years, I have taken with you three censuses, and I feel confident that I can leave my case in your hands.—(Signed) William Farr." The Government has possibly a complete justification to give for the appointment of Sir Brydges Henniker; if so, they should lose no time in making it public, as their treatment of Dr. Farr has roused universal indignation.

MR. EDISON publishes through the columns of the *New York Herald*, an elaborate and detailed account of his labours with his new form of electric lighting. Minutely describing the course of his studies, Mr. Edison says that he has made the discovery that the carbon framework of a small piece of paper is the best substance for incandescent lighting. A piece of cardboard, known in the trade as "Bristol," is cut, with a suitable punch, into strips in the form of miniature horseshoes, about 2 inches long, and one-eighth wide. A number of these strips are placed in a wrought-iron mould, separated from each other by tissue paper. The mould, after being well covered, is placed in an oven, where it is gradually exposed to a temperature of about 600° F., so as to allow the volatile portions of the paper to pass away. The mould is then removed to a furnace, kept there till it retains almost a white heat, and subsequently allowed gradually to cool down. On opening the mould, the charred remains of the cardboard must be taken out with great care, in order to prevent them from falling to pieces. They are placed in a small globe and attached to the wires connecting the generating machine. The next thing is to extract the air, by means of the pump, from the globe; that being accomplished, the globe is sealed, and the lamp is ready for use. It should be observed that the new lamp requires no complex regulating apparatus, such as characterised the earlier efforts. In fact, Mr. Edison finds that all previous labour in regard to regulators was practically wasted, and furthermore, that electricity can be regulated with absolute reliability in a manner precisely similar to that in which the pressure of gas is now produced. The system now adopted by Mr. Edison in connecting the wires admits of a given number of lights being extinguished without affecting those of other burners. In the same way as we would shut a certain number of gas burners and permit others to draw a supply from the meter, the electric light can be obtained or shut out. From the description now given it appears that the apparatus primarily used by Mr. Edison was in the shape of a large tuning-fork, constructed in a manner that both ends would vibrate when placed near the poles of the great magnet. Experience has demonstrated the impracticability of that apparatus, and it became necessary to search for other means. One experiment was made after another, which had the tendency to lead gradually to the adoption of the system now employed in the generating machine, and which Mr. Edison terms the Faradaic machine. It is briefly described thus:—Two upright iron columns 3 feet in height, and 8 inches in diameter, covered with coarse wire and resting upon a base, form the magnetic poles. Fixed on an angle, so as to admit a free revolution between the poles, is a cylindrical armature of wood, wound parallel to its axes with fine iron wire. This cylinder is made to revolve rapidly between the magnetic poles, and by means of a belt, driven by an engine, strong currents of electricity are generated in the wire surrounding the armature, and these currents are carried along the wires to the electric lamp.

A CHANGE has taken place in the French Ministry, and M. Freycinet, the Minister of Public Works, has been created Prime Minister by the President of the Republic. M. Varoy and General Farre, two pupils of the Polytechnic School, have been appointed to the Department of Public Works and War Office. It is known that M. Freycinet was educated in the same institution, which has never, since it was created in 1798, given at once so many Ministers to France.

IN the Annual Report of the Royal Botanical Garden at Calcutta for the year 1878–79, Dr. King confirms the opinion he has expressed in former reports regarding the unsuitability of the Para rubber plants for acclimatisation in some parts of India. He acknowledges that plants may be coaxed into growing in conservatories, but considers the species far too thoroughly tropical to withstand without protection the vicissitudes of the climate of Northern India. He says, "I believe it is useless to try it anywhere in India except in the south of Burmah or the Andamans, or perhaps in Malabar. Contrary to the experience with Para rubber, the Ceara Kina (*Manihot glaziovii*) promises well, and if the quality of rubber yielded by it in India proves to be good, its introduction will no doubt turn out of much importance. Seeds of a species of *Landolphia* yielding African rubber have been received at Calcutta from Zanzibar. Dr. King reports upon them as not looking very promising, but thought possibly some of them might grow. Seeds of the mahogany tree have been received at Calcutta in large quantities, and a large number of seedlings have been distributed. The cultivation of this valuable timber tree has been taken up by the Forest Department in the Government Plantation near Chittagong. Large quantities, also, of the seed and seedlings of the *Pithecolobium saman*, or rain-tree, have been distributed; and as the plant grows rapidly and seems to flower and seed freely, it may prove a valuable introduction to India.

THE annual prize of 25,000 francs (1,000*l*.), given by the King of the Belgians for works of a scientific character, is now offered for the year 1881. It will be awarded to the author of the best work on the means of improving sea-ports situated upon low and sandy coasts, such as the Belgian ports. Foreigners as well as Belgian subjects may compete, as the competition is an international one. The works must be sent to the "Ministère de l'Intérieur," at Brussels, before January 1 next. The prize will be awarded by a jury composed of four foreigners and three Belgians, all of whom are nominated by his Majesty.

A PRIZE is offered by the Governor of the Prussian province of Saxony for the best text-book of natural science and agriculture. The exact title is as follows: "Lehrbuch der Naturwissenschaften und der Landwirthschaft zum Gebrauch beim Unterricht in den Ackerbauschulen und landwirthschaftlichen Winterschulen in Sachsen." The competing works must be sent to Dr. Julius Kühne, Professor at the University of Halle. The extent of the book is to be moderate, and should not exceed thirty sheets.

ON December 10, 1878, the first cremation was executed at Gotha. We announced the fact at the time. News from that town now states that during 1879 fifteen other cremations were performed. This is looked upon as an extremely satisfactory result for the first year in which the process may be chosen by and for anybody. The time for the complete incineration of the bodies was between one and a half and two and a half hours, therefore about two hours on the average. Besides Gotha, other German towns furnished subjects for cremation, such as Langensalza, Naumburg, Neustadt on the Orla, Leipzig, Dresden, Bamberg, Hanover, Breslau, and Vienna.

ONE of the *desiderata* of M. Leverrier has been fulfilled. A lectureship of astronomy has been created in Marseilles, and M. Stephan, Director of the Observatory, appointed as lecturer.

M. C. DETAILLE, of Paris, is organising in France, at the request of Lord Lindsay, a system of astronomical exchanges similar to that suggested in these columns by his lordship for England.

THE thaw set in in Paris about 4 P.M. on December 28, just when the partial eclipse of the moon was beginning. The temperature has been increasing almost without interruption. 14° Cent. in the sun has been reached, and 9° Cent. in the shade. The breaking up of the ice in the Seine took place on the 2nd, and was so sudden that it took the engineers by surprise. An immense number of boats have been wrecked, and have created obstacles to the flow of water and ice under the arches of the bridges. The consequence has been the total wreck of the wooden foot-bridge of the Invalides and the destruction of two arches of the stone bridge now building at a distance of a few paces down the river. So serious were the fears entertained by the authorities for the safety of the iron bridges that the traffic was prohibited during the whole of Saturday. The news from the mountainous parts of the Seine basin announce that an immense quantity of water is travelling towards the sea.

WHILE Paris and the whole of France have been recently covered with snow, in a period of exceptional cold, the weather has been comparatively very clement on the summit of the Pic-du-Midi and the snow rare. General Nansouty telegraphed privately as follows to M. Tissandier on December 24:—"We are in distress; we shall presently be unable to find enough snow to make water for the tea and the soup. Send us some snow if Paris has enough."

SINCE December 13 the temperature of Algiers has been that of spring, the temperature in the shade varying from 6° to 17°, and in the sun of 32° Centigrade; almost no cloud in the sky, and a magnificent sun shining all the day long.

M. W. DE FONVIELLE has just published a novel under the title of "Neridah" (Hachette and Co.), in which, with considerable ingenuity, he brings the tricks of spiritualistic mediums and the facts of electrical science to bear upon the development of the plot. The scene of the story is in England and India.

PROF. SCHÄFER will, on Tuesday next, January 13, begin a course of ten lectures on the Physiology of Muscle at the Royal Institution; and Mr. H. H. Statham will, on Thursday next, January 15, give the first of two lectures on Modern Architecture since the Renaissance; at the first Friday evening meeting of the season, January 16, Prof. Dewar will describe his "Investigations at High Temperatures." On Saturday, the 17th, Prof. T. Rupert Jones will give the first of three lectures on Coal.

THE officers and engineers appointed to proceed to Algeria for the survey of the Transaharan railway, are leaving Paris by batches. They take with them a number of aneroid barometers specially constructed, which will be verified frequently by boiling water with a hypsometer of verysimple construction.

THE earthquake in Switzerland on December 30, 1879, is exciting great interest in scientific circles, and arrangements are being made for accurately measuring the duration of future shocks. The occurrence of a shock at the beginning of the late phenomenal frost and of another at its close is too remarkable to escape notice. The oscillation of Tuesday, though felt at places so far asunder as Chambery and Berne, seems to have been most marked at Geneva, Lausanne, and in the mountains of Bex. At Grion, in Vaud, 3,500 feet above the sea-level, the oscillation lasted five seconds, and was accompanied by a rumbling sound as of subterranean thunder.

THE subject of the Wyatt Edgell Prize Essay of the Sanitary Institute is "The *Range* of Hereditary Tendencies in Health and Disease," not the *Cause*.

THE programme for the meetings after Christmas of the Society of Arts has just been issued. Among papers to be read at the ordinary meetings between Christmas and Easter are:—January 21, "Dome tic Poisons," by Henry Carr; January 28, "The Future of Epping Forest," by William Paul, F.L.S.; February 4, "Trade and Commerce with Siberia, *viâ* the Kara Sea," by Henry Seebohm; February 11, "The History of the Art of Bookbinding," by Henry B. Wheatley, F.S.A.; February 18, "The Euphrates Valley Railway," by W. P. Andrew; February 25, "The Art of the Silversmith," by W. Herbert Singer; March 3, "The History of Musical Pitch," by Alexander J. Ellis, F.R.S.; March 10, "Recent Advances in the Production of Lambeth Art Pottery," by John Sparkes; March 17, "Buildings for Secondary Educational Purposes," by E. C. Robins, F.S.A. In the Indian Section, Prof. Vambéry, the great Eastern traveller, has undertaken to read a paper on "Russia's Influence over the Inhabitants of Central Asia during the last Ten Years," and he has promised to come over from Buda-Pesth expressly for the purpose. The other papers to be read in this section, for which dates are fixed, are:—January 30, "Herat," by Col. G. B. Malleson. C.S.I.; April 2, "The Best Route for a Line of Railway to India," by Mr. B. Haughton, C.E.; May 7, "Agriculture in India," by Mr. Robertson, Superintendent of the Government Farm, Madras. In the Chemical Sections, Prof. Perry will read a paper on "The Teaching of Physics," on January 22. On February 12 there will be a paper on "Gas Furnaces and Kilns for Burning Pottery," by Herbert Guthrie, C.E. The course of Cantor Lectures during this part of the year will be on the "Manufacture of India-rubber and Gutta-percha," by Thomas Bolas, F.C.S. It will consist of six lectures, the first of which will be given on February 2.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. L. C. Piggott; a Common Ocelot (*Felis pardalis*), a Harpy Eagle (*Thrasaëtus harpygia*) from Central America, a Black-tailed Parrakeet (*Polytelis melanurus*) from Australia, purchased; a Tamandua Ant-eater (*Tamandua tetradactyla*), two Naked-throated Bell Birds (*Chasmorhynchus nudicollis*) from Brazil, a Tuberculated Iguana (*Iguana tuberculata*) from South America, two Giant Toads (*Bufo agua*) from Savauilla, deposited.

OUR ASTRONOMICAL COLUMN

Minor Planets.—The number of discoveries in the group of minor planets during the year 1879 is *twenty*, against *twelve* in the preceding year, so that there is no present indication that we are getting to the end of them. Elements more or less approximate have been calculated for seventeen out of the twenty new ones, but no one of the orbits has any peculiarity. We subjoin their ordinal numbers, names so far as published, discoverers and dates of discovery, with their magnitudes at the time.

192	Nausikaa	Palisa	Feb. 17	11
193	Ambrosia	Coggia	Feb. 28	12
194	Procne	Peters	March 22	10·5
195	Euryclea	Palisa	April 28	12
196	Philomela	Peters	May 17	10
197	Arete	Palisa	May 21	12
198	Ampella	Borrelly	June 13	11
199	Byblis	Peters	July 9	11
200	Dynamene	Peters	July 27	11
201	Penelope	Palisa	Aug. 7	10·5
202	Chryseis	Peters	Sept. 23	11
203	Pompeia	Peters	Sept. 27	11
204	Callisto	Palisa	Oct. 8	12
205	...	Palisa	Oct. 13	12
206	Hersilia	Peters	Oct. 15	11
207	...	Palisa	Oct. 17	12
208	...	Palisa	Oct. 21	13
209	Dido	Peters	Oct. 22	11
210	...	Palisa	Nov. 12	11
211	...	Palisa	Dec. 10	10·5

The elements will be found in Nos. 109-127 of the *Circular zum Berliner Astronomisches Jahrbuch*.

The Melbourne Observatory.—The fourteenth Report of the Board of Visitors to the Observatory, presented to the Governor of Victoria, with the Report of the Government astronomer for the year ending June 30, 1879, has been received. The great reflector is stated to be in capital working order, but unexpected difficulties have been met with in placing the results of work with it before the astronomical public, this work consisting mainly of drawings of nebulæ in Sir John Herschel's catalogue. Fifty-four of the smaller nebulæ and clusters contained in it have been observed and compared, and the great majority found to agree well with the Cape descriptions. "Some, however, have considerably changed, whilst others are completely altered in appearance." Five nebulæ described by Herschel have not been found after careful search. The drawing of the great nebula around η Argus made in March, 1875, still accurately represents its appearance. Observations of the trifid nebula No. 4355 were made on ten nights for comparison of those by Holden and Trouvelot with the Washington refractor. Stress is laid upon the need of a transit-circle of increased capacity, and it is understood that the Government propose a vote for this purpose.

The Biela Comet Meteors.—Contrary to what had been anticipated by more than one astronomer who has given special attention to the subject, from present information it would appear that the earth passed the descending node of Biela's comet at the end of November last, without encountering any portion of the meteoric swarm, which, in November, 1872, was moving in its orbit. The earth would reach the node on the morning of November 28, or perhaps earlier; the comet attains its least distance from our track thirty-two hours after its nodal passage, or, with Michez's orbit of 1866, in about heliocentric longitude, 67° 19′.

Uranometria Argentina.—Within the last week we have received this very important work from the Director of the Cordoba Observatory, Dr. B. A. Gould. Some account of it was lately given in this column from an article in the Buenos Ayres *Standard*, but we shall revert to it at an early date. Its publication will form an epoch in southern sidereal astronomy.

The Close Binary 85 Pegasi.—We learn from Mr. Burnham that his recent measures fully establish the physical connection of the close components of this star. A mean of five nights' measures gives:

1879·46 ... Position 284°·6 ... Distance 0″·75.

The earlier mean result being:

1878·7 ... Position 274°·0 ... Distance 0″·67.

For the stars A and C Mr. Burnham finds:

1879·9 ... Position 28°·7 ... Distance 15″·40.

BIOLOGICAL NOTES

A Blind Isopod.—For some years past, Prof. Forel, of the Academy of Lausanne, has been engaged in investigating the animal forms to be met with in the great depths of the Lake Leman. These researches have been published from time to time since 1869 in the *Journal* of the Vaudois Society of Natural History, and the series is apparently brought to a close in the recently published number of the journal in which he sums up the general results, and enumerates no less than seventy-six species of animals described as discovered in the Lake at depths of from 100 to 300 metres. Among these is one new blind form, closely related to our own very common fresh-water Isopod called *Asellus aquaticus*. When drawn up from the water it is found constantly associated with *Niphargus puteanus*. It is of a whitish colour, through which the brownish-coloured alimentary canal is easily perceptible. When placed in an aquarium it lives but a short time. The organs of vision are only rudimentary. The species comes near to *A. cavaticus*, and has been named by H. Blanc *A. forellii*.

Notes on Crustacea.—Dr. P. P. C. Hoek of Leiden has published some very interesting results of his investigations among the smaller crustacean forms made at the Netherlands Zoological Station. One series of notes are devoted to the anatomy and systematic descriptions of the species of Caprellidæ met with, viz., *Podalirius typicus*, Kröyer, *Caprella linearis*, Lin., and *Leptomera pedata*, Abilgaard. Another series treats of several species of Corophidæ. Those met with were: *Corophium crassicorne* (Hoek confirms Norman's statement that the *C. Bonellii* of Bate and Westwood is the female of this species); *C. longicorne*, *Cerapus difformis*, *Podocerus falcatus*, *Orthopalame Terschellingi*, nov. gen., nov. sp. (this new genus belongs to the sub-family Podocerinæ), and *Amphitoe littorina*. A third series is devoted to an account of *Orchestia cavimana*, Heller, found by Dr. Noman at Zalt-Bommel, a town in the province of Gelderland. It is more than 80 kilometres from the sea; the water is not brackish, but the amphipods were not even found in the neighbourhood of a stream, but in a walled-in garden some slight distance therefrom, in a corner of which, under some flower-pots, and while in search for onisci, the species was taken. It would appear to be the same as the one described by Heller as found on Olympus by Dr. Kotschy, at a height of some 4,000 feet, in moist spots in the neighbourhood of a spring. Mr. Noman found the species in the same locality again in August last (1879). The listribution of some of the other species of *Orchestia* is also referred to. Series four treats of some insufficiently-known Gammaridæ, such as *Atylus swammerdammi*, *Calliopius læviusculus*, *Melita obtusata*, *Cheirocratus brevicornis*, n. sp., *Ampelisca æquicornis*. Series five gives some short anatomical remarks on Gammaridæ. These researches are illustrated by six plates, and form portion of the *Reports* of the Netherlands Zoological Station.

Ptyaline and Diastase.—Physiologists have differed in opinion as to the action of the gastric juice on ptyaline and on diastase. While some hold that the saliva is destroyed in the gastric juice, others maintain that it continues, in the stomach, its action on starch. Recent researches by M. Defresne (*Comptes rendus*) appear to throw light on the subject; they prove, on the one hand, that the saliva is paralysed in pure gastric juice, whereas with mixed gastric juice, containing only organic acids, saccharification proceeds as well as in the mouth. Ptyaline, then, like pancreatine, is an excellent reagent for demonstrating the difference between mixed and pure gastric juice. The latter, as M. Defresne has proved, owes its acidity to hydrochloric acid, combined doubtless with leucine; the former to organic acids, probably combined also with azotised matters. Ptyaline and diastase, therefore, are not two identical substances, from a physiological point of view. Ptyaline saccharifies the starch in mixed gastric juice, as well as in the mouth; it is only paralysed an instant in pure gastric juice, and then recovers its action in the mixed gastric juice and in the duodenum. Diastase or maltine is irrecoverably destroyed in hydrochloric solutions or in pure gastric juice, and after having passed into the mixed juice it is profoundly altered; for, if it still dissolves starch, it no longer saccharifies it.

Existence of the Chamois in the Abruzzi.—A recent communication of Mr. C. J. Forsyth-Major to the *Bulletin* of the Club Alpino Italiano, records the occurrence of the Chamois (*Rupicapra tragus*) on the Gran Sasso d'Italia in the Northern

Abruzzi. Mr. Forsyth-Major made an expedition into this district with the object of identifying the so-called "Chamozzo" of the inhabitants, and ascertained that this animal, now nearly extinct, was either the chamois of the Alps or a closely allied form. At Isola del Gran Sasso he was shown the horns and skin of an example shot in 1878. The present existence of the chamois so far south in Italy, although mentioned in several works, has not been previously authenticated.

MOVEMENT IN THE LEAVES OF CONIFERS.—Dr. Maxwell Masters (Linnean Society, December 4) has called attention to the contrasts to be drawn between the leaves of the spruce firs (*Picea*) and those of the silver firs (*Abies*) as regards their arrangement, relative position, form, relative size, and internal structure, as described by Bertrand, MacNab, Chatin, and others. The leaves of the silver firs are endowed with a power of motion in virtue of which they are raised or depressed. On the other hand, the leaves of the spruces are comparatively motionless. In those cases where the leaves have the power of movement there is usually a well-marked layer of "palisade cells" which are absent in the motionless leaves. This circumstance has led Dr. Masters to correlate the differences before alluded to with varying degrees of functional activity, and with the adaptations manifested to secure as far as possible to each leaf an equally favourable amount of exposure to light, &c. The very remarkable movements of revolving nutation observable in the "leader shoots" of many conifers during their season of active growth were mentioned as having been investigated by him and the rotation duly registered on a disk.

GEOLOGICAL NOTES

CRUSTACEA IN THE OLD RED SANDSTONE.—The occurrence of eurypterid crustaceans of the genus *Pterygotus* in the Tilestones of Herefordshire and Worcestershire, and in the Old Red Sandstone of Forfarshire, has long been well known. These organisms have been regarded as characteristic of that section of geological time in the British area represented by the Ludlow and Lower Old Red Sandstone formations. Murchison used their presence in the Arbroath flagstones as an argument for placing these strata in his "Lower" division of the Old Red Sandstone, while on the other hand he argued from their absence in the Caithness flagstones and from the dissimilarity of the fishes, that these northern deposits must be of later age. He therefore classed the great flagstone series of Caithness and the Orkney Islands as "Middle" Old Red Sandstone, thus bringing this series of formations into correspondence with his favourite threefold classification of the Devonian system. Recently, however, in the first part of his memoir "On the Old Red Sandstone of Western Europe," published in the *Transactions of the Royal Society of Edinburgh*, Prof. Geikie has pointed out that the contrast between the fish fauna of the Arbroath flagstones, or the ancient basin which he terms "Lake Caledonia" and that of the northern basin or "Lake Orcadie," is by no means so marked as Murchison believed, and that the characteristic *Pterygotus*, on which the author of "Siluria" laid so much stress as an Upper Silurian and Lower Old Red Sandstone type, occurs on several horizons and at different localities in the Caithness and Orkney basin. An important discovery confirmatory of the extension of these crustacea into the northern area has recently been made by Mr. James Linn in the course of the Geological Survey of Elginshire, now in progress. From the valley of the Spey he has obtained numerous fragments of what must have been a remarkably large *Pterygotus*, though the specimens so far found hardly admit of specific identification with the *P. anglicus* of Forfarshire. *Pterygotus* has thus been discovered in Orkney, Caithness, and on the Moray Firth, not only over an extensive geographical area, but throughout a wide vertical range of strata. These crustaceans must evidently have had a considerable and prolonged development in the waters of the northern basin of the Lower Old Red Sandstone period.

SALSES OF MOUNT ETNA.—As the result of his recent observations among the mud volcanoes of Paternò on Etna, Dr. A. von Lasaulx gives the following conclusions:—1. The Salses arise from the association of gaseous volcanic emanations with spring-water traversing easily soluble strata in which common salt, gypsum, lime, and other salts occur. 2. The carburetted hydrogen escaping in connection with the salses is produced by the same volcanic emanations with the co-operation of these strata. 3. The so-called eruptions of the mud-volcanoes are merely the squeezing out under pressure of the dissolved and loosened parts of strata, that are disturbed and dislocated by underground movements.

NEW JURASSIC REPTILES.—Prof. Marsh announces in the *American Journal of Science* the arrival at Yale of numerous remains of reptiles from the Jurassic deposits of the Rocky Mountains. He finds that they belong to several distinct groups and throw considerable light on forms already described from the same horizon. Among them he briefly describes a new genus under the name of *Camptonotus*, most nearly allied to *Laosaurus*, and forming with it a distinct family, the *Laosauridæ*. The name of the genus is taken from the fact that, as in *Laosaurus*, the sacral vertebræ are not co-ossified, while some of the other vertebræ even in the same specimen have their neural arches so completely united to the centra that the suture is nearly or quite obliterated. The known remains of *C. dispar* indicate, according to Prof. Marsh, a herbivorous animal about eight or ten feet high. Another species, about three times as large, is named *C. amplus*. One of the largest reptiles yet known (*Brontosaurus*) has recently been brought to light from the same region. It probably belongs to the *Sauropoda*, but has a sacrum composed of five thoroughly co-ossified vertebræ. Fresh specimens have been obtained throwing much new light on the structure of *Stegosaurus*. This dinosaur was covered with huge dermal plates, some of which ranged from two to three feet in diameter. The remains of a much smaller reptile, about the size of a wolf, apparently also a Dinosaur, and probably carnivorous, are included in a new genus, *Cælurus*.

GEOGRAPHICAL NOTES

NEWS has been received of Herr Carl Boch, on his return to the coast after his travels in the centre of Borneo. He has been up the Klintjouw River as far as Longwai, and thirty miles beyond where no European has yet penetrated. There is, however, but little to see, and the dead silence of an almost uninhabited forest prevails beyond Longwai. The birds of this district, with five or six exceptions, are the same as those found in the highlands of Sumatra. Herr Boch has made some very interesting observations on the inhabitants of those districts, of which he is preparing an account. The Dyaks of the interior are far more wild and savage than those of the coast, and are not, as a rule, partial to seeing strangers, but appear to offer them no harm in times of peace. They are, however, veritable "head hunters," and talk about it in a very free and easy manner. The Rajah, with whom Herr Boch had dealings, had a collection of six, taken from Dyaks of another tribe, not in open fight, but by treachery when they were asleep. A more interesting race, also head hunters, however, and still further removed from civilisation, are the Orang Poonan, or forest people. With these strange border-beings, who construct no houses, but live in the open forest, Herr Boch seems to have made himself quite friends, and regards them as good and honest people—always excepting the little eccentricity in the matter of heads. They are not dark, but fair, and of a yellowish complexion, and as they have allowed Herr Boch to take sketches of both sexes, these will doubtless afford much further interesting information. He proposes now to cross the island from east to west, coming out at Band-jermassing.

A CORRESPONDENT supplies us with the following translation of a letter from Dr. Gerhard Rohlfs, concerning his recent journey in Africa, which may interest our readers. The letter addressed to a German friend, is dated Benghasi, November 10: "When you receive these lines I shall no doubt be in Italy, and, therefore, back in Europe. Your last letter of July 9 I received at Kufra, when I was free again, and already on my return journey. . . . I hope that Stecker, my young companion, will again take up the expedition. The Sueya have partly returned our property, part they are still going to return, and part the Turkish Government will compensate us. If Stecker proceeds by way of Sella and Mursuk, he will probably not encounter too many difficulties. I may communicate to you the statistical fact that the distance between Battifal and Taiserbo is about 400 kilometres. We travelled over this distance in exactly 100 *consecutive* hours, certainly a great feat. Thus we cleared more than 90 kilometres per day. It must be remembered that this was done on foot and on camels, then it will be appreciated. We hardly slept at all, only in the evenings and mornings we rested for awhile. But then who would have thought that Kufra lies $1\frac{1}{2}^{\circ}$ more to the south than is indicated on the maps? that Kufra is the largest oasis but one of the Sahara? that of all oases Kufra contains the largest *uninterrupted* areas of arable land. Are there *uninterrupted* areas at Fesan extending over 200 kilometres? Or at Tuat, or at Tafilet? No! And everywhere the finest water. There may be about 1,000,000 palm trees in the oasis, and if Kufra is otherwise poor as regards variety of species of plants, it is all the richer in numbers of plants of one and the same species. I have not reached Wadai on my tour. Thus I have not even been able to reach the basis upon which my operations were really to begin. But it is not my fault. I have the consciousness of having fully done my duty."

THE King of Sweden has expressed his wish that after the *Vega* has reached Naples Prof. Nordenskjöld and Lieut. Palander should, on their trip overland, visit several geographical societies on the continent. At Copenhagen they are to rejoin their ship, and with it proceed to Stockholm.

AT the last meeting of the Halle Geographical Society, the President, Dr. Kirchhoff, announced the formation of a geographical union amongst the students at that University, this being the first union of the kind. It is hoped that the students at other universities will imitate this commendable example. Later on at the same meeting Dr. Lilienfeld read a highly interesting paper on the South African diamond fields which he visited last year.

DR. OSCAR LENZ writes from Tetuan, under date of November 27, as follows:—"I arrived at Tangiers in excellent health. After having made excursions from this place in all directions, I travelled to Tetuan, which is highly interesting and situated most beautifully, and which was particularly attractive to me in a geological sense. For several days past I have been trying to start in a southerly direction for the Shishuaun district, which has never before been visited by a Christian, but I have not yet obtained permission from the Caliph; it is stated that the inhabitants are in open revolt against the Sultan, also that the Kabyl tribes are extremely fanatical and will not tolerate any Christians in their country. Between December 4 and 8 I expect again to be at Tangiers, from which place I shall send a detailed report of my interesting journey to the African Society. Then I shall prepare for a prolonged sojourn in the interior. About New Year's Day I hope to be at Fez."

THE January number of *Petermann's Mittheilungen* contains a detailed account, by Prof. Veth, of the Dutch expedition to Sumatra. He gives a statement of the literature relating to Sumatra previous to the expedition, a sketch of its programme, the results of Schouw Santvoort's expedition, and those of his own and Hassel's journeys in Rawas, Lebong, and Lemun, concluding with a sketch of the important Balang Hari river. A fine large map of part of Sumatra accompanies the paper. This is followed by a paper on the Sanpu river of Tibet, with a map from English sources. There is also a narrative of the recent voyage of the Dutch vessel, *Willem Barents* to the Barents Sea, also with a map, which is followed by one of Dr. Emin Bey's valuable narratives, describing his journeys between the Victoria and Albert Nyanza in 1878. We are glad to see from the monthly summary that the publication of the narrative of Baron von Der Decken's travels in East Africa, 1859-65, has at last been concluded.

A GRANT of 4,000*l.* has been made by the Minister of Public Instruction at Paris, to the French Committee of the International African Association, in order to enable them to establish two stations similar to those which the Belgian expeditions are about to found in Eastern Africa. One of these will be placed in the Ogowé region, and will probably be under the command of M. Savorgnan de Brazza, already well known for his explorations in that quarter. It is expected that the other station will be established in Usagara, on the eastern side of the continent. It had previously been proposed that M. de Brazza should lead an expedition from the Gaboon towards Lake Chad, and it is not impossible that there may be some further modification of the present projects.

IN the letters which, after long delays, have at length reached the London Missionary Society from Ujiji, Mr. Hore gives some account of his explorations on Lake Tanganyika and its adjacent rivers. In March apparently he explored the coasts of Ujiji, Ukaranga, and Ukawendi, and the Malagarasi and Kibwe rivers. At the end of April he started on another voyage, during which he visited Uguhha and explored the mouth of the Lukuga River; this he declares is the veritable outlet of the lake. Mr. Hore descended the river in a canoe as far as where the Mitwanse—now swept away—used to be, and landed at Stanley's farthest. He then walked for six hours, and mounted the Kijanka ridge, which is farther down the river than Stanley places it. He slept there, getting the latitude by stars and good bearings; and from above where he landed he had a glorious bird's-eye view of the river far into Urua. He states that the so-called Lukuga Creek is a wide and very swift river. With regard to Uguhha, Mr. Hore says that, by general consent, it is the gateway from Lake Tanganyika to the west.

THE new number of the Geographical Society's periodical contains only one paper, Capt. A. H. Markham's account of his Arctic cruise of 1879, in the Barents Sea; it has been rendered inordinately long by the introduction of many pages of irrelevant matter. It has, however, a redeeming feature, in that it is illustrated by two useful maps.

THE new *Bulletin* of the Belgian Geographical Society furnishes some interesting information in its "Chronique Géographique," more particularly in regard to the various expeditions of the International African Association, from which we gather that another expedition will before long leave Zanzibar for the interior. It is especially worthy of note, however, that no information is allowed to leak out respecting Mr. H. M. Stanley's proceedings on the Lower Congo, on which subject and his plans the Central Committee maintains a discreet silence.

WE have received Parts 9, 10, and 11 of the new edition of Stieler's Hand Atlas.

PHYSICAL NOTES

WE learn that Mr. Edison is attempting to construct a portable electric lamp which shall, including the constant battery employed to generate the current, be no larger than an ordinary moderator lamp.

THE *Scientific American* states that the story of Edison's telephone having been used over 2,000 miles of line is incorrect; the messages were transmitted over the greater part of the line by telegraph, and only over the last few miles in Pennsylvania by telephone.

A MEASURING polariscope, specially adapted for examining the angles between the optic axes of crystals upon the plan suggested a few months ago by Prof. W. G. Adams, has been constructed by Herr E. Schneider, and is described in Carl's *Repertorium*.

THE study of the spirit level has been continued by M. Plantamour. He has shown that the bubble of very accurately adjusted levels is continually moving; indicating a continual gently rising and falling of the earth's crust.

A SINGULAR phenomenon of atmospheric electricity during a snow storm was observed at Cherbourg on November 20, by M. Delamare. At about half-past five in the evening the snow-flakes fell so quickly that it was perfectly dark. M. Delamare, walking along under the shelter of his umbrella, heard a faint buzzing sound as of insects flying around, and at the same moment observed a pale luminous "brush" proceeding from the extremity of each of the ribs of his umbrella. On extending his finger towards one rib the brush-discharges ceased, and he received a continuous stream of faint sparks. It would be interesting to learn whether the handle of the umbrella was of ivory or any material of specially good insulating properties.

M. GUÉBHARD has recently shown an elegant method of procuring iridescent rings in a permanent form. These rings, which are, like Newton's rings, due to interference giving rise to the "colours of thin plates," differ however from Newton's rings in reversing the order of the colours, that corresponding to greatest thickness being at the centre. M. Guébhard drops a little collodion on to the surface of mercury. It is drawn out on all sides into a thin film of iridescent hue, which when hard may be floated off on to paper. Ten years ago the writer of this note similarly fixed on paper iridescent films obtained by dropping mastic varnish on to the surface of water. M. Guébhard produces similar rings, though of no permanency, with drops of volatile mineral oil on the surface of mercury, or even by the film of moisture condensed from the breath. At the meeting of the *Société de Physique* of Paris, on December 5, these experiments were shown by projection upon the screen; and M. Guébhard awakened a lively interest when he proceeded to show that such films, especially the fleeting films condensed from the breath, may exhibit phoneidoscopic properties. The various vowels being pronounced so that the breath impinges on the surface of the cooled mercury, rings are obtained having certain forms more or less strongly characteristic of their different qualities of tone.

THE influence of temperature on tuning-forks (which are now such valuable aids to research), has been lately investigated by Herr Kayser (*Ann. de Phys.* No. 11), and by the method of observing the alteration of the difference of phase of two forks with the temperature. The forks were furnished with mirrors and the Lissajous figures observed with a telescope. These results were arrived at: 1. The vibration number of a tuning-fork is, between 0° and 30°, a linear function of the temperature. 2. The influence of temperature is greater, the higher the tone of the fork, and with similarly arranged forks, the variation of the vibration number is about proportional to the square root of that number. 3. With moderate variations of temperature, such as occur in a room, the temperature affects the vibration number in the second place of decimals. 4. The co-efficient of elasticity of steel increases between 0° and 30° with the temperature.

OBACH proved, a few years since, that alloys of the metals proper, such as lead and tin, potassium and sodium, and sodium amalgam, conduct a current, without being decomposed. Herr Elsässer has recently (*Ann. der Phys.* No. 11) experimented with combinations of metals with the half-metallic elements antimony and bismuth, passing a current through the fused alloy in a glass tube with electrodes of gas carbon. There was here also no decomposition. The author notes that the transition from these compound conductors of the first class to the electrolytes, is no sudden one. Between the two groups are substances, which at a low temperature conduct without decomposition, but at a higher one, and even partly before they melt, are electrolysed, *e.g.* copper and silver sulphides, and the sulphides of lead, nickel, iron, bismuth, tin, and antimony. To this middle class, also, may be added a number of compounds, which have not hitherto been electrolysed, probably because they are so difficult to fuse (such as the oxides of tin, iron, and chromium); the electrolytes proper do not conduct without being electrolysed; and to this class belong especially the haloid compounds of the metals, which are not decomposed in the solid state because they are insulators; whenever they begin to conduct, being fused, they are decomposed. Lastly there is a fourth class of compounds, which in general do not conduct, either with or without decomposition.

AN experimental determination of the indices of refraction of some liquefied gases has been lately made by Herr Bleekrode (*Ann. der Phys.* No. 11). He used the method of Faraday's tubes, but observed the liquefied gas with a microscope in a small vessel with plane parallel sides having mirror plates. Only cyanogen, carbonic acid, and ammonia, were thus successfully examined, and the average numbers obtained for these were, severally 1·320, 1·163, and 1·314. The method is also useful for compounds which are liquid at ordinary temperature, but difficult to examine on account of their inflammability. Thus, the author applied it to zinc-ethyl, obtaining the number 1·489. *A propos* of the index of carbonic acid, Herr Bleekrode has some interesting remarks on liquid inclosures in certain minerals. In another paper he hopes shortly to give the indices of most of the other liquefied gases, his experiments on which were, in part, accomplished with Cailletet's compression apparatus.

THE somewhat doubtful name *Audiphone* has been given by Mr. Rhodes of Chicago to an instrument to improve the hearing powers of the partially deaf. We understand that it consists essentially of a flat flexible disk of resonant metal furnished with a handle, like a palm leaf fan and capable of being adjusted in curvature by means of a cord and a tightening clamp. The edge of the disk is to be pressed against the upper front teeth while its concave surface is presented towards the speaker to receive the sounds. The vibrations thus taken up by the disk are transmitted through the teeth and bones of the skull to the auditory nerves. This would appear to be a more practical instrument than the megaphone of Mr. Edison, of which nothing has been heard of late, or the apparatus recently explained by M. Paul Bert to the *Académie des Sciences*. Mr. J. Samuelson of Liverpool, exhibited the Audiphone at the late *soirée* of the associated scientific societies held in the St. George's Hall.

PROF. C. S. HASTINGS of the Johns Hopkins University has contributed to the current number of *Silliman's Journal* an important paper on "Triple Objectives with Complete Colour Correction." He controverts the opinion of Prof. Harkness expressed in a preceding number of the journal that the focal plane of a system of lenses does not correspond to the minimum focal distance.

IT is stated that a new photographic process has just been discovered in Japan by an inventor whose name is not given. One of the substances employed in the manufacture of Japanese lacquer has the property of becoming almost as hard as stone under the action of light. A slab covered with this material and duly exposed behind a photographic "negative" for some twelve hours, was afterwards scraped, and rubbed with spatula and brush, leaving the hardened portions raised in low relief, and capable of being used as a block for printing.

OUR contemporary, the *Electrician*, announces the startling discovery of an electric divining-rod, "whereby paying deposits of gold, silver, and copper can be positively indicated, and their exact location pointed out." This "discovery" is of course a trans-Atlantic one, but, "strange to say, it does not emanate this time from Menlo Park, though Mr. Edison may of course have pre-invented it many years ago!"

IN the *Institutes of Akbar*, whose reign over a considerable part of India extended from 1560 to 1600, are found the following directions for the artificial freezing of water. Into two parts of water is thrown one part of dry powdered nitre. In this mixture a small stoppered silvered jug containing pure water is stirred about briskly for a quarter of an hour, when its contents will be found to be wholly or partially frozen.

SCIENTIFIC SERIALS

Journal of the Royal Microscopical Society, vol. ii. Nos. 7 and 7*a*, contains:—Transactions of the Society.—W. H. Gilburt, On the morphology of vegetable tissues (Plates 22 and 23).—J. Beck, On the structure of the scale of a species of the genus Mormo.—Prof. E. Abbe, On new methods for improving spherical correction, applied to the construction of wide-angled object-glasses.—H. E. Forrest, On the anatomy of *Leptodora hyalina* (Plates 24 and 25).—Dr. H. Stolterfoth, On a new species of Eucampia.—John Mayall, jun., On an immersion stage illuminator, and on aperture measurements of immersion objectives expressed as "numerical aperture."—J. W. Stephenson, On a table of numerical apertures showing the equivalent angles of aperture of dry, water immersion, and homogeneous immersion objectives, with their respective resolving powers, taking the wave-length of line E as the basis; $a = n$ sin. w, n = refractive index, and $w = \frac{1}{2}$ angle of aperture.—The record of current researches relating to zoology, botany, and microscopy.—Bibliography.—Proceedings of the Society.—The editor announces that the Society has obtained the assistance of Mr. T. Jeffery Parker, Mr. A. W. Bennett, and Prof. F. Jeffrey Bell in the production of the journal.—No. 7*a* is a supplementary number containing the index to vol. ii., List of Fellows of the Society, &c.

Proceedings of the Boston Society of Natural History, vol. xx. part 2, November, 1878, to April, 1879.—Dr. H. A. Hagen, Larvæ of insects discharged through the urethra, and On birds swarming after white ants.—Dr. S. Kneeland, Traces of the Mediterranean nations in the Northern Ocean.—Dr. H. A. Hagen, Remarks on white ants.—President Bouvé, Remarks on the death of Dr. J. B. S. Jackson.—Prof. N. S. Shaler, Evidences of a gradual passage from sedimentary to volcanic rocks in the Brighton district.—Dr. H. A. Hagen, Flies from a petroleum lake.—W. O. Crosby, Occurrence of fossiliferous boulders in the drift of Truro, Cape Cod.—Dr. S. Hunt, On the pre-Cambrian rocks of Great Britain.—W. H. Patton, Synopsis of the New England species of Colletes.—J. S. Kingsley, Notes of North American Decapoda.—W. P. Crosby, A possible origin of petro-silicious rocks.—B. D. Halsted, The American species of Characeæ. The author enumerates eight species of Nitella, one of Tolypella, and nine of Chara, one of which, *C. robbinsii*, from Rhode Island, is described as new.—Dr. C. S. Minot, Growth as a function of cells, and On certain laws of histological differentiation.—Rev. G. F. Wright, The kames and moraines of New England.—Mr. W. Upham, Glacial drift of Boston and vicinity.

SOCIETIES AND ACADEMIES

London

Royal Society, December 18, 1879.—"On the Histology of *Hydra fusca*." By T. Jeffery Parker, B.Sc., Lecturer on Biology in Bedford College, London, and Demonstrator in the Royal School of Mines. Communicated by Prof. Huxley, Sec.R.S. (From the Biological Laboratory of the Royal School of Mines.)

The following is an abstract of the paper:—The correctness of Kleinenberg's view of the relations of the muscular fibres was proved by longitudinal sections of ammonic bichromate specimens, in which the fibres were obtained *in situ* in direct connection with the attenuated inner ends of the ecdoderm cells.

No interstitial tissue could be made out in the thinnest sections of the tentacles; this tissue, therefore, cannot be the exclusive source of the nematocysts.

A distinct supporting lamella was clearly made out between the muscular layer and the endoderm.

The endoderm is shown to be, in all probability, ciliated throughout. Sections of osmic acid specimens showed each cell to bear one, two, or three, long, flagelliform cilia.

The active amœboid movements of the endoderm cells during life is strongly insisted on, the pseudopodial processes given off from them sometimes almost or entirely obliterating the digestive cavity.

It is suggested that the dark irregular granules found in the endoderm cells are food particles derived from the alimentary canals of the Entomostraca devoured. In one instance a diatom frustule was seen to be imbedded in a cell. Hydra thus, unlike most Metazoa, exhibits what Metschnikoff calls a "parenchymatous" mode of digestion.

Nematocysts are proved to occur here and there in the endoderm.

Paris

Academy of Sciences, December 29, 1879.—M. Daubrée in the chair.—M. Faye presented the *Annuaire du Bureau des Longitudes* for 1880, which contains, *inter alia*, tables of refractive indices, densities of minerals, dilatations of metals and crystalline bodies, all known gases, with formulæ, &c., data of thermochemistry, a map of lines of equal magnetic declination for France and neighbouring localities, and a work on statistical geography.—Note on the different branches of kinematics, by M. Resal. M. Mannheim has recently introduced the expression *kinematic geometry;* this branch dealing with motion independently of forces and times. It is not simply the geometrical part of kinematics as studied hitherto.—On some applications of elliptic functions, by M. Hermite.—On hydride of copper; reply to M. Wurtz, by M. Berthelot.—On the heat of formation of gaseous hydrate of chloral; reply to M. Wurtz, by M. Berthelot.—On the butyric ferment (*Bacillus amylobacter*) in the coal epoch, by M. van Tieghem. Examining numerous silicified rootlets of coniferæ from the coal strata, he finds signs of the same process in destruction of tissues as now; development of *Bac. am.* in the organs, either in the form of slender jointed filaments, or inflated rods each with a terminal spore, or innumerable free spores, amid homogeneous silica or ranged against the cuticle or vessels.—On the oxidation of alcohol by ammoniacal bioxide of copper, by M. Letellier. He heated the mixture at 180° in a sealed tube; the blue liquor becomes colourless, and the alcohol is changed into acetic acid.—On a property of certain functions similar to algebraic functions, by M. Picard.—On the impossibility of the algebraic relation $X^n + Y^n + Z^n = 0$, by M. Lionville.—On the determination of the elements of a vibratory movement; measurement of the phase, by M. Mercadier.—On a new electric burner, by M. Perruche. The "candle" part consists of three carbons, two being cylindrical (0·004 m. diameter) and applied to each other, the other of square section (0·005 m. a side), and placed in the angle formed by the first two. The cylinders are in pivoted brass holders, between brass plates, brought together by a spring. The holder of the square carbon is also capable of oscillation, and this carbon is held by a spring in contact with the others, while no current passes, but, when the current begins, takes its separate position. It is regulated by an iron lever and electro-magnet in circuit.—On a new phoneidoscopic process by coloured rings, by M. Guébhard. A development of his experiment of producing coloured rings by breathing on a surface of impure mercury. He shows the characteristic figures of the principal vowel sounds. They prove that the vocal emission in uttering these sounds does not present merely the longitudinal vibratory state of a cylindrical column (as indicated by manometric flames, &c.), but a very complex vibratory state at right angles to the direction of propagation, and whose influence cannot be negligible in the final wave. This has an obvious bearing on the sensibility of telephonic plates, which are affected by multiple centres of percussion.—Action of permanganate of potash on cyanide of potassium, by M. Baudrimont. This generates much nitrite and little urea in an alkaline medium, while much urea is formed if the medium tend to acidity by addition of SO_3HO. The greatest proportion of urea results from mixture of cameleon and cyanide in equal equivalents in presence of an excess of sulphuric acid.—Action of hydracids on isoprene; reproduction of caoutchouc, by M. Bouchardat. Isoprene behaves to hydracids like valerylene, fixing one or two molecules of acid and giving identical or isomeric compounds, with very similar properties; only isoprene (unlike valerylene) furnishes with dissolved acids an elastic polymer.—On the structure of sudoriparous glands, by M. Ranvier.—Alterations of cutaneous nerves in a case of congenital ichthyosis, by M. Leloir.—On the locomotion of insects and of arachnida, by M. Carlet. Insects of slow pace, and with equidistant legs, rest on a sustaining triangle formed of the two extreme legs on one side and the middle leg on the other, while they move the three other legs. In arachnida the polygon of sustentation is formed by the first and third leg on one side and the second and fourth on the other.—On the presence of diamond in an ophitic rock of South Africa, by MM. Fouqué and Lenz.

Vienna

Imperial Academy of Sciences, October 16, 1879.—The following among other papers were read:—On the physiological regeneration of the ciliated epithelium of the trachea, by Dr. Drasch.—On the solubility of mixtures of chloride of sodium and chloride of calcium at different temperatures, by Herr Schönach.—On a species of configuration in the plane and in space, by Herr Kantor.—On the causes of severe winters in Europe, by Herr Wolz.—Researches on the rain-conditions of Austria-Hungary, by Herr Hann.—Contributions to a monography of the genus Megalodus, with special reference to the mesozoic forms, by Prof. Hörnes.—A new chemical photometer by means of mercury oxalate, for determining the intensity of ultra-violet rays, and contributions to the photo-chemistry of mercury chloride, by Dr. Eden.

CONTENTS

THURSDAY, JANUARY 15, 1880

ERASMUS DARWIN

Erasmus Darwin. By Ernst Krause. Translated from the German by W. S. Dallas. With a Preliminary Notice by Charles Darwin. Portrait and Woodcuts. (London: Murray, 1879.)

THE memory of this great man has suffered from the florid and spiteful biography written by Miss Seward. That she was animated by a feeling of bitterness towards Erasmus Darwin, engendered by disappointment, is clearly shown in these pages; she was an unsuccessful candidate for the post of his second wife, and she seems never to have forgiven him for his blindness towards her merits. A trustworthy life of the author of the "Botanic Garden" was therefore much wanted, and no one could have been better qualified for the task than his grandson, Charles Darwin. He has done his work so well and completely as to leave no room for any subsequent biography; further criticism there may well be, but the facts of the life of Erasmus Darwin can never be better put together, and they are as fully given as there is any need for. The critical essay by Herr Krause forms only little more than one-third of the modest volume, and is really an appendix to the life by Mr. Darwin.

Erasmus Darwin was born of a good family at Elston Hall, Notts, on December 12, 1731. He was educated at a school at Chesterfield, from which he went to St. John's College, Cambridge, and subsequently to Edinburgh to study medicine. In 1756 he settled at Lichfield as a physician, and married in 1757, his wife dying in 1770. He married a second time in 1781, when he settled at Derby, where he died in 1802. From his earliest years he seems to have had a taste for versifying and mechanics, and when very young he made experiments in electricity with a rude apparatus of his own invention. Mr. Darwin gives a most amusing letter addressed to his grandfather when at Chesterfield, by Susannah, the sister of the latter, in which she sets down in a very incongruous fashion the details of four days' fasting in Lent. The reply of Erasmus (ætat 16) was characteristic:—

> "I fancy you forget in Yours to inform me y^t your Cheek was quite settled by your Temperance, but however I can easily suppose it. For y^e temperate enjoy an ever-blooming Health free from all y^e Infections and disorders luxurious mortals are subject to, the whimsical Tribe of Phisitians cheated of their fees may sit down in penury and Want, they may curse mankind and imprecate the Gods and call down y^t parent of all Deseases, luxury, to infest Mankind, luxury more destructive than y^e Sharpest Famine; tho' all the Distempers that ever Satan inflicted upon Job hover over y^e intemperate; they would play harmless round our Heads, nor dare to touch a single Hair. We should not meet those pale thin and haggard countenances which every day present themselves to us. No doubt men would still live their Hunderd, and Methusalem would lose his Character; fever banished from our Streets, limping Gout would fly y^e land, and Sedentary Stone would vanish into oblivion and death himself be slain."

Even at this early age is seen his leaning towards vegetarianism and abstinence from alcoholic drinks, which he subsequently carried into almost regular practice. This was not the only respect in which Erasmus Darwin was far ahead of his own time and even of ours. In sanitary matters he could read a lesson even to our advanced age, and with his mechanical genius he carried out his ideas in this respect into practice as far as the circumstances of the time would permit. He advocated the abolition of intra-mural interments, a rational treatment of the insane, radical reform in female education, and the abolition of slavery at a time when all the world, including the Society for the Propagation of the Gospel, regarded it as a divine institution. His little work on female education was translated into German, where it was regarded as an authority, and he carried out his ideas on the subject in the case of his own daughters, whom, for example, he taught to swim. He was a radical in politics, and a theist in religion, as his works amply testify, though his indiscriminating and bigoted contemporaries stamped him as an atheist. His friendship was wide, both in England and on the Continent, and included many of the most eminent men of his time. He was a man of great influence among his neighbours, and was specially beloved by the poor and needy, a common epithet coupled with his name being that of Benevolent. He was slightly irascible in temper, his massive face pitted from smallpox, he walked with a limp, and although he stammered in speech, he was one of the best conversationalists of his time. He soon acquired a good practice in Lichfield, and as a physician his fame reached George III., who wanted him to settle in London; but Darwin's desires in regard both to fame and income were moderate, and he preferred the quiet of Lichfield. His chief recreation was in tending eight acres of land near the city, which he converted into a botanic garden. Apart altogether from his position in the history of science, it will thus be seen that Erasmus Darwin was a man of unusual originality and independence of mind, who could rise far above the beliefs and customs of his time. But for us he is mainly interesting for the position his works hold in the history of the doctrine of evolution. We are inclined to think that had Erasmus Darwin not chosen to throw his ideas on this and other scientific matters into the form of verse, the theory itself and his claim to be the originator of it in its modern form would have been much sooner recognised. The works in which he embodied his speculations and theories are "The Botanic Garden," in its two parts, "The Loves of the Plants," and "The Economy of Vegetation," the latter, although the first part, having been published last; the former probably first appeared in 1788. Then followed the "Zoonomia" in 1794, soon after translated into German, French, and Italian; the "Phytologia" was published in 1800, and "The Temple of Nature, or the Origin of Society," the year after the author's death. In England, at least, where these works first appeared, they were treated mainly as poems, the scientific speculations which they contained, if referred to at all, being generally regarded as the mere fancies of a poet, or the dreams of a rhapsodist. As poems they had a reputation which must seem to the readers of to-day wonderful. Such men as Walpole and Edgeworth spoke of them with rapture, though the parody of the "Loves of the Plants," known as the "Loves of the Triangles," seems to have done much to destroy the reputation of the original.

Coleridge invented the term "Darwinising" to express his contempt for the speculations of the elder Darwin, and the *Edinburgh Review* treated his poems in its well-known "this-will-never-do" style. Still Darwin's poems contain many brilliant passages, yet we fear no reader of the present day would care to read them through merely as literary productions. Any one, however, who desires to master the history of the progress of scientific theory, must study them carefully; and this is what Herr Krause has done in order to be able to write the critical essay appended to the biography by Mr. Darwin, an essay which Mr. Dallas has turned into excellent English.

Herr Krause, then, claims for Erasmus Darwin that he is the real father of the doctrine of evolution in its modern form, and that much of the credit which has been ascribed to Lamarck is really due to his predecessor. No one can read Herr Krause's careful paper, fortified as it is with numerous extracts from the elder Darwin's works, without being convinced that the claim he upholds is just. True, Darwin often saw as in a glass darkly, what his greater grandson has been able to see and to show us face to face. But when we remember the state of scientific theory in his time, and the scanty store of data at his command, we cannot but be struck with the real penetrative genius of the man, and wonder that he was able to see so much. His powerful and thoroughly scientific imagination helped him to leap over many difficulties, which the Darwin of to-day has been able to bridge by an abundance of fresh facts. As might be expected, the elder Darwin's ideas are sometimes crude and undeveloped; when he seems in a fair way to arrive at the full-blown ideas connected with the doctrine of evolution such as we have it now, he sometimes turns aside ere the goal is reached, and concludes with something that is only half the truth. Here is how Herr Krause speaks of him:—

"I was speedily convinced that this man, equally eminent as philanthropist, physician, naturalist, philosopher, and poet, is far less known and valued by posterity than he deserves, in comparison with other persons who occupy a similar rank. It is true that what is perhaps the most important of his many-sided endowments, namely, his broad view of the philosophy of nature, was not intelligible to his contemporaries; it is only now, after the lapse of a hundred years, that by the labours of one of his descendants we are in a position to estimate at its true value the wonderful perceptivity, amounting almost to divination, that he displayed in the domain of biology. For in him we find the same indefatigable spirit of research, and almost the same biological tendency, as in his grandson; and we might, not without justice, assert that the latter has succeeded to an intellectual inheritance, and carried out a programme sketched forth and left behind by his grandfather.

"Almost every single work of the younger Darwin may be paralleled by at least a chapter in the works of his ancestor; the mystery of heredity, adaptation, the protective arrangements of animals and plants, sexual selection, insectivorous plants, and the analysis of the emotions and sociological impulses; nay, even the studies on infants are to be found already discussed in the writings of the elder Darwin. But at the same time we remark a material difference in their interpretation of nature. The elder Darwin was a Lamarckian, or, more properly, Jean Lamarck was a Darwinian of the older school, for he has only carried out further the ideas of Erasmus Darwin, although with great acumen; and it is to Darwin, therefore, that the credit is due of having first established a complete system of the theory of evolution."

Herr Krause then proceeds to analyse "The Botanic Garden" and other works, in order to produce evidence of the claim he maintains on behalf of Erasmus Darwin. It is interesting to read in a note appended by Darwin to a verse in "The Botanic Garden," the following idea and first scheme of the theory of evolution:—

"'From having observed the gradual evolution of the young animal or plant from its egg or seed; and afterwards its successive advances to its more perfect state, or maturity; philosophers of all ages seem to have imagined that the great world itself had likewise its infancy and its gradual progress to maturity; this seems to have given origin to the very antient and sublime allegory of Eros, or Divine love, producing the world from the egg of Night, as it floated in chaos.'"

It is in the "Economy of Vegetation" that the well-known prophetic lines on the power of steam occur:—

"'Soon shall thy arm, Unconquer'd Steam, afar
Drag the slow barge, or drive the rapid car;
Or on wide-waving wings expanded bear
The flying-chariot through the fields of air.
—— Fair crews, triumphant, leaning from above,
Shall wave their flutt'ring kerchiefs as they move;
Or warrior-bands alarm the gaping crowd,
And armies shrink beneath the shadowy cloud.'"

Darwin goes on then to describe the formation of the earth, which he maintains was shot forth from a volcano in the sun, the formation of a nucleus, the precipitation of water, the formation of clouds, &c.:—

"In this connection the fossil marine animals also come under discussion; and after mentioning the singular circumstance that most fossil marine animals as, for example, the ammonites, are no longer found living, whilst the living animals do not occur in the fossil state, the author raises the questions, 'Were all the ammoniæ destroyed when the continents were raised? Or do some genera of animals perish by the increasing power of their enemies? Or do they still reside at inaccessible depths in the sea? Or do some animals change their forms gradually and become new genera?'"

How very near the now accepted truth is this! While he divined the principle of mimicry in plants, and speculated on the interesting subject of their fertilisation and their relation to insects, he here just missed the truth from his want of knowledge of facts; had he had as much power of patient observation as his grandson, he would have come nearer the truth in this matter. While he held even bold speculation to be of value to science, he distinctly recognised observation and experiment as the only true bases of scientific progress, as will be seen in his admirable address to the Philosophical Society of Derby, of which he was one of the founders; he defined a fool as "A man who never tried an experiment in his life." The fundamental idea of Darwin's "Zoonomia," it seems to Herr Krause—

"Is that in plants and animals a living force is at work, which, endowed in both with sensibility, is enabled *spontaneously* to adapt them to the circumstances of the outer world, so that the assumption of innate ideas, of divinely implanted impulses and instincts is rendered unnecessary, and even the process of thought appears attainable as the legitimate activity of a mechanical analysis and combination. All kinds of human knowledge originate from the senses, the action of which is regarded as the chief source of knowledge, and is accordingly first of all investigated.

"As regards the apparently inborn faculties which young animals bring with them into the world, the author explains them by repeated exertions of the muscles under the guidance of the sensations and stimuli.

"The author very carefully studied this subject, which has been elaborated by his grandson with so much success, and deduces his formulæ especially from the *first* impressions of new-born creatures. The trembling of fear may perhaps be referred back to the cold shivering of the new-born infant; and weeping to the first irritation of the lachrymal glands by cold air, as well as by pleasant and disagreeable odours. That anger and rage are universally expressed by animals taking the position of attack, is immediately intelligible. As regards smiling and the expression of the agreeable sensations, the author refers them, as well as the feeling of the beauty of undulating lines and of rounded surfaces, to the pleasure of the first nourishment derived from the soft and gently rounded maternal breast."

Here also is a remarkable passage in which the principle of heredity is distinctly recognised:—

"'The ingenious Dr. Hartley in his work on man, and some other philosophers,' says Darwin, 'have been of opinion, that our immortal part acquires during this life certain habits of action or of sentiment, which become for ever indissoluble, continuing after death in a future state of existence; and add, that if these habits are of the malevolent kind, they must render the possessor miserable even in heaven. *I would apply this ingenious idea to the generation, or production of the embryon, or new animal which partakes so much of the form and propensities of the parent.*' And he continues as follows: 'Owing to the imperfection of language the offspring is termed a *new* animal, but is in truth a branch or elongation of the parent; since a part of the embryon-animal is, or was, a part of the parent; and therefore in strict language it cannot be said to be entirely *new* at the time of its production; and therefore it may retain some of the habits of the parent-system.'"

In the "Zoonomia" there are many passages we should like to quote, in which many of the doctrines associated at the present day with the name of the younger Darwin, are enunciated with wonderful clearness, even to sexual selection, the struggle for existence, and the survival of the fittest. Speaking of the weapons with which the males of animals are armed, and their contest for the possession of the female, he says:—

"'*The final cause of this contest amongst the males seems to be, that the strongest and most active animal should propagate the species, which should thence become improved.*'"

He concludes as follows the long passage in which this idea occurs:—

"'From thus meditating on the great similarity of the structure of the warm-blooded animals, and at the same time of the great changes they undergo both before and after their nativity; and by considering in how minute a portion of time many of the changes of animals above described have been produced; would it be too bold to imagine, that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine that all warm-blooded animals have arisen from one living filament which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end!'"

In his "Temple of Nature":—

"About the first hundred verses are devoted to a description of the pitiless struggle for existence which rages in the air, on the earth, and in the water, making the earth, with its incessantly warring inhabitants, like a vast slaughter-house:—

"'Air, earth, and ocean, to astonish'd day
One scene of blood, one mighty tomb display!
From Hunger's arm the shafts of Death are hurl'd,
And one great Slaughter-house the warring world!'"

Many more passages might be quoted all tending to prove what a really wonderful grasp the elder Darwin had of these doctrines, to which, through his grandson, his name is now so justly attached. But enough has been given to show that he deserves one of the highest places among those who have contributed to the progress of true science, and that the verdict of Herr Krause is amply borne out:—

"*That he was the first who proposed and consistently carried out, a well-rounded theory with regard to the development of the living world,* a merit which shines forth most brilliantly when we compare with it the vacillating and confused attempts of Buffon, Linnæus, and Göthe. It is the idea of a power working from within the organisms, to improve their natural position; and thus, out of the impulses of individual needs, to work towards the perfection of Nature as a whole."

Erasmus Darwin's system was in itself, as Herr Krause puts it, a most magnificent first step in the path of knowledge which his grandson has opened up for us. We ought to be grateful to Herr Krause for taking the pains he has done to show the true place of Erasmus Darwin in the history of science. There are many points in Mr. Darwin's intensely interesting, simple, and characteristic memoir we should have liked to notice, did space permit. The memoir is eminently candid and free from bias or anything like strong language, even when rebutting calumnies. Mr. Charles Darwin, we may say, is the son of Robert Waring Darwin, the third son of Erasmus by his first wife. A genealogy of the family is given which is of great interest in connection with the subject of hereditary genius, so well treated by Mr. Francis Galton, himself a descendant of the elder Darwin.

NORTH AMERICAN ETHNOLOGY

Contributions to North American Ethnology. Vol. iii. *Tribes of California.* By Stephen Powers. (Washington, 1877.)

"IT has been the melancholy fate of the Californian Indians to be more vilified and less understood than any other of the American aborigines. They were once probably the most contented and happy race on the continent, in proportion to their capacities of enjoyment, and they have been more miserably corrupted and destroyed than any other tribes within the union. They were certainly the most populous, and dwelt beneath the most genial heavens and amidst the most abundant natural productions, and they were swept away with the most swift and cruel extermination." Words such as these are now only too familiar to the ethnologist, and do not refer alone to the Californian Indians. As the ethnographic facts are slowly accumulated upon which general anthropology is founded, there comes the conviction in many cases that we are dealing with customs and beliefs that have already reached the twilight of their existence. The crania in our museums will soon be the only physical relics of many races that can just be said to still exist. The desire has therefore long been expressed for the immediate production of faithful and exhaustive monographs, by competent observers, of many of these fast-fading anthropological shadows. To this demand America is now contributing largely; the present volume relates to the habits, customs, legends, religious beliefs, and geographical distribution of the Californian Indians, information collected by Mr. Powers during three years' residence and travel among those tribes.

This work being the result of personal experiences, and as such of the greatest value, other authorities are necessarily not much quoted, but the reader who would desire a more exhaustive treatment of the subject, can supplement his perusal of this volume by that of the fourth chapter of the first volume of Bancroft's "Native Races of the Pacific States," and it is possible that little more in the way of general Californian ethnological information can be desired. In the introduction it is acknowledged that there is a difficulty in drawing a fine distinction between the Californian Indians and their neighbours, and although there are some customs which appear to differentiate them, these alone are not sufficient, and Mr. Powers considers the "crucial test is that of language." Twenty-eight principal tribes and some smaller ones related thereto are recognised and receive separate treatment.

La Pérouse compared these Californians from their dark colour to the negroes in the West Indies, and Prichard, generalising from the accounts of Rollin and Kotzebue, boldly compared the shape of their heads and features to those of the "Negroes of Guinea, New Guinea, and the New Hebrides." Without however ourselves attaching importance to these assumed or superficial resemblances, the above writers might have adduced another fact for the supposed negroid type from Mr. Powers, who tells us that "all Californian Indians emit an odour peculiar to themselves."

The women of the Kā-rok tribes are described as having, apart from tattooed chins, "a piquant and splendid beauty," which has resulted in much intermarriage with the whites, many pioneers, "including four county officers and the only editor in Klamath County, having taken them to wives." This is another illustration of the pregnant fact, pointed out by many writers during the last few years, that with the Indian tribes in North America there has in many cases been much assimilation, and not only extermination. It is stated, however, that among "half-breed" children a decided majority are girls. "Often I have seen whole families of half-breed girls, but never one composed entirely of boys, and seldom one where they were more numerous." It would be interesting to know the proportion of male to female births among the Californians themselves. Franz Mayer has stated that there are more boys than girls in Upper California. Among the Nozi tribe, whose stature is short, the children "often remain mere dwarfs until they are ten or fifteen years old, when they start and shoot up suddenly eighteen inches or so."

These Californian Indians have a considerable power of botanical discrimination. Of the Patawat tribe it is stated, "there is not the smallest moss or lichen, not a blossoming shrub, or tree, or root, not a flower or vine, no forest parasite, bulrush, or unsightly weed, growing in the water or out, or any sea-weed or kelp, for which they have not a specific name;" and Mr. Powers asserts without hesitation that an average intelligent Indian, even if not a shaman, has at command a much greater catalogue of names than is possessed by nine-tenths of Americans. It is, however, incorrect to say, at p. 419, that savages have no systematic classification of botanical knowledge —"there are no genera, no species." The same remark has been made by Dr. Peschel in his "Races of Man." Dr. Hector, on the contrary, has informed us that the Maoris of New Zealand have not only distinct names for nearly all their plants, but generic names, by which they group plants according to their affinities, in a way impossible to most people who were not educated botanists. These Californians sometimes exhibit morbid anticipations of death. Amongst the Pomo, the authority of Robt. White is given for the fact that aged men and women in early expectation of their demise, frequently dig their own burial-place, and then repair thither daily for months together, eating their repast at the mouth of the grave; whilst amongst the Wintun, Mr. Powers relates that sometimes an aged woman will wear around her for months, the rope wherewith she is to be wrapped when a corpse.

Mr. Powers also contributes a most valuable addition to Californian folk-lore in the numerous legends that have been exhaustively collected and excellently narrated. It becomes a question, however, whether some of these are truly aboriginal, and uninfluenced by the teachings of the early Spanish missionaries; the "Legend of Gard," p. 80, seems to have had a very possible inspiration from Eastern sources.

This work is more intended for the careful study of the ethnologist than to afford extracts for a reviewer; and though naturally a great part of the information has been previously collated, there is not only much that is decidedly new to science, but the whole forms an excellent example of what can be observed and collected by an ethnologist for ethnology. It is likewise another token of "American Progress;" published by the "Department of the Interior," it is distributed to European students, without barter and without price. It is well illustrated, many patterns of facial tattoo marks being shown. A good map also accompanies the volume, the value of which is farther enhanced by an appendix on Linguistics, edited by J. W. Powell, in which a number of vocabularies are given.

W. L. Distant

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.*]

Sunshine Cycles

In Nature, vol. xxi. p. 81, your correspondent, Mr. B. G. Jenkins, with the best intentions, yet does me too much honour in quoting my name from a former volume of NATURE in 1872, as having then announced a cold wave of climate temperature being due to commence in 1878·8; or, as he is kind enough to say, the very day on which the severe winter of the years 1878 and 1879 did begin.

I must decline, at all events, the full honour, for these two reasons: *firstly*, the quoted datum was intended by me to signify the middle, not the beginning, of that cold wave; and as that lasted thirteen months, my date was between six and seven months too soon. *Secondly*, when I published again on the subject in the *Edinburgh Astr. Observations* of 1877, I indicated not 1878·8, but 1877·8 as the probable date of the then coming, now past, wave of cold, or erred much more than in 1872.

I have recently been looking into the reason of that latter calamitous failure, and find it clearly enough now on the plates of projections in that volume in this fact—that the then expected minimum of solar spots was inserted for 1877·5, or nearly two years sooner than sun observations have since then shown it to be. Rectifying, therefore, now that quantity, and in the then absence of our rock thermometers (which had first indicated the remarkable cycles of temperature in striking connection with the whole period, though not the details, of the sun-spots) using merely air-temperatures and re-drawing the curves, the middle epoch of the late cold wave comes out 1879·1, and of the next hot wave 1880·8.

Now these hot waves, I have always maintained, are more important, more regular, and more directly of solar origin, than the cold waves which are rather due to some indirect earthly effects of watery vapour and its transformations. It may be worth while, therefore, when we are now, as I believe, on the threshold of one of the heat-waves, to mention shortly the data on which the expectation is founded.

These are mainly the actual observations of no less than five occasions of such maxima of temperature occurring in a peculiar kind of dependence on successive sun-spot minima; or rather on the beginning, in each case, of the forces of a new spot cycle. The last such heat-wave was in 1868·8, or 1·8 year after the then last sun-spot minimum. Next before that in 1857·9, or 1·9 years after its previous sun-spot minimum. Before that, in 1846·4, or 2·4 years after the same solar test. Before that again, but then depending only on old atmospheric temperature observations, as our rock thermometers were not then existent, in 1834·5, or 1 year after; and still further back, in 1826·5, or also about 1 year after the then last sun-spot minimum.

These intervals from one to the other of the hot waves are by no means arithmetically equal, being 10·9, 11·5, 11·9, and 8·0. This last (really the earliest of the series) is a frightful inequality, but is borne out, *first*, by the sun-spot period of that cycle as given by M. Schwabe, having been also anomalously short; and *second*, by this remarkable testimony, which I have only just become acquainted with, in a pamphlet of most independent character by Sir Robert Christison, Bart., M.D., on tree-growth, read before the Botanical Society in Edinburgh:—

"The wonderful season of 1826, when warmth and sunshine, commencing with March, ended only with September, and when the summer was continuously such as to change in some respects the habits of the people."

The year 1826 was therefore a crucial case, not only for a maximum of temperature and sunshine in Scotland, but for its keeping such remarkable pace with the then anomalously shortened period of sun-spots. While the presently coming case of 1880 will equally prove, by what I have detailed above, that no certain success in weather predictions for several years beforehand can be hoped for, unless the dates of sun-spot minima can be also announced by authority beforehand to a very much smaller quantity than two years of error; and that no *mean* duration of the sun-spot cycle comes close enough to the fact of the large variations between one cycle and another. We must have therefore each cycle of sun-spots fixed by its own dates alone, and not smoothed away and improved out of creation by being made apparently conformable to others.

I have not yet seen, by those able men who believe they have traced sun-spots to planetary influences of position on the sun, any attempt, from the planetary places in almanacs, to compute the dates of all the solar minima of spots, say from 1825 to 1900. But something of that kind appears now to be necessary for the next steps of the science of the future.

PIAZZI SMYTH

15, Royal Terrace, Edinburgh, January 9

Cranial Measurements

IN the notice of my catalogue of crania which you have been good enough to insert in NATURE, vol. xxi. p. 222, your reviewer has given me credit for originality of method, to which I have no wish to lay claim.

1. In reference to the mode of taking the horizontal circumference, it is said that I pass "the tape line, not over the prominence of the glabella, as is customary with craniologists, but above it, around the supra-orbital line." The fact is, that the method which I have adopted, so far from being a deviation from what is customary, is that recommended in the valuable "Instructions Craniologiques," drawn up by Broca and published by the French Anthropological Society, and which is used, certainly by the large majority, if not by all the craniologists with whose writings I am acquainted.

2. With regard to the more important measurement of the antero-posterior diameter of the cranium, more important on account of its influence on some of the most characteristic indices, there are, unfortunately, still considerable differences of method, and it was only after very full consideration of the subject that I decided not to follow the French instructions, but to adopt the plan used by Rolleston in "British Barrows," by Barnard Davis in his "Thesaurus Craniorum," and by the majority of German anthropologists. So fully was I convinced of the expediency of the latter, that after having already measured the whole of the crania in the collection, and calculated the indices by the method which included the prominence of the glabella in the cranial length, I took the trouble to remeasure them, with the results given in the catalogue. The object being to obtain, as near as may be, an idea of the form of the brain case, it appears desirable to exclude all extraneous projections which have no relation to this form. The impossibility of eliminating every source of fallacy, such as those occasioned by the varying thickness of bone or of diploë, is no argument against endeavouring to reduce them, as far as we can, to a minimum. The projection caused by the development of the frontal sinuses should certainly not be omitted in a complete description of a skull, but it no more affects the form of the cranium proper, than the prominence of the nasal bones or of the maxilla, which, important and instructive as they are from other points of view, are usually ignored in giving what is called the maximum length of the skull, although if the term is to be taken in its literal sense, they have as much claim to be included as the glabella or supra-orbital ridges.

Many other arguments might be adduced and authorities given for the usage I have adopted, but I will bear in mind your request for brevity.

W. H. FLOWER

Royal College of Surgeons, January 11

"Why the Air at the Equator is not Hotter in January than in July"—Freezing of the Neva

IN NATURE, vol. xxi. p. 129, Mr. Croll gives his reasons why the equator is not much warmer in January than in July, notwithstanding the greater nearness of the sun at the former season. To state the case briefly, he, having recalled the fact that the whole earth is colder in January than in July, because in the former the cold winter of the northern (or principally land) hemisphere coincides with the mild winter of the southern (or principally water) hemisphere, he continues: "Consequently the air which the equatorial regions receive from the trades must have a higher temperature in July than in January. The northern is the dominant hemisphere; it pours in hot air in July and cold air in January, and this effect is not counterbalanced by the air from the opposite hemisphere. The mean temperature of the air passing into the equatorial regions ought therefore to be much higher in July than in January, and this it no doubt would be were it not for the counteracting effects of eccentricity." And further: "There is another case which must also tend to lower the January and raise the July temperature of the equator: the northern trades pass farther south, and consequently cool the equatorial regions more during the former than the latter season."

I maintain that there is no such influence of the northern trades on the temperature of the equator, because they scarcely anywhere reach it, and then because the lower latitudes of the northern hemisphere are not colder in January than those of the southern hemisphere in July. *In the Atlantic the northern trades do not reach the equator at all in January*, but only in February, March, and April, and this but in the western part of the ocean.

The same may be said of the Pacific in its eastern part, where alone the trades are regular. In the Western Pacific, as well as in the Western Indian Ocean, I admit that air from the northern hemisphere reaches to the equator and somewhat beyond in January, but not that this tends to give the equator a lower temperature in this month than in July. According to Dove, the mean temperature of 10° N. in January is 77°·2; of 10° S. in July, 76°·1.

So far as the temperature of the equator is concerned, the southern is the dominant hemisphere, and the equator is certainly cooled by winds coming from the south. If the equator is not everywhere warmer in January than in July, this is caused by the rainy season, which on the equator, and even a few degrees north of it, generally coincides with the southern summer. Where the rains are not very heavy, as, for example, on the Isle of St. Thomas, West Africa, we have: January, 78°·3; July, 75°·7; at Padang, Sumatra, where the rains are exceedingly heavy all the year, there is scarcely any difference at all between the months. Somewhat to the south of the equator, where to the difference in the nearness of the sun is added a much greater height above the horizon in January, we have—

	Jan.	July.	Rainy Season.
Amboina, Molucca Islands, 4° S.	80·9	77·4	May to August.
Batavia, Java, 6° S.	77·7	78·8	December to February.
Pernambuco, Brazil, 8° S.	80·6	75·0	April to July.

so, by the first-rate observations of Batavia, it is established that, so far as 6° S., January is 1°·1 colder than July, because the former is very rainy, while the latter has little rain. Even to 9° lat. N., July is colder than January, if the former has much more rain, so for example—

Island of Fernando Po, W. Africa, 4° N.	79·9	76·5	March to November.
Gondokoro, Upper Nile, 5° N.	81·3	75·7	April to August.
Freetown, W. Africa, 8½° N.	80·4	77·0	June to October.

Thus, in the lowest latitudes of the northern hemisphere, we find differences amounting to 5°·6, while in the southern greater differences than 1°·1 are not known, which may, to a certain degree, be ascribed to the nearness of the sun in January.

I think I have proved that, as to what we call the temperature of the air (really that of the lowest stratum), it is, on the equator and a few degrees north and south from it, far more influenced by the yearly distribution of clouds and rain than by the different amount of heat received from the sun. The result would be different if we knew the temperature of the whole stratum of air. The heating of the upper surface of the clouds by the sun, and especially the heat liberated in the condensation of water must give to the higher strata a superior temperature than that they had in the dry season; in other words, the decrease of temperature with elevation is much slower during the rains than in the dry season, as was shown for India by Mr. Blanford. This is true for other regions, and where the sky is cloudy and rains abundant in the greater part of the year, the temperature of the whole air may yet be higher than in drier climates, where the soil and the lower stratum of air are hotter.

I do not agree with Mr. Croll in what he states at the end of his letter as to the effect of winds in cooling the equatorial regions and rendering them habitable, as they would be too hot for man without the cool air brought from the temperate regions. I think Mr. Croll has enormously over-stated the effects of winds on the temperature of the equator. The extent of the tropical zone is so great, its temperature so very near to that of the equator, the winds which blow across it so gentle, that I consider the effect of the winds from the temperate regions in directly cooling the temperature of the equator to be nearly imperceptible. The following is a good illustration:—Nowhere is the winter temperature so low near the tropics as in Southern China, for example, in January, Canton, 55°·6, Victoria, Hong-Kong, 59°·2. Yet Saigon, in Cochin China, but 11° to the south of Hong-Kong, and subjected to the full force of the north-east monsoon from the China seas, has a January temperature above 77°. Clearly the thermal effect even of the cold winter monsoon is scarcely perceptible farther south.

I consider water to be the only direct cause of the mildness and uniformity of equatorial temperatures, and this in three ways—(1) by the great heat-capacity of water; (2) by the clouds which interpose a screen between the sun and the surface of the earth; (3) by the evaporation of rain-water by the soil and plants.

The first cause is especially powerful on the ocean, while the two latter act especially on land, even very far from the sea. If it was not for the clouds and evaporation, how could we explain, for example, the absence of great heat (hottest month, 78°·6) at Iquitos, on the Amazons, 4° S., and more than 1,000 miles from the Atlantic, where the winds are generally weak?

As to the winds, I admit of their effect in this case; but (1) in causing ocean-currents, and thus removing the heated water from the equator; (2) in spreading the cold air from over the cold currents over a greater distance. The latter is the cause of the low temperature in the equatorial regions of the Eastern Atlantic and Eastern Pacific.

Where the sky is clear and humidity and rains deficient, very high temperatures of the air are attained, even at a great distance from the equator (10°–30°) and this notwithstanding winds of considerable force blowing from cooler regions. So, for example, the north winds blowing in the summer in the Sahara, and coming from the cooler Mediterranean, are certainly stronger than the trades of the ocean and yet do not prevent the desert from attaining a higher temperature than known in any equatorial region.

In the same number of NATURE you committed an error by giving the dates of freezing of the Neva in *old style*. The dates in *new style* are: Mean day of freezing, November 25, earliest October 28 (1805), latest (not quite certain), January 9 (1711), next latest December 26 (1826); mean day of opening, April 21, earliest, March 18 (1822), latest, May 12 (1810); number of days open, 218, least, 172 (1852), greatest, 279 (1822).

A. WOEIKOF

Sekpaleruaya 8, St. Petersburg, December 5-17, 1879

Hearing through the Mouth

THE principle of the so called "Audiphone," described in NATURE, vol. xxi. p. 243, is by no means a new discovery, although the application of it may be novel. It has long been known that sounds may be conveyed to the auditory nerves through the mouth when the drum of the ear is defective in its action, although the principle has, perhaps, been little acted upon by aurists. Mr. Rhodes's system is to press the edge of a vibrating metal disk against the upper teeth, and "the vibrations thus taken up by the disk are transmitted through the teeth and bones of the skull to the auditory nerve." (?) Such a remedy will, in many cases, be thought more inconvenient than the defect, and it is by no means necessary thus to jar the teeth and the bones. Although I am not deaf, some years ago I practised the listening to very feeble sounds through the mouth instead of by the outward ear, at the recommendation of the late Sir Charles Wheatstone. The inducing cause was to verify by experiment the true character and the notes of resultant tones, or Tartini's tones, about which no two authors had agreed. Sir Charles lent me one of his symphoniums—little instruments made like his concertinas, except that they were blown by the mouth directly upon the metal springs instead of by bellows. According to his directions I stopped my ears lightly with cotton, but pressed it into the *concha* with a thumb upon the lip of each ear. The little instrument was supported by my third and fourth fingers, leaving the notes to be touched by the first and second fingers of each hand. By thus excluding external sounds I could hear the deep and soft resultant tones to perfection; the instrument should not be tempered because they result from coincident vibrations of the notes sounded above. In these experiments I touched the symphonium as lightly as possible with elongated lips, the cavity of the mouth receiving the sounds. The teeth were covered by the lips.

WM. CHAPPELL

Strafford Lodge, Oatlands Park

Intellect in Brutes

THE numbers of NATURE containing the interesting discussion on this subject have only lately reached us, and it is late to bring forward anything on the question, yet the readers of NATURE will be interested in two instances of "calculation" on the part of wild birds that I have noticed. Some years ago I was overlooking a penguin "rookery" as it is called, at the Falklands, and watching the goings on of the numerous colony below me. It was breeding season, and the birds were sitting on their eggs on the bare earth, crowded together with hardly walking room between them. Amongst the birds stepped a pretty Sheath-bill (*Chionis alba*) with a quiet jaunty stride, picking what he could, and apparently perfectly indifferent to the motions of the penguins, who drove at him with their beaks as he passed, but never struck him. I saw him pass and repass one bird always just out of reach, till the bird could stand it no longer, but reached off her nest about an inch to strike him; he was still just out of reach and busy with something, apparently not noticing the penguin; she reached further, he crossed her again, still just out of reach, and this went on till he had drawn her about two feet from the nest, then in one stride he was beside the egg, had punched a hole, and was sipping the contents before the slow penguin could turn and hop back to save it; he again led her away by the same manœuvre and increased the hole and got a greater part; a third time he led her off and was eating the egg when he was driven right away by another penguin, who was wandering at liberty, the mate, I suppose, being on turn on the egg. The proceeding on the part of the sheath-bill was a perfect trap for the poor foolish old penguin.

The other instance I will give occurred in the Pacific, where some albatross were circling about, and frequently settling on the water in flocks; some sharks were about, and I watched to see if any albatross would be pulled down; then I noticed a cordon of sentries round the flock, who were relieved at times from the flock, a single bird going out and sitting near the sentry who flew in. Whenever a shark's fin approached the sentry he flew in, and the whole flock took up new position. Here was distinct organisation. The ship was going very slowly through the water, and I was able to study the whole carefully. J. P. MACLEAR

H.M.S. *Alert*, Straits of Magellan, November 5, 1879

THE following account of an incident in the early life of a South African baboon may not be out of place in your journal The person who witnessed it was a very trustworthy native attached to Bishopstowe, Natal, and who is employed from time to time to get game for the house. He used to find it an agreeable addition to this duty to collect objects of natural history for the cabinet as well as for the table. He was fully alive to, and took a keen interest in, what went on among the animals of all kinds, and was much struck with what he saw take place one day at the bottom of a little *iDonga*, or dry watercourse, over the brink of which he peeped, on the slope of a table-mountain, the grand object that lies in the front of Bishopstowe, some twelve miles distant.

It was a hot day, and a number of baboons were sunning themselves along the bottom of the *iDonga*. They lay upon their backs, with half-closed eyes, rubbing their stomachs in a state of placid enjoyment. Two or three young baboons had wandered to a little distance down the *iDonga*, searching for scorpions from stone to stone just below them. They were not very successful, and it did not appear that their movements were of much concern to their elders. Presently, however, one of the young ones, turning up a stone, lit upon a particularly fine and fat scorpion, which, with a furtive glance round at his elders, he seized and popped into his mouth, having first pinched off the sting. He at once proceeded to turn the stone over again with great assiduity, as though in further unsuccessful search for scorpions. He had not escaped notice, however, for down the gully in a sluggish roll came a great baboon, who seized the young one by the scruff of the neck, shaking him vigorously until the plump morsel dropped from his pouch. Having gobbled this up, the elder baboon at once regained his lounge, and all went on as before in the sleepy hollow.

London, January 8 FRANCIS E. COLENSO

Notes on the Papuans of Maclay Coast, New Guinea

THE articles on the above subject which have appeared in NATURE, vol. xxi. pp. 204, 226, have been read by me with great interest in consequence of the resemblance which certain of the customs therein described have to some which have come under my observation among the inhabitants of the Andaman and Nicobar Islands.

With regard to the custom of the relatives of deceased persons in the Andamans ornamenting and carrying about the skulls of the departed, which is alluded to in a note on p. 205, I believe I may claim to have first described and figured such a skull. My paper entitled "On a Visit to the Andamanese Home, Port Blair, Andaman Islands" (of which I inclose a copy), was published in the *Proceedings* of the Royal Irish Academy for 1871. In it I mentioned, together with some other facts, that I had witnessed the process of making flakes from a piece of bottle-glass which I saw subsequently employed for shaving.

An Andamanese necklace made of human clavicles and turtles' ribs is now in my possession, and I believe human finger and toe bones are also sometimes strung together and worn round the neck. In reference to the ideograph discovered by Mr. Maclay among the Papuans I would refer to a paper "On Nicobarese Hieroglyphics or Picture Writing," which I communicated to the pages of the *Indian Antiquary* (Bombay) in the year 1875.

The screen which is figured is one out of many which I saw in the Nicobar Islands. It consists of the spathe of a palm and is covered with representations, done in vermilion, of men (in various attitudes), pigs, fish, houses, canoes, weapons, &c., &c. It would take up too much space to give details of it here, but I may state that my conclusion regarding it was that it was the pictorial record of some past event. Both skull and screen are described, but unfortunately not figured, in my recently-published work, "Jungle Life in India."

To any of your readers who may be specially interested in the matter I shall be happy to forward, on application, copies of the papers above mentioned and photographs of the screen so far as the numbers available for the purpose will go. V. BALL

37, Northumberland Road, Dublin, January 9

The Word "Telegraph"

THE word "telegraph" appears to have been naturalised in our language at a much earlier date than that given by Mr. Warren de la Rue in his letter in NATURE, vol. xxi. p. 226. There are several references to the apparatus in the *Gentleman's Magazine* for July, December, 1794, and the next three volumes. At first the word appears in its French form with the final "e," but the sign of its foreign origin soon disappears. Under the date January 28, 1796, we find amongst "Domestic Occurrences" a paragraph stating that "a telegraph was this day erected over the Admiralty." This, I think, was removed about thirty years ago. In case your correspondent should wish to verify the references in the indexes to the *Gentleman's Magazine*, I may point out that there are two pages numbered 106 in the volume for January to June, 1795, and that there is an article at p. 1176 of that for July to December, 1794, not mentioned in the index.

Watt, in his "Bibliotheca Britannica," gives a still earlier reference to the word in R. H. Gower's "Theory and Practice of Seamanship," but there is no mention of a telegraph in the first edition of that work, published in 1793.

The word occurs many times in Dr. Thos. Young's "Lectures on Natural Philosophy," 1807, and some interesting information on the subject may be found in Gregory's "Treatise of Mechanics" (2nd ed.), vol. ii. p. 434 (London, 1807), where several sorts of telegraphs are described.

H.M. Patent Office, January 12 RICHARD B. PROSSER

Stags' Horns

THOUGH, no doubt, as Mr. Stokoe suggests, many antlers are picked up and sold to knife-handle makers, or, if they happen to be good ones, used for "making up" deers' heads, yet many, I believe, are really eaten by the deer themselves. I have never myself seen a deer engaged in eating a fallen antler, nor, though I have more than once found cast horns on the hills, did the latter present any appearance of having been gnawed.

All the hill men will tell you, however, that it is a well-known fact that red-deer eat the horns that are shed every year, and the late Sir Thomas Moncreiffe once told me that he watched a hind—a cervine Delilah—gnawing the tips of the tines of the horns of a stag that was lying beside her, and which he afterwards shot. In Blair Castle there is a magnificent stuffed stag—"Tilt"—which was reared by the late Duke of Athole, who fed it upon, amongst other things, ground deer-horns. As tame stags often do, "Tilt" became dangerous, and had to be killed when he was eight or nine years old. In size he far surpassed any of the wild red-deer, and had most magnificent antlers. As each year's antlers fell off they were preserved, and form an interesting and instructive series.

Considering how fond cows are of gnawing bones, and also how they will eat any woollen garment they can get at, there does not seem to be anything very remarkable in the fact of red deer consuming shed horns. F. BUCHANAN WHITE

Perth, January 2

VISUALISED NUMERALS

I HAVE lately been occupied in eliciting the degree and manner in which different persons possess the power of seeing images in their mind's eye, and am collecting a large and growing store of materials, partly of verbal answers made by friends to my inquiries, but principally by means of written replies to a printed list of questions that I am distributing. The subject bears in many ways upon psychological and ethnological studies, and I should be glad if the present memoir upon one particular branch of it should induce correspondents to furnish me with authentic information of the kind I seek.

The various ways in which numerals are visualised is but a small subject, nevertheless it is one that is curious and complete in itself. My data in respect to it are already sufficiently numerous to be worth recording, and they will serve to show that parallel results admit of being arrived at in other directions.

I may begin by mentioning one or two general experiences. I have been astonished to find how superior women usually are to men in the vividness of their mental imagery and in their powers of introspection. Though I have admirable returns from many men, I have frequently found others, even of the highest general ability, quite unable for some time to take in the meaning of such simple questions as these. "Think of some definite object,—say your breakfast table, as you sat down to it this morning, and consider carefully the picture that rises before your mind's eye. Is the image dim, or fairly clear? Is its brightness comparable to that of the actual scene? Are the objects sharply defined? Are the colours quite distinct and natural, &c.?" On the other hand, I find the attention of women, especially women of ability, to be instantly aroused by these inquiries. They eagerly and carefully address themselves to consider their modes of thought, they put pertinent questions, they suggest tests, they express themselves in well-weighed language and with happy turns of expression, and they are evidently masters of the art of introspection. I do not find any peculiar tendency to exaggeration in this matter either among women or men; the only difference I have observed between them is that the former usually show an unexpected amount of intelligence, while many of the latter are as unexpectedly obtuse. The mental difference between the two sexes seems wider in the vividness of their mental imagery and the power of introspecting it, than in respect to any other combination of mental faculties of which I can think.

Another general experience is that the power of seeing vivid images in the mind's eye has little connection with high or low ability or any other obvious characteristic, so that at present I am often puzzled to guess from my general knowledge of a friend, whether he will prove on inquiry to have the faculty or not. I have instances in which the highest ability is accompanied by a large measure of this gift, and others in which the faculty appears to be almost wholly absent. It is not possessed by all artists, nor by all mathematicians, nor by all mechanics, nor by all men of science. It is certainly not possessed by all metaphysicians, who are too apt to put forward generalisations based solely on the experiences of their own special ways of thinking, in total disregard of the fact that the mental operations of other men may be conducted in very different ways to their own.

I have much to say on this and cognate topics which I pass by on the present occasion, that I may at once proceed to the subject of this paper. The first section of it is of minor interest and may be quickly dismissed. It is the power of mentally seeing numerals, of holding them fast in the field of view, of perusing them when there, and of working sums by mental imagery in the same form as that in which they are usually carried on with pen and paper.

Here is a well marked case of the power of visualising numerals. The writer is an office-bearer of one of our scientific societies:—

1. If words such as fifty-six be spoken, I most clearly, easily and instantly visualise the figures. I do so almost automatically. I perceive that when I speak the word "thousand" or hear it spoken, the figures at once group themselves together. I find it quite impossible to think of the date of a year without remembering and visualising the figures, though I express myself in words. The figures are always printed; in type and size they resemble those commonly used for the headings of newspapers. I cannot, however, appreciate a back-ground, the figures appear simply in space. I think that by practice and concentration I could hold fast many figures.

The next is by a friend who has a most tenacious memory for numerical administrative details:—

2. I can see and mentally retain many figures, and can multiply four figures by four figures without practice, the operation proceeding visibly in my mind like a sum upon paper.

The following is by a school-boy who is a near relation of a man of the highest mark in science:—

3. I can visualise a fairly long line of figures, and I do mental sums by putting down the working of them in my mind's eye, up to square roots with two figures in the root, and in algebra, to simple quadratics.

A schoolmistress writes:—

4. I can retain several figures in my mental view and work examples, seeing every figure in the process.

A late Fellow of Trinity College, Cambridge, states:—

5. All arithmetical processes performed mentally, are exactly the processes I should perform on paper.

It must not, however, be imagined for a moment, that the processes of mental arithmetic are necessarily wholly dependent on the faculty of visualising numerals. Here is a good instance to the contrary. The writer is the author of a valuable work on a branch of Mental Philosophy:—

6. The numerals are merely ideal sounds [to me], not ideal sights in any way. I have, or used to have, very considerable powers of mental arithmetic and mental algebra, but always used in thought the sounds of the signs. In the process I always forgot every step as soon as I had reached the result of that step.

This last sentence is exceedingly suggestive, and reminds one that many so-called "unconscious" acts are not really unconscious, but are acts characterised by an exceedingly brief and evanescent period of consciousness.

The processes of mental arithmetic are commonly dependent on the representation of more than one sense, as in the following instance:—

7. I can multiply with effort four figures by four; but partly only by images, chiefly by memory.

I am as yet unable to determine the percentage of persons who possess in the various degrees, the power of visualising numerals, because my returns are chiefly derived from persons who are exceptionally gifted. An excellent way of obtaining average returns to psychological questions would be by the help of schoolmasters, who have an admirable field of psychological research immediately before them, which they wholly neglect. If a hundred boys in a large school could be set simultaneously to answer such questions as those I am putting, after their masters had clearly explained their purport to them, and had taken common precautions to insure independent replies, and to sift away lax and untrustworthy statements, the thing would be effected by a single stroke, and both boys and masters would enjoy the satisfactory feeling of having accomplished a substantial piece of scientific research.

I have many curious cases of colour association with the various numerals, but shall only give a very few instances of them, and those incidentally, in the present paper. I shall also abstain at present from speaking of the many different ways in which dates, days of the week, and months of the year are apt to be visualised.

The topic to which I especially wish to direct attention, is the innate and hereditary tendency of certain persons to see numbers in definite and constant arrangements or schemes, whose various characters will be easily understood from the extracts I am about to give and by the accompanying illustrations, which are reductions to a small scale of the pictures I have received, with a necessary sacrifice of detail in a few cases.

The simplest instances do not seem to be the commonest; thus, I have very few indeed that could be classed with the following:—

8. When a child, I counted by means of imaginary cards from ace to ten. My little boy in the same way, used an imaginary domino.

Or this:—

9. I picture numbers in groups, thus 5 is sometimes ⁚·⁚, sometimes ⁖·, 8 is ⁞⁞, 7 is ⁞⁝, 100 is ten rows of ten.

I may as well give the remainder of this communication here; it is written by a lecturer upon mental philosophy. He says:—

10. The numerals 1, 2, 3, 4, &c., from the part they play in the multiplication table, have been personified by me from childhood. 9 is a wonderful being of whom I felt almost afraid, 8 I took for his wife, and there used always to seem a fitness in 9×9 being so much more than 8×8. 7 again is masculine; 6, of no particular sex but gentle and straightforward; 3, a feeble edition of 9, and generally mean; 2, young and sprightly; 1, a common-place drudge. In this style the whole multiplication table consisted of the actions of living persons, whom I liked or disliked, and who had, though only vaguely, human forms.

The schemes in which numerals appear are usually fantastical and sometimes very elaborate. I will (by permission) give the name of the writer of the first instance about to be adduced, on account of the hereditary interest that is attached to it. It is by Mr. George Bidder, Q.C., a son of the late eminent engineer, who was known in early life as the calculating boy. Mr. George Bidder inherits much of his father's marvellous power of mental arithmetic, being able, though not with equal precision and rapidity, to mentally multiply fifteen figures by another fifteen figures. This faculty has been again transmitted, though in an again reduced degree, to the third generation. (*See* letter in the *Spectator*, December 28, 1878, also the early numbers of that paper in 1879.)

He writes to me as follows:—

11. One of the most curious peculiarities in my own case, is the arrangement of the arithmetical numerals. I have sketched this to the best of my ability. Every number (at least within

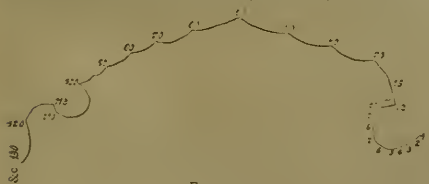


Fig. 1.

the first thousand, and afterwards thousands take the place of units) is always thought of by me in its own definite place in the series, where it has if I may say so, a home and an individuality. I should, however, qualify this by saying that when I am multiplying together two large numbers, my mind is engrossed in the operation and the idea of locality in the series for the moment sinks out of prominence. You will observe that the first part of the diagram roughly follows the arrangement of figures on a clock-face, and I am inclined to think that may have been in part the unconscious source of it, but I have always been utterly at a loss to account for the abrupt change at 10 and again at 12.

It occurs to me that the change is probably due to the wrench given to the mental picture of the clock dial in order to make its duodecimal arrangement conform to the decimal system, and that the same action is repeated at 110.

The next diagram exhibits the most compact of all the mental schedules which I have as yet received:—

12. The representation I carry in my mind of the numerical series is quite distinct to me, so much so that I cannot think of any number but I at once see it (as it were) in its peculiar place in the diagram. My remembrance of dates is also nearly entirely dependent on a clear mental vision of their *loci* in the diagram. This, as nearly as I can draw it, is the following:—

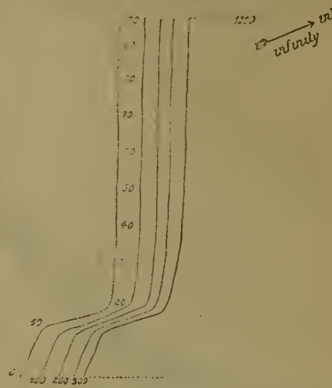


Fig. 2.

It is only approximately correct (if the term "correct" be at all applicable). The numbers seem to approach more closely as I ascend from 10 to 20, 30, 40, &c. The lines embracing a hundred numbers also seem to approach as I go on to 400, 500, to 1,000. Beyond 1,000 I have only the sense of an infinite line in the direction of the arrow, losing itself in darkness towards the millions. Any special number of thousands returns in my mind to its position in the parallel lines from 1 to 1,000. The diagram was present in my mind from early childhood; I remember that I learnt the multiplication table by reference to it, at the age of seven or eight. I need hardly say that the impression is not that of perfectly straight lines, I have therefore used no ruler in drawing it.

Some writers have somewhat rashly asserted that our idea of numbers is always based on our ten fingers and ten toes. There are, however, other forms in use by various nations than those of decimal arithmetic, and the last paragraph of the foregoing seems sufficient to show that the finger and toe hypothesis is not universally true. This opinion was strongly maintained by the lady writer of the following remarks, whose imagery dates beyond her earliest recollections:—

13. The annexed column [a portion only of it is represented here] represents how I see the numbers from 1 to 140. There is no break up to 30, and none from 90 to 130, but I think this is because the three figures at 100 make a sort of break of themselves. After 140 they go on regularly, but farther off. The figures are not one *above* the other, as they appear in the diagram, but are one *beyond* the other, stretching away into space. They are about half an inch long, of a light grey colour on a darker and brownish grey ground.

&c.
41
39 40
38
37
36
35
34
33
32
31
29 30
28
27
&c.

Fig. 3.

The next example is very curious; the diagram which accompanies it is carefully and minutely drawn on a large sheet of paper and looks like a detailed route survey made by a careful traveller. I have been obliged to treat it much as a map maker would treat such a survey.

14. I find it very difficult to represent my visualisation of numerals diagrammatically. I scarcely ever see the lower numbers written; I simply know exactly where 6, 7, 4, &c., are to be found. I cannot properly represent the crowding of numbers in some places, nor the edgewise positions they occupy, nor can I at all adequately express the compactness and yet extent of the line. On either side of it there seems to be indefinite space. But there is a boundary at 1, *beyond* which I have to look for *minus* quantities. After 108 the notion of place becomes hazy and indistinct, though I can visualise the higher numbers in respect to their position, if I make the effort. I think of a million as *very* far off and high up. When multiplying for example 5 × 6, I know instantly the spot where the product will be, and look to see what number it is. But if asked to multiply 14 × 17 I first go up to the place whereabouts I expect it will be, and am baffled. I do not know where to look. In the coloured parts, it is the place rather than the number that is coloured, and the number is connected with colour because it happens to be in that place. The brightness and darkness may possibly in the lower numbers have some connection with the events of my life, the numbers which correspond to years of my age which were eventful, being as a rule much more distinct. As a child I had great liking for the number six, arising I fancy from a keen desire to be six years old. I had also an excessive love for blue, so perhaps this accounts for the connection between them. N.B.—I learnt arithmetic in a thorough old-fashioned unintelligent style, the first step being to learn to count without the least conception as to what the numbers meant.

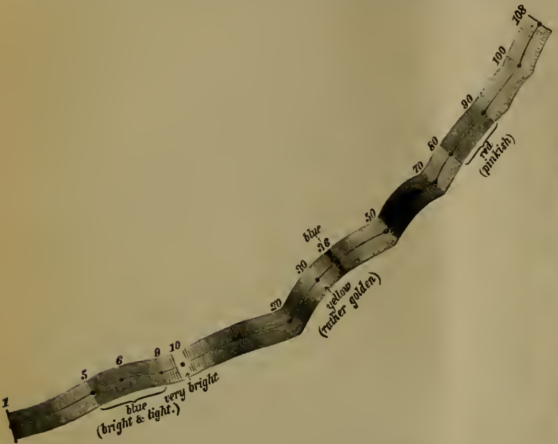


Fig. 4.

Fig. 5.

The writer of the foregoing has two sisters and a brother. One of the sisters sees numerals in a differently arranged diagram, and the figures themselves are coloured, (1) black, (2) white, (3) yellow, (4) red, (5) greenish yellow, (6) blue, (7) black, (8) red, (9) grey, (0) gold. The othe sister has a fainter, but still a decided tendency to ee figures in a mental diagram. It is without colour but has variations of shade. The brother has a definite diagram of numbers arranged in a line sloping upwards to the right as far as 120, and absolutely devoid both of colour and variations of shade. No trace of these colour-peculiarities has yet been made out on either the father or the mother's side, but there is a tendency in both father and mother to visualise in diagrams.

The effects of heredity are also strongly marked in the next set of instances, consisting of two families of cousins. A sister in the first family writes:—

15. From the very first I have seen numerals up to nearly 200, range themselves always in a particular manner, and in thinking of a number it always takes its place in the figure. The more attention I give to the properties of numbers and their interpretations, the less I am troubled with this clumsy framework for them, but it is indelible in my mind's eye even when for a long time less consciously so. The higher numbers are to me quite abstract and unconnected with a shape. This rough and untidy production is the best I can do towards representing what I see. There was a little difficulty in the performance, because it is only by catching oneself at unawares, so to speak, that one is quite sure that what one sees is not affected by temporary imagination. But it does not seem much like, chiefly because the mental picture never seems *on* the flat but *in* a thick, dark grey atmosphere deepening in certain parts, especially where 1 emerges, and about 20. How I get from 100 to 120 I hardly know, though if I could require these figures a few times without thinking of them on purpose, I should soon notice. About 200 I lose all framework. I do not see the actual figures very distinctly, but what there is of them is distinguished from the dark by a thin whitish tracing. It is the place they take and the shape they make collectively which is invariable. Nothing more definitely takes its place than a person's age. The person is usually there so long as his age is in mind.

Another sister says:—

16. I always see figures ascending in a directly perpendicular line in front of my eye [according to the sketch and memorandum sent in illustration, which it is hardly necessary to reproduce, the 1 stands opposite to the eye, and the scale reaches vertically up to 1,000]. Then all becomes vague, but I know that the thousands and tens of thousands are not in the same perpendicular line, and I believe they turn to the left hand.

A maternal aunt of these ladies "sees figures in a diagram," which has not yet reached me, and the other family that I am now about to mention are the children of a maternal uncle. There are three sisters and a brother who have the same faculty in varying degrees.

The brother writes from Cambridge:—

17. Numerals are always pictured by me in a straight line from left to right. They are black, on a ground varying in illumination, which is bright up to 10, then getting very shady from 10 to 20; 20 to 40, bright; 40 to 60, moderate; 60 to 80, shady. Shadiest are from 10 to 20, 60 to 80 or 90, 1,000 to

2,000. The millions are in a vague, bright distance to the right.

One of the sisters writes:—

18. Figures present themselves to me in lines [as in the annexed diagram]. They are about a quarter of an inch in length,

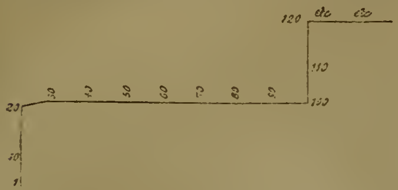


FIG. 6

and of ordinary type. They are black on a white ground. 200 generally takes the place of 100 and obliterates it. There is no light or shade, and the picture is invariable.

Another sister gives a picture in which the numbers form a vertical line from 1, opposite to the eye, up to 100, at which point the scale appears to recede from her.

The third sister writes:—

19. Figures always stand out distinctly in Arabic numerals; they are black on a white ground, of this size [the specimen was

FIG. 7.

clear and round, and in rather large ordinary handwriting], but the numeral 19 is smaller than the rest.

It is curious that the lines of most of the diagrams I have thus far given should be so feeble and, to appearance, wandering, although as a matter of fact they are firmly fixed. Artists speak of the "leading lines" in a picture, and commend pictures in which the leading lines are graceful. I have little doubt that one of the reasons why minds vary in artistic power is that the leading channels in the blank schedules of their minds vary in character. I should expect that natural artists might be found whose habit was to visualise numerals not in shaky lines, but in bold and beautiful curves. In the instances I am about to give, especially in the first of them, there is more tendency to geometric precision, and I should be most curious to learn (by actual and careful test) whether or no such cases are generally correlated with a true eye to straightness, squareness, and symmetry.

In the following example the numbers are not associated with visual figures, but with points on an ascending and descending scale, which is a pure line having neither breadth nor colour. It is described as perfectly flexible and extensible, much, I suppose, as if it were printed on a strip of india-rubber sheeting, and it is applicable to the measurement of large distances or small ones, to fractions, and to straight lines or curves. A very curious description is given in detail, which I will not here reproduce, of the way in which the scale is used in mental arithmetic. The writer adds:—

20. The accompanying figure lies in a vertical plane, and is the picture seen in counting. The zero point never moves, it is *in* my mind; it is that point of space known as "here," while all other points are outside or "there." When I was a child the zero point began the curve; now it is a fixed point in an infinite circle . . . I have had the curious bending from 0 to

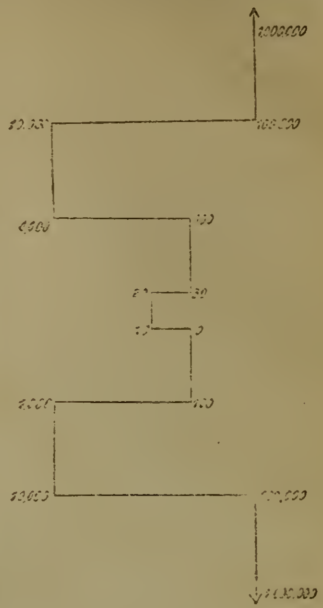


FIG. 8.

30 as long as I can remember, and imagine each bend must mark a stage in early calculation. It is absent from the negative side of the scale, which has been added since childhood.

Another correspondent sees figures in a circle, having 0 at the right hand of its horizontal diameter and 100 at the left hand. Positive numbers are reckoned from 0 to 100 from the right, over the top to the left, and negative numbers the other way. The same takes place with figures between 100 and 200, 200 and 300, &c.

Another correspondent sees them for the most part in a regular row like park palings. The description and sketch are as follows:—

21. As far as 12 the numerals appear to be concealed in black shadow; from 12 to 20 is illuminated space, in which I can distinguish no divisions. This I cannot illustrate, because it is simply dark and light *space*, but with a tolerably sharp line of division at 12. From 20 to 100 the numerals present themselves as follows, but less distinctly:—

FIG. 9.

An account is appended of the way in which simple mental arithmetic is effected by this arrangement, which at present I pass over.

I will conclude my list with a statement written by a mathematical astronomer of rapidly rising reputation, whose "practice of working arithmetic" mentioned in the concluding paragraph must be understood to signify "performing masses of laborious calculations":—

22. The numbers 1, 2, 3, 4, &c., are in a straight row, and I

am standing a little on one side. They go away in the distance so that 100 is the farthest number I can see distinctly. It is dusky grey, and paler near to me; up to 20 it occupies a disproportionate size. There are sorts of woolly lumps at the tens. These pictures are not of such frequent occurrence in my mind as formerly. The practice of working arithmetic has rather expelled them.

Since the foregoing remarks were first sent to the printer, many additional cases have reached me, which I regret to have no space left to include. One very interesting group consists of three cousins and the daughter of one of them. Another case was brought to my notice by a correspondent; it was published in the *Atlantic Monthly*, February, 1873, p. 199, with an accompanying diagram, and is signed by Miss H. R. Hudson. I have little doubt that many allusions to the faculty of visualising numerals in diagrammatic and coloured shapes might be found to exist scattered here and there in various books.

Of the many results to be drawn from the foregoing extracts, I do not at present care to dwell upon more than these. In the first place I am sure that all will agree with me in saying that the descriptions bear evident marks of careful and trustworthy observation. In the second place, although they refer to characteristics which the majority of my readers may not possess, their language is sufficiently clear to convey a good idea of what is meant to be conveyed. In the third place, these independent statements powerfully corroborate and explain one another. Therefore, although philosophers may have written to show the impossibility of our discovering what goes on in the minds of others, I maintain an opposite opinion. I do not see why the report of a person upon his own mind should not be as intelligible and trustworthy as that of a traveller upon a new country, whose landscapes and inhabitants are of a different type to any which we ourselves have seen. It appears to me that inquiries into the mental constitution of other people is a most fertile field for exploration, especially as there is so much in the facts adduced here, as well as elsewhere, to show that original differences in mental constitution are permanent, being little modified by the accidents of education, and that they are strongly hereditary.

I trust, therefore, that the publication of this memoir may prove to be the means of inducing some persons to furnish me with information of the kind I am now seeking. I want to hear of well-marked and properly-authenticated instances of persons who are able to recall, or represent to their imagination, with great vividness, either sights, sounds, smells, or tastes, and to obtain information that may throw light on the peculiarities of the representative faculty in different families and races.

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ON A MODE OF EXPLAINING THE TRANSVERSE VIBRATIONS OF LIGHT

THERE has been considerable difficulty in arriving at a satisfactory conception of the means by which the transverse vibrations of light are produced in the ether. In the attempt to surmount this difficulty some have gone so far as to conjecture that this structure of the ether must resemble that of a *solid*; for it was imagined that nothing but such a structure could propagate transverse vibrations. Yet the supposition of the ether being anything like a solid appears to be in direct antagonism to the evidence of our senses; for we move about so freely in this "solid" as to be unconscious even of its existence.

My object here is to direct attention more especially to a suggestion thrown out by the late Prof. Clerk Maxwell in regard to this point. This suggestion is contained in the article, "Ether," in the new edition of the "Encyclopædia Britannica," in connection with a notice of a theory of the constitution of the ether (considered in special relation to the problem of gravitation) by the present writer, and published in the *Philosophical Magazine* for September and November, 1877, and February, 1878. After referring to the fact that the present writer "has supposed that the ether is like a gas whose molecules very rarely interfere with each other, so that their mean path is far greater than any planetary distances," Prof. Maxwell continues as follows:—

"He has not investigated the properties of such a medium with any degree of completeness, but it is easy to see that we might form a theory in which the molecules[1] [atoms of ether] *never* interfere with each other's motion of translation, but travel in all directions with the velocity of light; and if we further suppose that vibrating bodies have the power of impressing on these atoms of ether some vector property (such as rotation about an axis) which does not interfere with their motion of translation, and which is then carried along by the atoms of ether, and if the alternation of the average value of this vector for all the atoms of ether within an element of volume be the process which we call light, then the equations which express this average will be of the same form as that which expresses the displacement in the ordinary theory."

There is one point in the above suggestion I would briefly remark upon, viz., the supposition made by Prof. Maxwell that the atoms of ether "*never* interfere with each other's motion of translation" [*i.e.*, never encounter each other]. This supposition seems to have been called for by the fact previously mentioned in the same article ("Encyc. Brit.," p. 572), viz., that "the ether transmits transverse vibrations to very great distances without sensible loss of energy by dissipation," whereas it is contended that if the ether atoms encountered each other (frequently at least), "the energy of the regular vibrations would be frittered away into that of the irregular agitation which we call heat." But I would venture to suggest that, as we have no proof that no dissipation *whatever* of the energy of light takes place in long distances (but perhaps even some indication to the contrary), it would appear evident that no necessity really exists for supposing that the atoms of ether *never* interfere with each other's motion of translation. I think it will be admitted as a reasonable conclusion that so long as the dissipation of the energy (of the light) attendant on the mutual encounters of the ether atoms is no greater than observation allows us to suppose it to be, all conditions are satisfied. Moreover, it would seem that to suppose the ether atoms *never* to interfere with each other's motion of translation would be equivalent to assuming that their mean path is *indefinitely* great, which appears to involve the assumption that the atoms have no finite size or dimensions, which would put a difficulty in the way of a satisfactory or consistent conception of matter. On this ground I would therefore suggest that the atoms of ether may be considered to have a reasonably long free path [which may be conceived as great as we please, by simply conceiving the atoms small], and thus the dissipation of the energy of the light may be reduced within the limits required by observation. This does not alter in the least in its essential details the above suggestion by Prof. Maxwell as to the mode of production of the transverse vibrations of light, which I would accordingly enlarge upon and elaborate somewhat here (in connection with the special structure of gross matter required by the physical theory of gravity). First it is important to observe that many observed facts lead us to infer that gross matter (probably the molecules[2] themselves) possesses a more or less *open* structure (or possesses a high degree of porosity). The transparency of some bodies, the free passage of the magnetic disturbance through all bodies,

[1] I merely substitute "atoms of ether" in the above passage for "molecules," to avoid any possible ambiguity, as the word "molecules" is often applied to the parts of gross matter.

[2] This is also in harmony with the modern theory of vortex-atoms.

and many other well known independent facts render this inference necessary. The fact that gravity is proportional to mass, on the basis of the dynamical theory (first started by Le Sage) also renders it essential to conclude that gross matter possesses an open structure [so that the atoms producing gravity can penetrate and act upon the interior of bodies]. If we admit this, and figure to ourselves the streams of ether atoms passing in all directions freely through the open structure of gross matter, and further, if we conceive the molecules of gross matter to be in a state of vibration (of regular periods, as proved by the spectroscope), then it is evident that these streams of ether atoms during their passage can, from the very nature of the case, be solely effected by the *transverse* component of the motion of the molecules of the luminous body. It is much as if the meshes of a sieve were in vibration, and a continuous stream of fine particles of sand (impelled by a current of air) were urged through it, when in however many different directions the filament forming the meshes of the sieve might be conceived to be vibrating, the sand particles that passed through in the onward stream could be only affected by the *transverse* component of the motion of the meshes. So the atoms of ether in their passage through the vibrating molecules of gross matter are solely affected by the *transverse* component of the motion of the molecules. The ether atoms passing through the open structure of gross matter would be thus periodically deflected (or the ether atom itself thrown into vibration or rotation), and as the transverse impulses (whatever their exact nature) thus received by the stream of ether atoms would be perfectly ryhthmical or periodic, in harmony with the known periodic vibrations of the molecules through which the ether atoms pass, the *transverse* pulsatory or periodic nature of light would thus be produced. This view would also seem to be capable of surmounting in a very simple manner the difficulty that there has been in conceiving how the ether can transmit transverse vibrations to great distances without sensible loss of energy by dissipation. For it is evident that an ether atom after having passed through a luminous body and received energy from it, would have nothing [1] to give that energy (say vibration or rotation) to during its transit, since, by assuming the ether atom small, we may conceive its mean path as long as we please; so, therefore, the energy carried by the ether atom from the luminous body could not possibly be dissipated during the transit of the atom, but this energy would be carried intact by the ether atom (through its normal motion of translation) until the distant object is reached, where the energy is given up in the form of heat and light. The normal motion of translation possessed by the ether atom performs the part of simple carrier of the energy received by the atom from the luminous body.

It might possibly be thought at first sight that this theory had some resemblance in principle to the emission theory of light, but this is evidently not the case, as no atoms are emitted by the luminous body, but simply the atoms of ether in their normal state of translatory motion pass through objects in streams equally in all directions —the ether being regarded simply as a gas (according to the modern kinetic theory) with atoms of very long free path. It is a known mathematical fact that no consequence how close the atoms of ether may be together (*i.e.*, no consequence how many in unit of volume) their mean path may become as great as we please, by simply conceiving the atoms adequately small. It further follows from the known principles investigated in connection with the kinetic theory of gases, that these atoms will of themselves automatically adjust their motions so as to move with perfect uniformity or *equally in all directions;* this adjustment being of such a rigid character that if the atoms were imagined to be disturbed or made to move in the most chaotic manner, they would, when left to themselves, instantly correct the irregularity, and return to the above regular form of motion, *i.e.*, so that the atoms move *equally in all directions.* It follows from this, therefore, that if we take any given point (such as where a luminous body is situated), the atoms of ether will "radiate" from and to this point along all the imaginary radii of a sphere described from this point as a centre; so that those ether atoms which have passed through the luminous point (and have carried energy off with them) will diminish in number (per unit of spherical area) as the *square* of the radial distance from the luminous point, the energy, therefore, diminishing in the same ratio, which is the "law" of light. The "law" of gravity (which is found also to diminish as the *square* of the distance) may be accounted for on the same principle.

It has been shown by the present writer (in the papers published in the *Phil. Mag.* previously alluded to) that in accepting Le Sage's ingenious sheltering principle as the fundamental basis of the explanation of gravity, there is no necessity for admitting any of his postulates regarding the particular motions of the atoms (corpuscles) required to produce the result. For it may be shown that the whole of the conditions requisite for gravity will automatically fulfil themselves by simply admitting the existence of a body in space, constituted according to the kinetic theory of gases (and whose atoms have an adequately long free path). There is no necessity to suppose, with Le Sage, the existence of "ultramundane corpuscles," or that the atoms producing gravity come from outside the bounds of the visible universe, so that a continuous supply of matter from without is necessary to maintain gravity within the confines of the visible universe. On the contrary, the conditions are satisfied by merely supposing the universe to be immersed in a gas, which, *as a whole* (like any other gas) is at rest. The motion (in streams) requisite for gravity takes place solely *within the range of free path* of the atoms of the gas; just (as is known) in every ordinary gas the atoms within the range of free path are moving in streams equally in all directions. The only difference is that in the case of the ether, on account of the smallness of the atoms (which is in harmony with their high velocity), the range of free path is great—equal to the range of gravity. We have no proof that the range of gravity extends across stellar distances, and there is clearly no necessity for assuming it to prevail over greater distances than observation warrants. By the explanation of gravity by the physical theory, the remarkable and anomalous distinction between *two kinds* of matter ("ponderable" and "imponderable") vanishes. Matter is shown of its essence to be all alike, "ponderability," or the tendency to approach, not being an occult or magic quality, but simply an effect dependent on differing dynamical conditions,[1] and the variation of the intensity of which as the *square* of the distance it is as necessary to account for dynamically as in the analogous case of light.

It appears, therefore, from the above considerations, that the same medium shows itself to be capable of accounting for, in their essential groundwork, the phenomena of both gravity and the propagation of light. The theory of gravity is based upon the well-known sheltering principle of Le Sage, which has already found favour with some eminent physicists. The normal translatory motion of the atoms of the medium produces gravity, and this motion serves as a vehicle for the propagation of light, while the light itself consists in the

[1] This holds equally true, whether we conceive space as empty, or space to be filled with a perfect (frictionless) liquid that *plays the exact part of empty space*, in so far as it is known to be impossible to operate upon or communicate energy to such a liquid.

[1] The fact of the property of "ponderability" having been attributed to gross matter as an occult quality (not an effect depending on dynamical conditions), has naturally brought the ether—which does not possess this property—into direct contrast with gross matter, as if it were an anomalous substance, of its essence distinct from gross matter. This circumstance has no doubt naturally contributed to produce a distaste for the study of the ether and to cause some to treat this magnificent physical agent as if it were desired rather to ignore than to take a rational interest in its existence.

abnormal *transverse* disturbance produced in the streams of atoms in their passage through the vibrating molecules of luminous bodies.

Finally, it may be shown that, quite independently of any consideration of the effects of gravity and light, the inference is a necessary one that the constitution of the ether must in principle be that of a gas, because this solution to the problem of the constitution of the ether exhausts the limits of the conceivable: *i.e.*, if any *rational* solution to the problem or *explanation* capable of appreciation by the reason exists, then it would follow that this must be the true solution to the problem. This will become more and more evident on reflecting on the subject. For it is clear that a motion *in straight lines* is the only motion possible to particles of matter moving freely in space; for particles of matter cannot of themselves change the directions of their motions. They can only do this at their encounters. Hence the inference is necessary that the particles of ether move *in straight lines* (and therefore that the ether is constituted as a gas). Hence in principle it seems apparent that the above is essentially the only conceivable solution of which the problem of the constitution of the ether admits. It seems remarkable that this fact (important as it is) is not more generally recognised and appreciated. Can this be referable in any way to the influence the theory of "action at a distance" has had, and that the endless empty and profitless speculations arising therefrom have diverted attention from the subject?

It might be said that we have expressly assumed the existence of "particles" (or atoms) of matter in the above result as to the constitution of the ether, whereas some might contend that the ether is not *atomic* at all My answer to this is, that unless we assume the ether to be atomic,[1] we cannot give any explanation of its properties, and these properties can exist solely in virtue of the explanation that underlies them. In connection with this the following remark of Prof. Clerk Maxwell ("On the Dynamical Theory of Gases," *Phil. Trans.*, 1867, p. 49) may be quoted, as to the point:—

"In certain applications of mathematics to physical questions, it is convenient to suppose bodies homogeneous, . . . but I am not aware that any theory of this kind has been proposed to account for the different properties of bodies. Indeed, the properties of a body supposed to be a uniform *plenum* may be affirmed dogmatically, but cannot be explained mathematically."

Hence to assume the ether to be anything else than *atomic*, would be to affirm its properties "dogmatically." If we avoid this, therefore, we must consider it *atomic* (and therefore a gas): for (as we pointed out), atoms in free motion can only move *in straight lines*. It is of course evident that, unless the atoms of ether be *in motion*, we cannot account for any of its properties, unless, indeed, we resort to the now practically defunct theory of "action at a distance," and assume the atoms to be endowed with mysterious and occult powers, which renders any *explanation* impossible, and only increases instead of diminishing the difficulty.

To illustrate somewhat further the insuperable nature of the difficulty involved, unless we assume the atoms of ether to be in motion in their normal state, I quote the following passage from a lecture by Prof. Tait on "The Position and Prospects of Physical Science," delivered November 7, 1860 (p. 15 in pamphlet):—

"If we suppose it [the ether] to consist . . . of detached particles . . . we are met by the further difficulty, *how* do these particles act on each other, and without some such action there could be no transmission of motion—they are not in contact, there must therefore be something between them to convey the effect. This appears certain, for how can action be conceived as exerted across empty space?"

I will merely here remark parenthetically that the fact appears to have escaped notice here that this difficulty is got over by assuming the particles (of ether) to be *in motion*; for then the particles can act on each other by direct impact without the necessity for anything "between them to convey the effect." The passage goes on to say:—

"We must, therefore, have a second medium to fill the interstices between the particles of ether. If this again consist of detached particles, there will be a third required that these may act on each other—and so on. If, then, we would not have an infinite number of different kinds of matter in each element of space, we must suppose one of these—say the ether itself—to be *continuous*, that is, not consisting of ultimate parts. *How* vibratory motions could be transmitted through such a substance, it is difficult to imagine—the whole subject is beset with overwhelming difficulties."

In the above passage the difficulties that attend the assumption of the ether being a *continuous* substance, or uniform *plenum*, are well illustrated. It will be seen that the main dilemma vanishes by assuming the particles of ether to be *in motion* in their normal state. Indeed, this is evidently the only conceivable way of solving the difficulty.

I would, therefore, venture to suggest that the result above arrived at as a solution to the problem of the constitution of the ether might be worthy of the attention of physicists, especially in its bearing on the explanation of gravity (on the basis of Le Sage's fundamental principle now recognised by several eminent authorities, including Sir W. Thomson)—also in relation to a mode of explaining the *transverse* vibrations of light, the main idea involved in which was suggested by Prof. Clerk Maxwell.

Addendum.—I may mention that I have lately received a book ("Das Räthsel von der Schwerkraft"—Wieweg und Sohn, Braunschweig) through the kindness of the author, Dr. Isenkrahe, of Crefeld, where a theory is applied to the constitution of the ether and to gravity, which resembles in some points that adopted by the present writer. This book bears date 1879, but the MS. was prepared earlier (1877). I may note that a book, "Physics of the Ether" (E. and F. N. Spon), was published by me in 1875, where in principle the same theory of the ether as here given is developed, though it was not applied by me to gravity until 1877. The work of Dr. Isenkrahe contains, in addition, a valuable description and criticism of the various attempts to solve the problem of gravitation. Perhaps I may append, for the benefit of those who are interested in the question, the references to some of the chief of these here, viz.:—

Huyghens' "Discours sur la Cause de la Pesanteur." Leyden, 1690.

Le Sage's theory 1764, given in "Deux Traités de Physique mécanique," by Pierre Prevost.

Sir W. Thomson's development of Le Sage's theory, Royal Society of Edinburgh, 1872, and *Philosophical Magazine*, May, 1873.

Schramm, "Die allgemeine Bewegung der Materie als Grundursache der Naturerscheinungen," Vienna, 1872.

Secchi, "Die Einheit der Naturkräfte" (German edition). Leipzig, 1876.

These facts may show an awakening to the importance of the problem of gravitation, and I may conclude with

[1] It is almost needless to add that the vortex-atom theory is essentially an *atomic* theory. Although it assumes a perfect liquid to fill all space, yet this liquid (outside the portions of it that form the atoms) plays the part of pure space, since it is impossible to communicate energy to the liquid outside the atoms, or to act upon it at all. It is therefore (as far as practical effects are concerned) as if the liquid exterior to the atoms did not exist. The vortex-atom theory does not, therefore, essentially alter (as some might be disposed to imagine) the conceptions of the ancients of indestructible atoms surrounded by space in which they can freely move. The main purpose of the vortex-atom theory is to prove dynamically how atoms can be "*elastic*," and be capable of executing regular vibrations as the spectroscope proves (and actually measures the number of vibrations executed per second, in the case of the molecules of gross matter).

the words of Dr. Isenkrahe [translation]: "One is beginning to recognise that physics has been quietly sleeping for two centuries upon [in the words of Newton] 'a great absurdity,' for which no one less than Newton can be made responsible" [page 125].

S. TOLVER PRESTON

THE NATURAL HISTORY OF THE TRANSIT OF VENUS EXPEDITION[1]

IN 1870 one of our correspondents called attention[2] to the favourable opportunity that would then shortly present itself for the exploration of some very little known parts of the earth's surface. Some of the positions selected by our astronomers for the observation of the Transit of Venus of 1874 were in little known islands of the Pacific and Indian Oceans, and it was pointed out that the addition to the astronomers' staff of a small corps of naturalists would not materially increase the expenditure, and would possibly lead to very interesting scientific results.

The same subject was brought before the notice of the British Association at their Meeting in 1871 by Mr. Sclater,[3] who likewise suggested that so good a chance of adding to our knowledge of the natural history of some of the least known parts of the world should not be thrown away, and urged that Naturalists should be appointed to at least three of the stations to be occupied by the astronomers, namely Kerguelen Island, Rodriguez and the Sandwich Islands.

Subsequently the same idea was taken up by the Council of the Royal Society, who resolved to request the Treasury to attach naturalists to the expeditions destined for the two first above-named localities—"two of the least explored and most inaccessible islands in the southern hemisphere"—and appointed a committee consisting of Sir Joseph Hooker, Prof. Huxley, and Mr. Sclater, to prepare the necessary application to the Government for this purpose. We need not now repeat the arguments which these gentlemen brought before Her Majesty's chief advisers—it is enough to say that they were of a sufficiently cogent character to obtain the sanction of the Treasury to the appointment of four naturalists for the purposes required; three for Rodriguez and one for Kerguelen's Land.

The gentlemen selected for the work by the Council of the Royal Society were for Rodriguez, Mr. George Gulliver, Dr. I. B. Balfour, and Mr. H. H. Slater, and for Kerguelen's Land the Rev. A. E. Eaton. Mr. Gulliver was directed to investigate the fauna of Rodriguez generally, Dr. Balfour was charged with the duties of botanist and geologist, and Mr. Slater was set to dig out the caves of the same island, and to collect the fossil remains of extinct birds known to be imbedded in them. Mr. Eaton was thought to be specially qualified to investigate the fauna and flora of Kerguelen's Land, as having been previously naturalist to one of the Arctic expeditions.

The collections and observations made by these naturalists fulfilled, as we are informed, the expectations of the Council. The results of them are given in the present work, which is issued as an extra volume (No. 168) of the *Philosophical Transactions*.

The plan upon which the collections were worked out, and which is in fact the only plan upon which a mass of heterogeneous materials can be properly worked out now-a-days, is an admirable one. The different objects were assigned for examination to experts in different branches of science, each of whom has prepared his own report on what was submitted to him. These reports, prefaced by a few introductory remarks, and illustrated by notes of the collectors, constitute the volume now before us. It is divided into two sections, the first relating to Kerguelen, and the second to Rodriguez.

After a chapter by Mr. Eaton on the physical features of Kerguelen, and on the previous visits to it by naturalists, we find a series of essays on the botany by Sir J. Hooker, Mr. Mitten, the Rev. J. M. Crombie, Dr. Dickie, and other well-known authorities. Then follows a similar series of memoirs upon the zoology of the same island.

The zoological and botanical collections made in Rodriguez are next treated of in the same way, and we have here also a valuable memoir on the petrology of Rodriguez by Mr. N. S. Maskelyne. From the last-named essay it turns out that the notion that this island consists of "granite overlaid with limestone, and other recent rocks," which was entertained by the Committee of the Royal Society, misled by previous inaccurate observations, is altogether erroneous. Mr. Maskelyne tells us that "the numerous specimens illustrating the rock formations of the Isle of Rodriguez, collected by Mr. I. Bayley Balfour from different localities, need only a cursory inspection to attest the volcanic character of the whole mass of the island.

"Rodriguez, in fact, consists of doleritic lavas that appear to have been poured out at a considerable number of volcanic orifices at successive periods. It would be difficult, without more minute description of the physical geography of the island than is accessible, to assign any precise date of duration to these volcanic eruptions, or to trace with any certainty the degree to which, and the mode in which, subsequent denudation has helped in giving the island its present remarkable aspect.

"But the fact of that denudation and the degree to which alteration has proceeded in affecting the minerals composing rocks that by their position must have been among the later of the out-poured lavas, would point to a remote date, possibly to one contemporary with the tertiary period, as that of the volcanic activity of Rodriguez."

We have not space here to go separately into the numerous essays that compose this work. For many of them, the name of the author is quite sufficient to assure us of their excellence, some of the most accomplished naturalists of the present epoch having contributed to the volume. But it is quite evident that a thoroughly good and satisfactory piece of scientific work has been thus accomplished at a very small cost, and that the council of the Royal Society, who planned the whole scheme and carried it out, and especially those two members of it (Sir J. Hooker and Dr. Günther), who have so efficiently edited this account of the results attained, are entitled to the warmest thanks of all naturalists. Several other nations sent out expeditions to observe the Transit of 1874, and likewise had naturalists attached to their staffs, who have published some valuable observations. But nothing like the handsome and solid volume now before us, with its fifty-five admirably executed lithographic plates, has been produced on this occasion in France, Germany, or America. There are certainly some advantages in having a Royal Society at the head of Science instead of a Royal Academy!

Having said this much, we will venture on two small criticisms:—First, it is a great pity that there are no *maps* given in the volume now before us. Without reference to maps it is not possible to appreciate the significance of many of the observations made by the naturalists, and as no generally available atlas contains charts of such obscure islets as Rodriguez and Kerguelen, maps ought to have been attached to the work itself. In fact, every zoo-geographical memoir now-a-days ought to be illustrated by a map.

[1] "An Account of the Petrological, Botanical, and Zoological Collections made in Kerguelen's Land and Rodriguez during the Transit of Venus Expeditions, carried out by Order of Her Majesty's Government in the Years 1874-75." *Philosophical Transactions* of the Royal Society of London, vol. clxviii. Extra volume, 1879.

[2] See article on the Transits of Venus in 1874 and 1882. NATURE, vol. i., p. 526.

[3] See "Remarks on a Favourable Occasion for the Establishment of Zoological Observatories." By P. L. Sclater, M.A., Ph.D., F.R.S. Rep. Brit. Ass., 1871, pt. ii., p. 134.

Secondly, it is unfortunate that naturalists were not likewise sent to Oahu, in the Sandwich Islands, where there was likewise an astronomical station in 1874. The Sandwich Islands, as was pointed out by our correspondent in 1870, are the seat of a most peculiar indigenous flora and fauna, which is now fast perishing beneath the assaults of European weeds and animals introduced from other countries. Dr. Finsch, who was lately at Honolulu on his way to the Northern Pacific, tells us (*Ibis*, 1880, p. 79) that during a week's stay in that city and its vicinity, he saw *no birds* except introduced species, and had to go far into the interior to obtain examples of the indigenous Avi-fauna, and that the "native forests are going in the same way." It is a great misfortune, then, that this should happen before we have any good account of this peculiar flora and fauna which rivals in eccentricity even that of the Galepagos. And as another Transit occurs in 1882, we trust that should our astronomers again visit any one of the Sandwich Islands group, a staff of efficient naturalists will be sent in their company.

ARTIFICIAL DIAMONDS

UNDER the heading of "The Crystallisation of Carbon" Mr. Crookes writes as follows in the last number of the *Chemical News*:—

Since sending the telegram[1] announcing that carbon crystals, apparently diamond, could without difficulty be produced from any carbon compound, Mr. Mactear has sent me several specimens of his supposed artificial diamond. He has also called upon me with other specimens, and has explained the whole process by which he obtains such remarkable results. As, however, he has sent to the Royal Society a paper which will probably be read in the course of a week or two, I am not yet at liberty to give details of the process.

The general character of the specimens now in my possession may be described as irregularly shaped masses from 1 mm. downwards in diameter, with rounded angles, and showing no definite crystalline appearance. They are whitish looking, translucent, and as a rule lustreless; many pieces are almost spherical and appear like fragments of corundum which have been water worn. Amongst these are perfectly clear fragments larger in size, some being 3 or 4 mm. across, having a conchoidal fracture exactly like glass.

In a paper "On Molecular Physics in High Vacua," read before the Royal Society in March last, and now being published in the *Philosophical Transactions*, I referred to the remarkable power possessed by the molecular rays in a high vacuum of causing phosphorescence in bodies on which they fall, and I remarked that the only body which surpassed Becquerel's luminous sulphides both in brilliancy and variety of colour is the diamond. Most of these gems, whether cut or in the rough, when coming from the South African fields, phosphoresce of a brilliant light blue colour. Diamonds from Brazil shine with different colours, such as bright blue, pale blue, apricot, red, yellowish green, orange, and light green. A beautiful collection of diamond crystals, kindly lent me by Prof. Maskelyne, phosphoresced with nearly all the colours of the rainbow, the different faces glowing with different shades of colour. On receiving the specimens from Mr. Mactear, I immediately submitted them to the molecular discharge. The following are the results I have at present obtained:—

In a high vacuum the specimens phosphoresce brightly of different colours—pale blue, orange, apricot, and yellowish green. The clear glassy fragments are also phosphorescent. The appearance of the phosphorescence is very similar to that shown by small, rough diamonds from Brazil, called in the trade "Boart;" indeed, had I not known the history of the fragments in my tube, I should, from their appearance, have said that they were small fragments of Brazilian Boart.

The opaque rounded appearance of the fragments is unlike that of the natural diamond, but by heating a rough diamond before the blowpipe until it has partly burnt away, it assumes a very similar appearance to that of Mr. Mactear's crystals, and it is therefore not unlikely, from their mode of preparation, that these crystals have undergone partial combustion after their formation—a fact which would explain this difference in appearance. Other specimens having been placed by Mr. Mactear in competent hands, with a view of determining their hardness and chemical properties, I have refrained from making experiments in this direction. W. C.

[1] *Chemical News*, vol. xl. p. 306 (December 26, 1879).

We append a letter on the subject from Prof. Maskelyne in the *Times* of the 8th inst.:—

As I know that a portion of the public is very much interested in the diamond question, and in the result of the interview Mr. Mactear announced that he and I were to have in connection with it, I think, perhaps, it will be well to say that I have had the pleasure of working with that gentleman many hours yesterday and to-day, and that our results so far convince me that, while my own conclusions, as announced in the *Times*, are borne out as regards at least the portion of the substances on which I worked, there are other portions of those substances that differ from these in properties and still require investigation; that, in fact, the material is a mixture of different bodies. When I say that I have as yet no evidence of the existence of crystalline carbon, whether as diamonds or in some other condition, among these bodies, I feel that Mr. Mactear makes a reasonable request of me in asking that I should invite a suspension of opinion regarding a discovery he believes that he has made. A portion of the material he has produced is very hard, and, I believe, bears out his claim to have scratched topaz and sapphire. Mr. Mactear wishes me to add that the diamond has been also abraded by his product and to inclose to you a certificate to that effect. Mr. Mactear wishes me also to state that he claims simply to have produced a crystalline form of carbon irrespective of the question of whether this is the diamond.

I am, Sir, your obedient servant,
NEVIL STORY-MASKELYNE

British Museum, January 7

We may state that in the *Times* of the same date is a certificate from Mr. L. Boston, of Glasgow, that he has been able "to scratch a diamond and to engrave two rubies, two sapphires, an amethyst, and a cairngorm" with Mr. Mactear's "crystallised carbon sand."

THE "TIMES" ON BRITISH BIRDS

NATURALISTS live a life of surprises, but the surprise with which ornithologists must have one day last week received certain positive assurances of the leading journal would surely overstep the bounds of ordinary astonishment. We have, no doubt, been passing through a "silly season" of unwonted severity, as the morris-dance of late performed by many of the pseudo-ornithological correspondents of the *Times* proves; but a recent leading article in that journal eclipses all else that it has published on the subject.

After declaring that "our birds are the glory of the land," and piously ascribing that glory to the upper regions, the writer goes on to compare England with France in the matter of its birds, saying, of course, nothing that was not quite well known before, except the extraordinary statement that "France has produced ornithologists, but they have had to leave her shores." The meaning of this is entirely beyond us, for every one knows who cares to know that France now possesses a large number of ornithologists—and one indeed, M.

Alphonse Milne-Edwards, who on some points is the greatest ornithological authority that has ever lived. We are then told of an Oxford undergraduate who "took a walk with his gun in Bagley Wood and brought home fifty different specimens which he carefully stuffed." "He had a museum," it is added, "of several hundreds." We are not told whether this Oxford undergraduate's conduct is worthy of praise or blame, nor would it much signify, for the writer is evidently confused in his notion of "specimens" and "species." To kill specimens of fifty different *species* in one day and in one wood, though not easy, could no doubt be done in many places, but it would be hard to kill fifty birds that were not different *specimens!* Would the writer also be surprised to learn that "a museum," or a collection, as people nowadays more humbly style it, "of several hundreds," was some fifty years ago by no means uncommon, and that of late years private collections include not only thousands of specimens, but thousands of species?

But now comes the most astonishing assertion of all. We are told that "Mr. Morris describes more than twelve hundred birds," and that there may be no mistake in the writer's meaning, he subsequently repeats the statement in this wise: "Of the twelve hundred British birds, a good many are represented by a single stray specimen," and so on! The ornithologists of this country have hitherto been deemed by their continental brethren somewhat too hasty in enrolling as "British" every chance waif from foreign lands and seas that has had the ill luck to show itself (and of course be shot) within the limits of the United Kingdom, and we have never understood that on the most liberal interpretation of the expression, "British birds," the number has exceeded four hundred. How blind and inefficient have they been when they have omitted more than two-thirds of the species that occur here! It is really to be hoped that the writer of the leading article on English birds in last Thursday's *Times* will bring them to a due sense of their neglected duties by furnishing a list of the 800 species whose rights of citizenship have been so shamefully ignored, and if he will at the same time say in which edition of Mr. Morris's work "more than twelve hundred" British birds are described, he will possibly contribute to a more comfortable understanding of the matter, for Mr. Morris has hitherto been supposed to follow very closely the late Mr. Yarrell in the information he gives, so that when the latter in his last edition included 354 species, the former a few years later made the number 358!

There are many other assertions in the same article which excite a degree of amazement inferior only to the last particularised, and we have heard persons suggest that the writer must have been all the while perpetrating a solemn joke.

EDISON'S ELECTRIC LIGHT

THE *Times* New York correspondent gives some interesting details in Monday's paper of Mr. Edison's new form of electric lighting and the steps by which he was led to its discovery. So far the light has withstood every test that has been tried, and so confident do the public seem that success has been attained at last, that the shares of the Edison Company have risen from 20 dollars to 3,500 dollars.

The Philadelphia correspondent of the same journal gives some further information in yesterday's issue. Probably 200 people make up the population of Menlo Park, we are told, nearly all Edison's workmen and their families. He gets an income of 40,000 dollars to 50,000 dollars a year from his various inventions, and he spends it all, the most of it for machinery and wages, and the balance in charity. The correspondent then gives some interesting details concerning Mr. Edison, his habits, his enthusiasm, and his relations with his numerous employés. There is no discipline enforced or any apparent time-table for work, yet with all hands it seems a labour of love, and if you pick out from the crowd the grimiest and most woe-begone of the whole party of overworked alchemists it will be Edison himself. It appears to have been the system at Menlo Park, as with the alchemists of old, to do most of the work at night, and it seems the regular habit of Edison and his chief subordinates to work straight through the twenty-four hours without stopping, until tired nature compels them to drop down in any handy place and go to sleep. "We went there," the correspondent writes, "hoping that Edison had succeeded, but nevertheless sceptics, and we came away thorough believers. His lamps were burning when we arrived, and they burnt continuously until our departure, excepting from half-past four to half-past five P.M., when about an hour's time was taken in putting in a new generator to do the work, which he had just finished and desired to try. During the daylight we could see the lamps burning, supplied by the first generator, and perceived that the little carbon loop or horseshoe giving the light remained intact. After dark, when the second generator went to work, we saw for three hours the lamps successfully burning as a complete substitute for gas for every purpose for which illumination was necessary at Menlo Park. The gas jets were idle, being put out of use by the steadier and more genial glow of the electric light. We ate our supper by it in the little restaurant that has been established at the Park, and I sat down in Edison's office under two of his lamps attached to a gas bracket and wrote the rough draft of the telegram sent to the *Times*. In this room a telegraph operator worked in a corner with an Edison lamp in a movable table stand illuminating his work. Down stairs his bookkeeper was paying off the hands by the aid of two more electric lights on a gas bracket. Out in the roadway in front of the building two street lamps were set up with the Edison light in full operation. In his workshop the engineer was running his engine and a couple of men watching the operation of the new generator by the light of more Edison's lamps, while in the laboratory some fifteen of them were giving light for various operations, and downstairs a young man sat at the regulator, and, watching another light, by the aid of the galvanometer, kept the flame steady, just as the regulator is worked constantly in the gas-house to adjust the gas pressure, so that it will compensate for turning lights on or off throughout the town. It was between seven and eight o'clock on a dark winter evening, and the electric light had put into disuse both the gas jets and the petroleum lamps that were in profusion around. I visited four dwellings in the village and saw the Edison lamps doing the work of illumination for all household purposes in each of them. In Edison's own house, where he had at least a dozen of them, we remained over half an hour, and I shall never forget the glee with which Edison listened to the reading of a newspaper slip, wherein an ambitious 'expert' offered to forfeit 100 dollars for every lamp that Edison could keep burning over twenty minutes."

NOTES

ON Friday, the 9th inst., the St. Andrew's University Court agreed to report to the Queen in Council in favour of an application by Prof. Swan to be permitted to retire, on the usual retiring allowance, from his Chair of Natural and Experimental Philosophy in the University, on the ground of failing health.

MR. E. W. COOKE, R.A., F.R.S., whose death at the age of sixty-nine years, took place at Groombridge on the 4th inst., deserves some notice in these pages for his connection in various ways with science. From his boyhood he had the keenest interest in natural history, and was probably one of the first amateur horticulturists. He was connected with most of our scientific societies, and was an early member and constant attendant at the meetings of the British Association. His first artistic work was botanical, the drawing of many hundred of the illustrations to London's "Encyclopædia of Plants," all drawn from living specimens. The professional work of Mr. Cooke as an artist was throughout an advancement of science through a channel which we have often had occasion to point out, is generally too independent of the claims of science, and suffers accordingly. Mr. Cooke's representations of natural objects, of plants and animals and rocks, were always scientifically accurate, and his coast scenes are in themselves a geological study. He was always ready to help other artists whose ignorance of natural science was apt to lead them into ludicrous blunders. He was, we believe, one of the first who ever attempted to grow ferns and tropical plants under conditions similar to those under which they are found in nature. Both at Kensington and at Tunbridge Wells his fernery and tropical garden were masterpieces in their way. For his eminence as a horticulturist and for his contributions to geological science by his series of pictures and drawings illustrating the principal geological features of the British Islands, Mr. Cooke was, in 1863, elected a Fellow of the Royal Society. His series of drawings of "Grotesque Animals," published a few years ago, afford a remarkable example of his intimate knowledge of comparative anatomy, as well as of his sense of humour. Mr. Cooke counted among his friends nearly all the leading men both in science and art.

Mr. William Alexander Forbes, B.A., F.Z.S., Scholar of St. John's College, Cambridge, has been appointed by the Council Prosector to the Zoological Society of London in succession to the late Prof. Garrod. Mr. Forbes, who is already well known for his contributions to scientific literature, obtained a first-class in the Natural Sciences Tripos at the late examination at Cambridge, and was designated as specially distinguished in the sciences of comparative anatomy and zoology.

We understand that, at the suggestion of several practical teachers of botany, a new piece of ground at the Royal Gardens, Kew, will, during the ensuing season, be set apart for the study of botany, and that students will, under certain regulations, be able to carry home specimens for examination. Papers recently read at the Chemical Society by Mr. Church on the respiration and transpiration of albino foliage, and at the Linnean Society by Mr. Marshall Ward on the embryology of phanerogams, were in both cases founded on observations made in the laboratory.

The *Journal of Botany* announces the death, at the early age of twenty-eight, of one of the most promising of the younger generation of physiological botanists, Dr. H. Bauke, of Berlin. His researches on cryptogams, and especially on the phenomenon of bilateralness in the prothallia of ferns, gave promise of a brilliant future.

The Fourth Annual Report of the Johns Hopkins University contains much that is of great interest. It gives a sketch of the foundation and plan of instruction of the University, showing how the latter has been based on the best ideas as to what ought to be the functions of a university. The system of fellowships at the Johns Hopkins institution is one calculated to encourage and call forth the best energies of the Fellows, and in the short career of the University the success of these fellowships has been fully shown. The University has the use of the magnificent library of the Peabody Institute of Baltimore, and in its own various laboratories much good work is being done. The University has contrived happily to combine teaching and research in such a way as to give students real help and yet leave the teachers ample time to carry on original work. The *American Journal of Mathematics* and the *American Journal of Chemistry* both emanate from this Institution, while special publications contain the results of biological work, and a long list of papers in various departments by members of the University is appended to the Report. We have also a long list of apparatus for scientific researches involving accurate measurements in the physical laboratory, and of some of the most important apparatus in the biological laboratory. Altogether from this Report it will be seen that the Johns Hopkins University is doing its best to carry out the noble purpose of its founder.

From the Twelfth Annual Report of the Peabody Institute of Baltimore, we see that the magnificent new buildings are now complete and occupied. It now forms one of the best equipped centres of culture in the United States.

In the *Bulletin* of the Paris Anthropological Society (tome ii. fasc. 3) M. J. Geoffroy gives a *résumé* of his great work on the knowledge and denominations of colour, in which he attempts to controvert the views of Magnus and Geiger, and those of Mr. Gladstone, which ascribe colour-blindness to Homer. On the grounds taken by these writers he insists that we should be equally justified in asserting that Corneille, La Fontaine, and others who happen not to mention in their works any one special colour, must have been blind to it; he considers that the delight taken by savages in bright colours is a sufficient proof that the sense of colour is not due to culture.

In the same number M. de Jouvencel draws attention to the curious circumstances that the Latin races by preference take the right side, where the Teutonic races, including our own, and that of Scandinavians, take the left. With regard to the former, he finds a sufficient explanation in the superstition of the Romans, who deemed all omens favourable which manifested themselves on their right side, and *vice versâ*; while the barbarian enemies of Rome may be assumed to have regarded as favourable to themselves whatever the Romans accepted as of evil portent. The Saxon races as masters of the sea and pioneers in the laying of railways, have imposed their own rules of the left side on the French and other Latin nations, who, however, still in driving, riding, &c., keep to the practice of their progenitors.

M. Zaborowski recently communicated to the Paris Anthropological Society his discovery, on the banks of the Lower Vistula, of certain sepulchral vessels of a kind never before described. At the depth of 50-80 centimetres below the surface he found cinerary urns filled with bones, in the midst of which were various objects in bronze, iron, and bone, and over each urn there was a cover, like an inverted bell, resting in some cases on a kind of stand, or plateau. He proposes to give to these singular urns the name of *tombeaux sous cloches*; of which outline drawings with full description of their form and size are given at pp. 337-8 of the *Bulletin* (t. ii. fasc. 3).

The *North American Entomologist* for August, 1879, contains a paper by Mr. A. R. Grote "On the Neuration in certain Genera of *Pyralidæ*," illustrated by a plate with outline figures of the neural characters of fourteen genera, which should prove of great service to students of *Lepidoptera*.

Mr. T. R. Archer Briggs, of Plymouth, announces the early publication of a Flora of Plymouth, including the Flowering Plants and Ferns growing within a distance of about twelve miles from the town. The almost unrivalled critical knowledge of our native plants possessed by Mr. Briggs will render this a valuable contribution to geographical botany.

Messrs. D. M'Alpine and A. N. M'Alpine announce the publication of a Biological Atlas, being a guide to the practical study of plants and animals, illustrating the characters of typical forms by drawings of the object, dissections, microscopic preparations, and diagrams, with explanatory text, specially designed for the London University, Science and Art, Medical, and other examinations, and for use in schools and colleges. The Atlas will consist of 24 plates, containing 423 coloured figures and diagrams, and is to be published by Messrs. W. and A. K. Johnston.

THE Göttingen Royal Society of Sciences offers a prize of 50 ducats for the best treatment, by new researches, of the question as to the processes of development of the adult echinoderm. In addition to what is known of the embryonal development of echinoderms, it must specially be shown how the animal grows from the larva form to the completed system of organs. It is open to competitors either to examine a characteristic kind of development-process in all its features, or by exhibiting the development of different forms, to establish a common behaviour for the whole; in the latter case, the chief agreements and divergences in the formation of the organic system in different forms of echinoderms must be indicated from their earliest occurrence. The Society re-propose their question as to the nature of the *unpolarised light-ray*, researches being desired which will bring conceptions as to natural light of any source, near, in definiteness, to those which theory associates with polarised light. Papers on these subjects have to be sent in before the end of September in 1881 and 1882 respectively.

THE Reale Istituto Lombardo offers prizes of various value in connection with the following among other subjects:—The climatology of Italy; Critical history of the telephone; Œnology, especially in ancient Italy; The nature of miasma and contagion; Motor centres of the cerebral cortex; Etiology of cretinism and idiocy; Demonstration by experiments, whether the generative matter of hydrophobia is a virulent principle or an organic germ; Elucidation of some facts of the macro- or microscopical anatomy of the human brain. Particulars with reference to these will be found in the *Rendiconti* of the Institute (vol. xii. fasc. xvii.-xviii.).

A GERMAN translation of Schiaparelli's work on the planet Mars has just been published by Herr Georgi, of Leipzig.

MR. SHRUBSOLE asks us to say that he will exhibit specimens of the diatoms he states he has found in the London Clay at the annual meeting of the Geologists' Association on February 6.

A SEVERE earthquake was felt at Coire, in the Grisons, early on the morning of the 7th inst.

DURING these last twenty years numerous complaints have been published or sent to the public authorities with regard to the organisation of the observatory of Algiers. This unhappy state of things has now come to an end. This establishment has been placed under the authority of the rector of the Academy, and a lectureship in astronomy has been created. The same decree has organised the several preparatory schools recently created by law. An Oriental Section has been organised, and the lectureship for Arabic existing in Algiers, Oran, and Constantine have been connected with it. Chairs for Mussulman Law, African Geography, African Antiquities or History, have been created by the same decree. M. Pomel, one of the Senators for the Algerian provinces, has been appointed director of the School of Sciences and Professor of Mineralogy in the same schools. He will be obliged to resign his senatorship.

MR. C. LLOYD MORGAN, Associate of the Royal School of Mines, F.G.S., Lecturer on Science and English Literature at the Diocesan College, Rondebosch, Cape Town, has been appointed Examiner in Natural Science at the Cape Town University.

WE have received the first number of the *Angler's Note-Book and Naturalists' Record*, a repertory of fact, inquiry, and discussion on field sports and subjects of natural history. It is a neat small quarto, and might serve a very useful purpose; the first number, however, contains far too many extracts from othe journals, many of them years old. The publishers are Satchell and Co.

THE *New York Herald* articles and telegrams relating to the new Edison light have created much sensation in Paris, and caused a fall of 3*l*. in the shares of the Compagnie d'Eclairage et de Chauffage par le Gas. It is said that the judicial authorities are engaged in an inquiry directed against the *Figaro*, which published the news with aggravating embellishments.

M. FERRY has taken an important resolution obliging students to make use of the magnificent opportunities afforded by the Jardin des Plantes. The professors of botany and natural history of the schools of medicine and pharmacy have been authorised to deliver their lectures in the amphitheatre of that establishment. A special commission has been created consisting of these professors and the professors of the museum. A new chair has been instituted of vegetable physiology, and M. Dehairain has been appointed professor. M. Dehairain has edited during a series of years the *Annuaire du Progrès des Sciences*, written by himself and a large staff of contributors selected from among the most popular scientific writers.

THE new number of the *Proceedings* of the Berwickshire Naturalist's Field Club is as varied and interesting as usual, with papers on the natural history, antiquities, folk-lore, and local history of the Border.

THE new volume of the "Year Book of Facts in Science and the Arts" (Ward, Lock, and Co.) is no improvement on its predecessor; it is solely the work of unintelligent scissors and paste, and no more represents the science of the year than a few clippings from a third-rate illustrated journal would do the art.

DR. SCHOMBURGK, the director of the Botanic Garden, Adelaide, has issued a little pamphlet "On the Naturalised Weeds and other plants in South Australia." As this writer truly says, "From the past and present constant intercourse with Europe and other parts of the world, and the abundant importation of seeds into Australia for agricultural and horticultural purposes, it is no wonder that a very great number of the weeds most troublesome at home are now naturalised in South Australia." It is shown that a point of interest might occur whether the altered circumstances which now seem to be so favourable to the growth of the acclimatised weeds will prove permanent, or, by a change effected by over-stimulation, whether degeneracy and subsequent extinction might not follow. Such an effect, however, is not yet observable, the growth being quite as luxuriant as they were eighteen to twenty-five years since. The list contains the names of many of our best, or worst, known weeds, some of which have so firmly established themselves that it is almost impossible to eradicate them. Thus the extension of *Onopordium acanthium* was so rapid that the Legislature passed an Act in 1862 for preventing the further spread of this plant as well as those of *Carduus marianus*, and *Xanthium spinosum*. "According to the Act every owner or occupier of land upon which, or upon the adjacent half of any road, the above-mentioned thistles are growing, is obliged in twenty-one days after notice, signed by any chairman of a Road Board or District Council, has been served upon such owner, to destroy the thistles on his land; otherwise he is liable to a penalty not exceeding ten pounds. The Government must, on all unoccupied Crown lands, employ the necessary labour to eradicate the thistles. This stringent measure it is true has decimated the plants, but without effecting the object desired. Although thousands of pounds have been spent for the purpose, the destruction of thistles is generally commenced too late to prevent the dispersion of the developed seed." The pamphlet, though composed of only thirteen pages, appears to have been hurried through the press, for numerous mistakes occur in the spelling both of the common as well as of the scientific names; thus we have Spury for Spurry, Cornwell for Gromwell, Torn-apple for Thorn-apple, *Hordeum murianum* for *H. murinum*, *Anthoxanthum oderatum* for *A. odoratum*, &c.

In four bone-caves of Upper Franconia different proportions of mammalian remains are met with ("Some Franconian Cave Faunas," by A. Nehring, in Report of Proceed. of the Imperial Geolog. Instit. Vienna, August 31, 1879). The bones of the older layers are darker in colour, and belong to the collared lemming and other decidedly arctic species. Bats are absent. This fauna probably existed at the end of the glacial period, when there were as yet few forests, or none, in the surrounding region. The bones belonging to a later period are lighter in colour, and indicate a post-glacial forest-fauna, mingled with a few arctic species. Bats requiring a temperate climate are abundant. These more delicate remains may have been brought to the caves by owls. This later cave-fauna of Upper Franconia agrees with that of Balve in Westphalia.

In the United States a series of experiments has been made by the Ordnance Department in the use of the telephone to assist in determining the time of flight of small-arm projectiles, which has hitherto been a matter of great difficulty at long ranges, owing to the impossibility of seeing them strike. One telephone was placed within a few feet of the gun, and the other (both being provided with Blake's transmitters) in the shelter, about thirty feet in front of the target. The telephone being placed to the ear, a stop-watch, beating fourths of a second, was started at the moment of firing, and stopped on the bullet striking. The observations founded on a large number of experiments never differed more than a quarter or half of a second from each other, the slight delay in starting the watch being neutralised by the delay in stopping it. It was found that the time of transit was affected by the wind, being shortened by a rear and lengthened by a head wind.

From the Canaries we continue to receive the *Revista de Canarias*, which we are pleased to see has reached its twenty-third number, and still continues to devote a fair amount of its space to science.

A second edition of Mr. W. H. Penning's "Text-Book of Field Geology" has been published by Baillière, Tindall, and Cox, with several additions and improvements.

It is stated that a seam of exceedingly good coal has been opened up on the Irwin River in Western Australia. Its existence appears to have been known, though no attempt had been previously made to work it.

M. Cochery, Minister of Postal Telegraphy, has asked from the French Parliament a credit of 320,000*l.* for establishing a subterranean telegraphic communication between the principal French cities and Paris. This resolution has been taken in consequence of the number of interruptions experienced in the aërial service during the present winter. For days the communication with Marseilles was conducted by a single line.

The number of the *Transactions* of the Asiatic Society of Japan which has just come to hand, contains several papers of interest from different points of view. Among these may be mentioned "Analyses of Surface Waters in Tokiyo [Yedo]" by Mr. R. W. Atkinson; "The Chemical Industries of Japan," by the same; "A History of Japanese Art," by W. Anderson; and notes by the Rev. J. Summers on Osaka, usually known to the outer world as the commercial capital of Japan.

The additions to the Zoological Society's Gardens during the past week include a Brown Bear (*Ursus arctos*), three — Snakes (*Tropidonotus tigrinus*) from Japan, presented by Messrs. James Veitch and Sons and Mr. Chas. Maries; an Arabian Gazelle (*Gazella arabica*) from Arabia, presented by Miss M. Murray; two Corean Pigs (*Sus sp. inc.*) from the Island of Quelpart, Corea, presented by Dr. Sydney Ringer; a Japanese Hawk Eagle (*Spizaëtus orientalis*) from Japan, presented by Mr. Harry Pryor, C.M.Z.S.; two Common Gulls (*Larus canus*), British, presented by Mr. George Weaver; a Robben Island Snake (*Coronella phocarum*), four Rufescent Snakes (*Leptodira rufescens*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Rhomb-marked Snake (*Psammophylax rombeatus*) from South Africa, presented by Mr. Eustace Pillans; three Oyster-catchers (*Hæmatopus ostralegus*), three Brant Geese (*Bernicla brenta*), British, purchased; a Yellow Conure (*Conurus solstitialis*) from Guiana, received in exchange.

OUR ASTRONOMICAL COLUMN

Winnecke's Comet.—The only known comet of short period due at perihelion within the present year is that discovered by Winnecke in March, 1858, which was soon found to be identical with the third comet of 1819, detected by Pons at Marseilles on June 12, having completed seven revolutions in the interval. Encke had shown that the observations in 1819, extending over thirty-six days, were best represented by an ellipse, with a period of 2052 days, or 5·618 years, but it is not upon record, so far as we know, that any serious attempt was made to recover the comet when with Encke's period it might be expected to be near perihelion, and thus it remained for Winnecke to find it again after a lapse of nearly forty years. The perturbations by Jupiter and Saturn during this period have been calculated by Clausen, with the view to fix the precise value of the mean motion at the perihelion passage in 1858 Another revolution would be completed in November, 1863, but the comet's track in the heavens under that condition is so unfavourable, that no observations were secured. At the next return in 1868, however, it was well observed, and again in 1875. The calculations for this comet are understood to be in the hands of Oppölzer, of Vienna. With his elements for 1875, the next perihelion passage, without having regard to perturbations which must be small in the present revolution, would fall at the beginning of December next, in which case, the comet's apparent track must be again an unfavourable one; indeed it seems questionable if it will be possible to obtain observations. The most likely time will perhaps be late in January, but the intensity of light will then be very small.

Oppölzer has suggested that the comet imperfectly observed by Pons in February, 1808, in the constellation Ophiuchus, may have been identical with Winnecke's, if it were in perihelion on or about April 12. The following particulars relating to the comet of 1808 appear to have been obtained from Pons's papers, and were communicated to Schumacher by Mghirhami:—"La comète du 6 fevrier 1808, est une des comètes qui ont echappé aux astronomes sans pouvoir en calculer les elemens à cause que l'on n'en a pu avoir que quelques positions très-douteuses par méprise avec d'autres nébuleuses. Elle était très faible et difficile à voir. La nébulosité était ronde, elle s'étendait à peu pres un dégré et on y soupçonnait par intervalle un très faible noyau en deux parties. Son mouvement était assez rapide vers le sud et l'on n'a pu l'apercevoir que 3 jours parceque la clair de lune était très-fort, de sorte que malgré de recherches très-opiniatres, on ne pouvait pas même la soupçonner le 10." There is then given a "Configuration renversée du 3 fevrier vers les 5h. du matin dans le grand chercheur qui à peu près a 3 dégrés de champ;" and it is added: "Les deux nébuleuses marquées dans la figure sont sur le ventre d'Ophiuchus un peu au-dessous de l'Equateur." Oppölzer identifies the nebulæ as Nos. 9 and 10 of Messier. In Zach's *Correspondenz* the comet is called a very small one, and nothing is said as to its rapid motion. It is evident that if the statement forwarded to Schumacher is the correct one, the comet moving quickly and with an apparent diameter of nearly a degree must have been in near proximity to the earth. Winnecke's comet in perihelion, on April 12, would have had about the following positions:—

Feb. 5 at 16 h.	...	R.A.	237° 56′	...	Decl.	−7° 0′	... Dist. 1·04
„ 8 at 17	...	„	241 39	...	„	−7 31	... „ 1·01

So that the motion, though southerly, would be but small. The identity of the comet of 1808 with Winnecke's comet is therefore at least doubtful.

In 1833 Clausen made what appears a more likely suggestion, that the comet of July, 1819, was identical with the second comet of 1766, which was observed for a short time only by Messier at Paris, before perihelion passage, and after perihelion by La Nux in the Isle of Bourbon, though but roughly. Burckhardt found, in 1817, that the whole of the observations could be represented within their probable limits of error by an ellipse with a period of revolution little over five years. The planet Jupiter must have acted powerfully upon Winnecke's comet towards the end of the last century, and, so far as we can see, it appears possible that the perturbations occasioned at that time may account for the differences in the orbits of 1766 and 1819. If Burckhardt's elements for the comet of 1766 are approximately correct, as seems probable, it may have been detected at its first visit to perihelion in the actual form of orbit, perhaps at its first visit after being fixed in the system through the agency of Jupiter. We know that Brorsen's comet of short period was discovered under similar conditions.

METEOROLOGICAL NOTES

SIX years ago we remarked (NATURE, vol. ix. p. 164) that what was required in order to describe and classify many forms of clouds, were accurate delineations of these forms in their different aspects, and systematic inquiries as to the relations of clouds to the mode of their formation, to the states of the aqueous vapour composing them, and to the varying elasticity, temperature, and electricity of the atmosphere. Since then but slow progress has been made, the great desideratum being the contribution of data in a form on which science can lay its hands. A contribution of data of this sort has just been made by Dr. Hildebrandsson, the director of the meteorological observatory of Upsala, in a memoir on the "Classification of Clouds employed at the Observatory," illustrated with sixteen photographs of clouds. The photographs, which are about nine by seven inches, are very fine ones, and well chosen out of a large number taken under the direction of Dr. Hildebrandsson, to illustrate the different forms of cloud and their more important modifications and transitional states. The series representing the more marked changes from the delicately-pencilled cirri of the flimsiest texture to the nimbus of a rain-cloud is a most instructive one; as is also the series showing the strato-cumulus as commonly observed during the winter season in Scandinavia. The relations of the varying forms of clouds to cyclones and anticyclones which pass over Sweden is just touched on, but this important phase of the inquiry we hope Dr. Hildebrandsson will again return to, seeing he can so readily refer to the observations of his observatory, which give so complete and satisfactory a record of the various fugitive phenomena of the weather changes of that part of Sweden. Dr. Hildebrandsson's photographs of clouds may be studied with equal interest and professional advantage by artists as well as by meteorologists, it being scarcely possible to point to any department of art standing more in need of a thorough reformation than the cloudscapes of our landscape painters.

THE Hydrographic Committee of the French Marine has at a recent sitting sanctioned the publication of the last four of the series of sixteen wind-charts prepared by M. L. Brault. In these four charts the winds of the Pacific are dealt with, the winds of the North Atlantic, the South Atlantic, and the Indian Ocean being discussed in the twelve charts previously prepared. In preparing these sixteen charts M. Brault has made use of upwards of 3,000,000 observations made over the oceans and continents of the globe. The chief results referring to the circulation of the atmosphere show as regards the South Pacific, which presents the largest expanse of ocean least influenced by land, a belt of calm or light winds near the equator; then the well-known south trades; to these succeeds a belt of winds variable as regards direction, but blowing with a force at least as great as the trades; and lastly, westerly winds, varying little, though more than the trades, in direction, and incurving upon the South Pole the nearer they approach it, and blowing much stronger than the trades and variables. As regards the other oceans, the disturbing influence of the land is felt in proportion to the extent of the continents which surround them, the disturbing influence reaching its maximum in August and January, in other words in those months when atmospheric pressure of the continents is in greatest excess or defect compared with that of the ocean as shown by the isobaric charts of the globe.

M. L. TEISSERENC DE BORT has prepared isabnormal charts of the temperature and pressure of the atmosphere, with the view of comparing, with some exactness, these two all-important factors of atmospheric circulation. He finds that when any region presents an excess of temperature, either absolute or relative to that of places in the same latitudes, a barometric minimum tends to be formed, and that the coincidence between the minimum of pressure and the maximum of temperature is almost complete. The tendency results in either a well-defined area of low pressure, or in the less pronounced form of a simple distortion of the isobaric lines as they cross the region of relatively high temperature. On the other hand, barometric maxima tend to establish themselves over regions whose temperature is either absolutely high or relatively so to the latitude, and the tendency to an increased pressure is the more decided when the region in question is surrounded by regions of low pressure.

AT a meeting of the Botanical Society of Edinburgh, held on Thursday, the 8th inst., Sir Robert Christison read a paper of very considerable importance on the relative growth of the trunks of trees during 1879 as compared with 1878. Upwards of two years ago Sir Robert set on foot a system of measurement of the girths of a large number of well-grown trees in Edinburgh and neighbourhood, the measurements being made by himself with the same measuring-line, and the same circumference to be measured secured by marking it at the time of the first measurement with paint. The inclement character of the summer months of 1879 as compared with 1878 was described by a reference to the daily maximum temperatures noted at the Edinburgh station of the Scottish Meteorological Society, from which it appeared that for the six months ending with September the mean for 1879 was fully 5°·0 less than for 1878, and the deficiency of day temperature amounting to nearly 10°·0 Of 11 deciduous trees, exclusive of oaks, the deficiency of growth during 1879 as compared with 1878 was 41 per cent.; of 17 evergreens of the pine tribe, the deficiency was 20 per cent.; and of 7 oaks the deficiency was 10 per cent. The 7 oaks were of different species, but they all gave results closely agreeing with each other. We shall look forward with the greatest interest to the annual reports of this investigation, which may be expected to reveal novel and valuable results illustrative of the bearings of meteorology on the growth of our forest trees.

AN interesting account of waterspouts observed on November 10, 1879, off Cape Spada, west of Canea, by Herr Miksche, has been communicated by him to the Vienna Academy. About 9 A.M. some heavy thunder-clouds rose in the west in a clear sky, reaching the zenith only after noon. One in advance, very black, and low-hanging, gave, about ten minutes to one o'clock, the phenomenon of the waterspout, a thick descending column, of milk-white appearance, being formed from it. The amount of downward gyrating force may be approximately estimated from the fact that at the distance of some eighteen miles one could distinctly see with the naked eye, a high round pedestal, formed by the foaming sea-water, like the socle of a monument. After ten minutes' duration, the column lost its conical form and began to assume a rectangular one; while, at the extreme eastern point of the cloud, a second waterspout was formed, conical in shape and of the same hue and intensity as the first. To this column also the sea presented a pedestal visible to the eye. For fully five minutes the water discharge continued with like intensity in both trombes. Precisely at five minutes after 1 P.M., *i.e.*, about a quarter of an hour after formation of the firs trombe, an angular discharge of lightning (without audible thunder) took place from the clouds at that part into the sea; then the trombe suddenly ceased, only the pedestal continuing some time to show where it had been. The second trombe remained unaffected five minutes longer, then was extinguished without lightning discharge, and without reverting to the original conical form (as the first did). This fine display of natural forces was quite finished at 1.16 P.M., the clouds then uniting and pursuing their course eastwards.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday last, a letter was read from Mr. Thomson which had that day been received *viâ* Mozambique, announcing the arrival of the East African expedition at Mbungo, at the north end of Lake Nyassa, on September 22. Mr. Thomson was unable to discover the Uranga country and river, described by the late Capt. Elton as lying near Merere's town, but he believes the river to be the

Mbangala, which flows into the Ruaha. According to Mr. Thomson, the formidable range, called the Konde mountains, is simply the termination of a plateau which rises from an altitude of 3,500 feet in 8° 50′ S. lat. to not more than 9,000 feet at the lake. Mr. Thomson was to leave for Lake Tanganyika on September 28, and we may fairly hope that by now he has completed his explorations, and is on his way back to the coast. The papers of the evening were "The Grand Canal and Yellow River of China," and "Hankow to Canton overland," by Mr. G. J. Morrison. During the journey referred to in the former, Mr. Morrison was enabled to examine some 200 miles of the Yellow River, a portion of which has materially altered since it was described by any traveller, and his observations are, therefore, very useful. Mr. Morrison, it may be noted, is of opinion that the Yellow River is now flowing in its natural channel, and that in former times it discharged its waters into the sea north of the Shantung promontory. His description of the condition of the Grand Canal is also interesting, as he looks at it from the point of view of a practical engineer. The other paper, from which only extracts were read, described a journey undertaken with the object of getting some idea of the country through which one of the great railway lines of the future may be expected to run, and a portion of which embraced the rich mineral field of Southern Hunan examined by Baron Richthofen a few years ago.

AN interesting piece of exploration has just been successfully accomplished by the Church Missionary Society's agents in Western Africa. In a small steamer they have ascended the River Binue from its confluence with the Niger to a point probably about 800 miles from the sea. The party penetrated 150 miles beyond Hamaruwa, which was reached by Dr. Baikie when in search of Dr. Barth in 1854, and a careful survey of the river has been executed.

M. PÉTRIMENT (*Bulletin* of Paris Anthropological Society, t. ii. fasc. 3), in confirmation of M. Madaillac's assertion that a blonde race existed in Persia, had engaged a Persian doctor, Mirzâ Mohammed, some time resident in Paris, to obtain definite information on this point. According to this gentleman there are about 2 per cent. of blonde persons in the Persian population, blonde children appearing in brunette families after the lapse of a generation or two. According to local tradition, the white men came from the north, and were *sheitâns*, or demons; this evil character is still attached to blonde individuals in Persia, where they are generally impetuous and artful, and seldom possessed of a lymphatic temperament.

M. DE UJFALVY, in his recent travels through the Russian territories of Central Asia, has visited the lands of the Galtchas, Sarts, and Tadjiks, where he found that caste and patriarchal authority were rigidly observed. The people are Mussulmans, and consequently polygamists, and the women are held in great subjection. The Galtchas in their nomadic wanderings ascend the mountain-slopes of Kohistan in search of pasture. To the east of their country we would seem, although close to the plains of Pamir, to be on the extreme limits of the Aryan race, for here in the Kuldja district the oblique-eyed Mongolians begin to predominate. At this point, where the Mountains of Heaven form a line of division, the white and yellow races meet, and even overlap one another to some extent, although the strict observance of caste has hitherto prevented their complete fusion, and has left the Aryan races to form isolated ethnic groups in the midst of an otherwise Mongolian population. M. de Ujfalvy is at present engaged in completing the narrative of his travels in this part of Central Asia, and his observations on the distinct characters of the Galtchas and other kindred races can scarcely fail to afford valuable aid in the solution of the vexed question of the limits of demarcation between the Mongolian and Aryan races.

IN No. 83 of the *Zeitschrift* of the Berlin Geographical Society Dr. Hildebrandt concludes the narrative of his journey from Mombassa to Kitue, and this is followed by some remarks on his measurements of heights in the Wakamba land. *Apropos* of the recent Karl Ritter celebration, we have two papers on that geographer; one by Pastor Tallin on Michael Servetus as a predecessor of Ritter and Humboldt, and the other by Dr. Marthe on what Ritter did for geography. In a letter from Gerhard Rohlfs, that traveller maintains that none of the greater carnivora are found in the Sahara, while, in reply, Drs. Ascherson and Hartmann endeavour to show that this statement must be received with some modifications The *Verhandlungen* (Nos. 1 and 9, Band vi.) of the same Society contains a paper by Herr Schütt on his travels in Central Africa.

TWO important congresses will be held next year by the French geographers. The first will be held at Lyons, and will deliberate on the means of regulating the explorations of Africa by French travellers or colonists. The second will be held at Nancy in Summer, at the conclusion of the meeting of the French Association, which will meet at Rheims, on general subjects.

A DEPUTATION waited on the Lord Mayor last week to bespeak his patronage in behalf of Commander Cheyne's elaborate and expensive scheme for reaching the North Pole. The Lord Mayor promised the use of the Egyptian Hall to have the scheme "thrashed out" at a public meeting.

IN connection with letters from Lieut. Bove on the work of the North-East Passage Expedition, the *Bolletino* of the Italian Geographical Society publishes several sheets of illustrations of the natural features along the routes, heads of the natives met with, sledges, implements, and weapons, native houses, &c., besides two excellent maps.

THE *Bulletin* of the Paris Geographical Society for November contains a translation, by M. Barrande, of the memoir by the Russian Grand Duke Nicholas on the Amu and Uzboi. Also an important paper by Dr. Lange, on the cartography of the Brazilian province of Santa Catharina, and the continuation of Admiral Fleuriot de Langle's article on African migrations.

THE new *Bulletin* of the Geographical Society of Oran, Algeria, is largely occupied with the Trans-Saharan Railway. The question is dealt with from a commercial point of view, and among the other contributions to the subject is a note on the western route and that proposed by General Colonieu.

THE new number of the *Bulletin* of the Société de Géographie Commerciale of Bordeaux contains the first portion of an address delivered by M. Soleillet on the Trans-Saharan railway project, in connection with which he is about to undertake explorations in West Africa.

THE publication of a new geographical journal is announced, the *Revista Geografica Internationale*. It will appear fortnightly, and will contain original articles in Italian, English, French, and Spanish, not a happy group, we think; French, English, German, and perhaps Italian, would have been much more representative. The editor is M. A. M. Mizzi, and the journal is published at Malta.

PHYSICAL NOTES

AN attempt is made in *L'Electricité* by M. C. E. Séguin, fils, to claim for France the honour of the invention of the phonograph; firstly, by the plea that M. Léon Scott (who died only last July) patented the instrument under the name of the phonautograph in 1857, and secondly, by the statement that M. Charles Cros deposited before the Académie des Sciences, in April, 1877, seven months before the date of Edison's patent, a sealed packet describing the possible reproduction of sounds from recorded traces. In justice to Mr. Edison, we can hardly admit the validity of either of these claims. The phonautograph of M. Scott merely recorded the graphic traces of vibrations in sinuous scratches upon a smoked surface, which, therefore, was useless for the purpose of reproduction of the sounds; and, moreover, Dr. König, who worked upon the instrument with M. Scott, and perfected it, has stated to us most candidly that the idea of reproducing the sounds from the recorded traces never occurred either to M. Scott or to himself; and that neither of them attempted or proposed to obtain graphic traces in hollows and ridges in tinfoil or soft metal, or otherwise than as plane curves. And as for the claims of M. Cros, we have yet to learn that he constructed an actual phonograph, or that his sealed packet contained any descriptions of a sufficiently detailed or practical nature to enable any instrument to be made from them.

PROF. BORLINETTO, of Padua, has devised two very simple and effective pieces of apparatus for showing the passage of electric sparks through such non-conducting liquids as turpentine, petroleum, &c. They consist of U-tubes of glass, with or without an intermediate branch, and having platinum wires led down the two branches or introduced through the glass walls, so as nearly to meet, the other extremities of which can receive the discharge from a Leyden jar or from an induction-coil.

To study the fluorescent spectrum many physicists adopt the method of projecting a spectrum sufficiently pure to show the principal Fraunhofer lines, on a fluorescent body, solid perhaps, or the side of a glass vessel containing a fluorescent liquid, and determining the parts where the fluorescence appears, reaches a maximum, and disappears. Others develop the direct spectrum on the surface of a liquid; Herr Hagenbach places the slit and the prism horizontally, and projects the spectrum on the free surface of the liquid. The disadvantages of these two methods M. Lamansky (*Jour. de Phys.*, Dec.) has sought to avoid in a spectroscope he has had recently constructed by M. Duboscq, and which he finds very convenient. The collimator and the telescope of this direct vision spectroscope are fixed separately on a graduated circle; they may be placed at various angles in the vertical plane. The collimator is furnished with a small adjustable mirror for directing the luminous rays along the optic axis. In the prolongation of the collimator tube is placed the direct-vision prism and a lens which throws the spectrum on the surface of the liquid contained in a small vessel on a table which can be raised or lowered. The telescope is directed to the same liquid surface, and the focal distance of the ordinary telescope is shortened by the addition of a second object-glass, which may be removed at will. The division of the circle allows of determining the angles at which the coloured rays fall on the liquid surface and the angles at which the fluorescent spectrum is observed. A dark cloth may be thrown over the apparatus to exclude disturbing light.

An interesting observation on the supernumerary or spurious rainbows occasionally seen lining the inner edge of the primary arc of a rainbow has been made by M. Montigny. These supernumerary rainbows usually consist of a red band touching the violet on the inner side of the bow, followed by green and violet, and passing again to red. Indeed it is possible occasionally to observe as many as four or five recurrences of the red and green tints. They are, however, almost always confined to the highest portion of the bow, and are rarely observed near the ground. M. Montigny, on August 30, 1879, watching a rainbow near Rochefort, a little before sunset, noticed that while the upper portion of the primary bow showed no trace of supernumerary bows, the lower portions on each side, which came out brilliantly against a stratum or zone of misty air, were furnished with no fewer than four supernumeraries of paler tint. According to the received theory of Young and Airy these bows are due to diffraction, caused by very small drops, the smallest drops giving the broadest and most brilliant fringes of colour. Usually it happens that in the higher regions of the air the falling drops are smaller than they are at the lower regions; hence the occurrence of supernumerary arcs at the upper part of the bow. In M. Montigny's observation, doubtless, the misty zone lying near the ground provided the drops of the requisite degree of smallness to produce the diffractive effects. This is, at least, his view of the case.

In the December number of *Silliman's Journal* is a memoir of extreme interest by Dr. E. L. Nichols on the character and intensity of the rays emitted by glowing platinum. Several tables of statistics of observations are given, and two graphic charts which embody the tabular results. Reviewing the *à priori* law of Kirchhoff, concerning the emission of rays of greater refrangibility at higher and higher temperatures, he remarks: "Strictly speaking, however, the temperature at which each individual wave length becomes visible depends solely upon the sensitiveness of the observer's eye. We are furthermore forced to conclude from experiment that the more refrangible rays really exist at temperatures far below those at which we begin to see them. The directions of the curves (Plates I. and II.) seem to denote that all the rays studied begin to be emitted at some temperature not included in the interval embraced by the experiments. *I suspect indeed that all of them originate at some very low degree* (*the absolute zero?*), *and are recognizable no sooner, simply because the various instruments at command, the thermopile, eye, photographic plate, &c., are not more delicate.* That the various colours do not appear simultaneously, follows from the very different degrees of sensitiveness shown by the eye for different rays."

An interesting electric toy, contrived by M. Pfeiffer, is described in a recent number of *La Nature*. It is a small electrophorus consisting merely of a thin plate of ebonite about 1 mm. in thickness; the usual wooden disk with tinfoil is replaced by a small piece of tin about the size of a playing-card, attached to one of the faces of the ebonite plate. This electrophorus produces electricity with great facility. You have merely to place it on a wooden table and rub it successively on its two faces with the open hand; then on lifting it with the left hand and bringing the right hand near the tin plate, a spark is obtained 1 to 2 centimetres long. Several small accessories, skilfully contrived, are added to the electrophorus; among these are dancing puppets made of pith, which manifest very amusingly the phenomena of electric attraction or repulsion. Electrify the ebonite plate, put the three puppets on the tin, and then raise the plate from its support. One small personage lifts his arms above his head; the hair of a second stands out; and the third, lighter than the others, jumps about like a clown, while two pith balls placed at his side dance with him. M. Pfeiffer has also collected in one small box all the known accessories of an electric machine; a miniature Leyden jar, an electric carillon, a Volta pistol, a Geissler tube, &c., these being operated with the electrophorus.

SCIENTIFIC SERIALS

American Journal of Science and Arts, December, 1879.—Mr. Brooks here calls attention to an important difference in the breeding habits of American and European oysters; the eggs of the former are fertilised *outside* the body of the parent; and during the period which the European oyster passes inside the mantle cavity of the parent, the young American oyster swims at large in the open ocean. Mr. Brooks traces the successive stages of oyster development.—Mr. Harting writes on triple objectives with complete colour-correction.—There are geological papers on Virginia, on Galisteo Creek, New Mexico, and on Catrosa Co., Georgia.—Prof. Verrill describes two new species of cephalopods caught off the coast of Massachusetts; also what is the second known representative of the remarkable family of *Cirroteuthidæ*.—Dr. Nichol's researches on the character and intensity of the rays emitted by glowing platinum (see Nature, vol. xxi. p. 184) are here given in detail.—Prof. Marsh's notes on Jurassic dinosaurs, and Dr. Draper's researches in photography of stellar spectra have been already noticed in our columns.—Prof. Peters contributes observations on the planets Hersilia and Dido; and in the "Scientific Intelligence" we note two useful lists of the (209) minor planets, numerical and alphabetical.

SOCIETIES AND ACADEMIES

London

Royal Society, January 8.—"On the Photographic Method of Mapping the Least Refrangible End of the Solar Spectrum (with a map of the Solar Spectrum from 7600 to 10750)," by Capt. W. de W. Abney, F.R.S., R.E.

The author refers to the sensitiveness of different forms of silver salts when exposed to the action of the spectrum, and shows how he has been able to prepare, by methods indicated, silver bromide which absorbs the red and ultra-red rays, and which is sensitive to these rays.

In his paper he describes the apparatus employed by him in the photography of the invisible least refrangible rays, both with a prismatic, and also with the diffraction apparatus. From photographs taken with the latter, he has constructed a map extending from λ 7600 to λ 10750, which he submits to the Society. He shows also that in the photographs of the prismatic spectrum, he has apparently reached the limiting length by comparing it with photographs of the diffraction spectrum. The author has also compared Lamansky's prismatic thermograph with his photograph. The paper closes with some theoretical remarks on the silver compounds employed.

Mathematical Society, January 8.—C. W. Merrifield, F.R.S., president, in the chair.—Prof. W. S. Burnside was elected a Member.—Prof. Cayley, F.R.S., communicated two formulæ in spherical trigonometry which are included in the one form—

$$\tan \tfrac{1}{2} c (\cos B - i \sin B) = \tan\left(\frac{c}{2} - \phi\right),$$

where

$$i = \sqrt{-1} \text{ and } \tan \phi = \tan \tfrac{1}{2} b (\cos A + i \sin A).$$

The note which the President read at the last meeting simply gives (as has been pointed out to him since) some symmetrical cases of the orthogonal transformation, of a much more general character (but unsymmetrical) given by Mr. Cayley, and reproduced in Salmon's "Higher Algebra" (3rd edition, p. 39). The symmetrical form may be obtained from the one there given by writing—

$$\frac{1}{\Delta} = k, \ \frac{\lambda}{\Delta} = a, \ \frac{\mu}{\Delta} = b, \ \frac{\gamma}{\Delta} = c,$$

and then putting $k = 0$. We thus get for the determinant the symmetrical form—

$$\begin{vmatrix} a^2 - b^2 - c^2, & 2ab, & 2ca, \\ 2ab, & -a^2 + b^2 - c^2, & 2bc, \\ 2ca, & 2bc, & -a^2 - b^2 + c^2, \end{vmatrix}$$

the value of which is r^3, and the sum of the terms on the leading diagonal $= -r$, where $r = a^2 + b^2 + c^2$. The terms of this determinant will be integral if a, b, c are either integral, or of the form integer $x \sqrt{2}$, or indeed if they contain any common factor entering under the square root only. It has been shown by Legendre and Gauss that every integer, or its double, is the sum of three squares. It follows that an orthogonal transformation of the above symmetrical character can be found for every whole number r. The transformation is, however, nugatory for certain low values of r. The symmetrical transformation means a turn of two right angles about an axis whose direction cosines are proportional to $a\,b\,c$. That is to say, if a cube be taken, with the axes for edges, and those of rational length, in a cubical system, it is always possible to find one or more axes, inclined to the co-ordinate axes, such that if we turn the cube about them through two right angles, its points will still rest on points of the system.—Mr. Hammond gave a form for the complementary function in fractional differentiation. Messrs. Cayley, Merrifield, Roberts, Glaisher, and Freeman took part in a discussion upon Mr. Hammond's communication.

EDINBURGH

Royal Society, January 5.—The Right Hon. Lord Moncrieff, president, in the chair.—At the request of the Council an address on the Trigonometrical Survey of Palestine was given by Lieut. Conder, R.E., late in command. Apart from its more technical nature, the paper contained many details of archæological, ethnological, and geological interest, including the discovery of the positions of not a few historic localities, such as the Cave of Adullam, Bethabara beyond Jordan, the vineyard of Naboth, &c.—Prof. Tait communicated a note on Minding's theorem by Prof. Chrystal. This beautiful theorem in rigid dynamics, the proof of which originally occupied many quarto pages of *Crelle's Journal* with elaborate analysis, had been proved by Prof. Chrystal by means of Plücker's congruencies, in a manner almost rivalling in brevity the quaternion demonstration by Prof. Tait. A generalisation of the theorem led to the discovery of a *volume-locus*.—Prof. Tait then communicated two mathematical notes: (*a*) on a problem in arrangements; (*b*) on a graphical solution of the equation $V\rho\phi\rho = 0$. The former was given under the name of The Mad Schoolmaster. A schoolmaster went mad, and began to operate upon his class of boys according to the following method:—The dux he put down one place, the new dux two places, the next dux three places, and so on till every boy in the class had been shifted at least once. He then began again putting the first dux down one place, the next dux down two, and so on as before. After 306 operations, he found the boys arranged exactly as they had been at the beginning. He then cast one out, and set to work operating similarly upon the remainder; but to his dismay found that he had to operate 1,120 times before they were brought back to their old arrangement. The problem is to find how many boys were in the class, and is of course a particular case of a much more general problem in arrangements. Prof. Tait gave a graphical method by which the inverse problem could be solved by a simple inspection for any number.

PARIS

Academy of Sciences, January 5.—M. Edm. Becquerel in the chair.—M. Wurtz was elected vice-president for 1880.—M. Daubrée gave information as to the Academy's publications and changes in members and correspondents. Two members have died in the year—MM. de Tessan and Gervais—and one correspondent—Mr. MacLear.—The following papers were read:—On the motion engendered by diffusion of gases and liquids, by M. Sainte-Claire Deville. The difference of velocity in passage of gases through a porous septum is utilised in raising liquid, a machine being thus produced which apparently does not consume heat. M. Debray's diffusion apparatus is used, being changed into a machine simply by adding tubes of discharge and valves. Dutrochet's endosmometer may be similarly changed to a machine.—On the hydride of copper; reply to M. Berthelot, by M. Wurtz.—On the heat of formation of hydrate of chloral; reply to M. Berthelot, by M. Wurtz.—Remarks on a recent communication regarding the photospheric network, by M. Janssen. The reticulated aspect produced by faculæ round spots has been long known, but has nothing in common with the photospheric network revealed by photographs. This is formed by the totality of points where the solar granulation is disturbed by upward currents of hydrogen, while the faculæ are due to gaseous masses above the granulated region. The former is in the photospheric layer, the latter above it; the network seen chiefly in the central parts, the faculæ only easily visible at the border. M. Lamey seems to have confounded the phenomena. The network is only visible in photographs 0·25 m. to 0·30 m. in diameter.—On treatment of phylloxerised vines, by M. Maren.—M. Perry was elected Member in Geography and Navigation in room of the late M. de Tessan.—Carbonic acid in the air in its relations with the great movements of the atmosphere, by M. Marié-Davy. A discussion of daily mid-day analyses (April, 1876, to June, 1879) at Montsouris, by MM. Levy and Allaire. The quantity of CO_2 in 100,000 parts of air in volume varied between twenty-two and thirty-six. Winds blowing from Paris contained, on an average, less CO_2 than those from the country. This might be explained by CO_2 occurring more largely in air *below* than *above* the layer of clouds. Three periods are noted: in the first, to November, 1877, the CO_2 was below the mean, and sometimes very low; in the second, to September, 1879, it was considerably above the mean; the third, commencing in October, 1879, showing very little CO_2. The second period was one of wet weather, and comprised two bad harvests; the equatorial current was predominant in France. This current had less extension in the first, which was also less wet, and gave better harvests. A complete change in the atmospheric circulation seems to have occurred since October.—On an application of the pre-existence of Ampère's currents in soft iron, by M. Trève. With iron solenoids he gets much better effects than with copper.—On new luminous tubes, by M. Trève. Into a large Geissler tube he introduces a Fizeau condenser, and fixes the electrodes (connected with the two poles of the induced current of a Ruhmkorff coil) to the eleventh and twelfth tin sheets. On reducing the pressure to 0·003m. or so, sound is no longer heard, but a brilliant white light springs in pearls from the sheets of the condenser, quite distinct from the common light of Geissler tubes.—Action of acetic anhydride on some phenol-aldehydes, by M. Barbier.—On a new synthesis of saligenine, by M. Greene. This is by reaction of chloride of methylene with phenate of sodium in presence of hydrate of sodium.—On the preparation of iodised and bromised derivatives of benzine, by M. Greene.—On the comparative value of monochromatic impressions in invertebrates, by M. Chatin. In arthropods, decapod crustaceans, and some insects, Dewar's current of the retina is well marked, and varies with different rays, reaching a maximum in the yellow-green region. In molluscs, and especially in pulmonated gasteropods, the differences are still more pronounced.—Histology, development, and origin of the testicle and ovary of *Campanularia angulata* (Hincks), by M. Fraipont. M. Touchimbert presented a photograph of forms of snow (resembling small roses) observed at Poitiers.

CONTENTS

THURSDAY, JANUARY 22, 1880

ON THE PHOTOGRAPHIC SPECTRA OF STARS[1]

THE author presented, in December, 1876, a preliminary note on the subject of this paper, together with a diagram of the spectrum of Vega compared with that of the sun.

The author refers to a paper by Dr. William Allen Miller and himself in 1864, in which they describe an early attempt to photograph the spectra of stars.

Other investigations prevented the author from resuming this line of research until 1875, when a more perfect driving clock, by Grubb, enabled him to take up this work with greater prospect of success.

The author describes the special apparatus and the methods of working which have been employed.

In consequence of the very limited amount of light received from the stars, it was of great importance not to spread out the spectrum to a greater extent than was necessary for a sufficient separation of the principal lines of the spectrum. The spectrum apparatus finally adopted consists of one prism of Iceland spar and lenses of quartz. The length of the spectrum taken with this apparatus is about half an inch, from G to O in the ultra-violet. The definition is so good that in photographs of the solar spectrum at least seven lines can be counted between H and K.

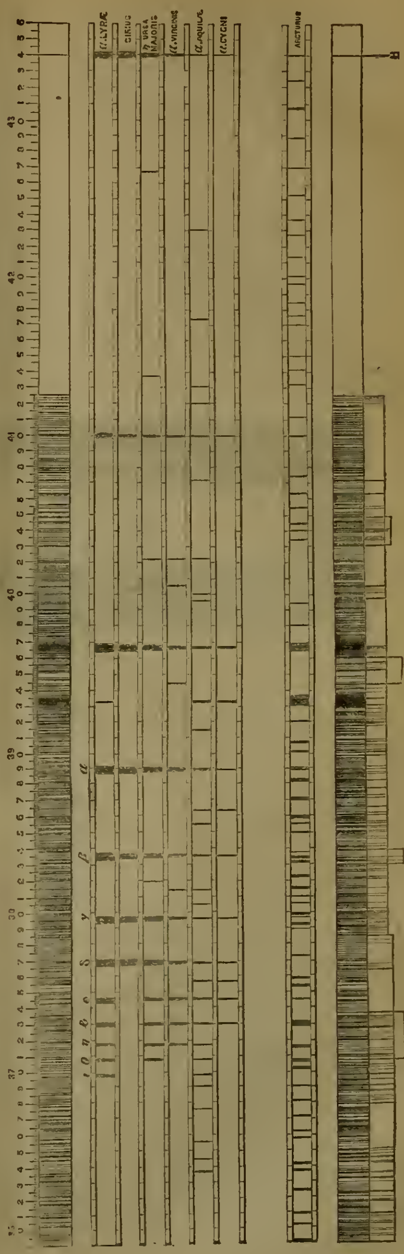
Though there is considerable loss of light in the employment of a slit, still, for the great advantage which it affords in obtaining spectra of comparison, a narrow slit one-three-hundred-and-fiftieth ($\frac{1}{350}$) of an inch in width was always employed.

This slit is provided with two shutters. By means of these through one half of the slit a solar or other spectrum may be taken on the same plate for comparison, and for the determination of the lines in position in the spectrum. This apparatus was adapted to a Cassegrain reflector with a metallic speculum of 18 inches aperture. The small mirror was removed and the slit of the spectrum apparatus placed at the principal focus of the mirror. A simple but perfectly successful method was adopted by which the image of a star could be brought exactly upon the slit, and retained there during the whole time of exposure, sometimes for more than one hour, by a system of continuous supervision, and instant control by hand when necessary.

Various photographic methods were tried, but the great sensitiveness which may be given to gelatine plates, together with the special advantages under long exposures of dry plates led finally to the exclusive adoption of this method.

The photographs were examined and the lines measured by means of a micrometer attached to a microscope of low power. These measures were reduced to wave-lengths by the help of solar and terrestrial spectra, use being made of M. Cornu's map of the ultra-violet part of the spectrum, and of M. Mascart's determination of the wave-lengths of the lines of cadmium.

Photographs have been obtained of the stars Sirius,



Map of Photographic Spectra of Seven Stars.

[1] Abstract of paper by W. Huggins, D.C.L., LL.D., F.R.S., read before the Royal Society, December 18, 1879, with additions by the author.

Vega, α Cygni, α Virginis, η Ursæ Majoris, α Aquilæ, Arcturus, β Pegasi, Betelgeux, Capella, α Herculis, Rigel, and α Pegasi. Also of the planets Jupiter, Venus, and Mars, and of different small areas of the moon.

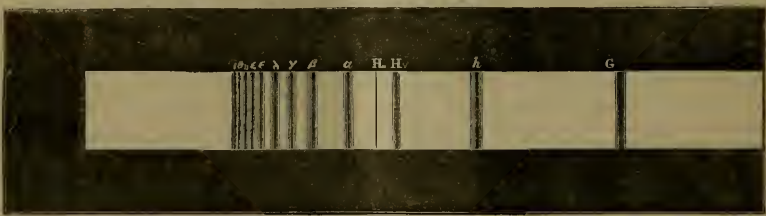
The spectra of Sirius, Vega, α Cygni, α Virginis, η Ursæ Majoris, α Aquilæ and Arcturus are laid down in the map on the scale of M. Cornu's map of the ultra-violet part of the solar spectrum.

The stellar spectra extend from about G to O in the ultra-violet.

Six of these spectra belong to stars of the white class. In 1864 the author pointed out the features in common in the visible spectra of these stars. These photographs present a remarkable typical spectrum consisting of twelve strong lines (seven only of these were given in the preliminary note in 1876). The least refrangible of these is coincident with the hydrogen line (γ) near G. The second with *h* also a line of hydrogen. The third with H. K if present at all, is thin and inconspicuous.[1]

These lines, H and K, are coincident with lines in the calcium spectrum, and are usually attributed to the vapour of this substance. Now there is another pair of strong lines in the spectrum of calcium, which in M. Cornu's map have the wave-lengths 3736·5 and 3705·5. There are no strong lines in the white stars coincident with these lines. A glance at the map will show how remarkable is the arrangement in position of these twelve typical lines. They form a great group in which the distance between any two adjacent lines is less as the refrangibility increases. It is at once suggested that they are connected with each other and represent probably one substance, and two at least belong to hydrogen.

It should be stated that the continuous spectrum extends in the photographs beyond S, but no lines can be detected beyond the twelfth line at λ 3699. For the sake of convenience of reference the author distinguishes these lines by the letters of the Greek alphabet in the order of refrangibility, beginning with the first line beyond K of the solar spectrum. The wave-lengths of these lines are as follows :—



Photographic Spectrum of α Lyræ.

Hydrogen near	
1. G	4340
2. *h*	4101
3. H	3968
4. α	3887·5
5. β	3834
6. γ	3795
7. δ	3767·5
8. ϵ	3745
9. ζ	3730
10. η	3717·5
11. θ	3707·5
12. ι	3699

In all these stars the line K is either absent or very thin as compared with its appearance in the solar spectrum.[2] In the spectrum of Arcturus, which belongs to the solar type, this line exceeds in breadth and intensity its condition in the solar spectrum. The white stars may, therefore, be arranged in a series in which the line K passes through different stages of thickness, at the same time that the typical lines become narrower and more defined, and other finer lines present themselves in increasing numbers. Arcturus seems to present a spectrum on the other side of that of the sun in the order of changes from the white-star group.

The spectra of the planets were taken on the plan suggested by the author in 1864, in which the planet's spectrum is observed or photographed together with a daylight spectrum. These photographs show no sensible planetary modification of the violet and ultra-violet parts of the spectrum of the planets Venus, Mars, and Jupiter.

Numerous spectra of small areas of the lunar surface have been taken under different conditions of illumination, and during eclipses of that body. The results are wholly negative as to any absorptive action of a lunar atmosphere.

The author is preparing to attempt to obtain by photography any lines which may exist in the violet and ultra-violet spectra of the gaseous nebulæ. He also points out the suitability of the photographic method of stellar spectroscopy, first inaugurated by his researches, to some other investigations, such as—differences which may present themselves in the photographic region in the case of the variable stars, the difference of relative motion of two stars in the line of sight, the sun's rotation from photographic spectra of opposite limbs, and the spectra of the different parts of a sun-spot.

In the hope of throwing light on many physical questions suggested by the stellar photographs, the author has taken for comparison a number of terrestrial spectra, especially of hydrogen and calcium, under different physical conditions. As he is still pursuing this inquiry, he reserves an account of this part of his work.

[1] The author refers to Mr. Lockyer's paper, *Proceed.* R. S., No. 168, 1876, in which he suggested that photographs of the spectra of the brighter stars might show modifications of this character of the lines of the calcium spectrum, and that such modifications would confirm his views on the dissociation of this substance. Reference is also made to *Proceedings* R.S., December, 1878, Fig. 1, where Mr. Lockyer gives a fuller statement of his views on this and other points in connection with different classes of spectra of the stars.

[2] Messrs. Dewar and Liveing have ound in their experiments similar relative changes of intensity of the lines of calcium corresponding to H and K in the *emission* spectrum of calcium.

VOCAL PHYSIOLOGY AND HYGIENE

A Treatise on Vocal Physiology and Hygiene; with Especial Reference to the Cultivation and Preservation of the Voice. By Gordon Holmes, L.R.C.P. (Edinburgh: Churchill, 1879.)

IT is one of the most singular facts connected with music that, notwithstanding the very wide spread of musical education, the kind of performance which is within the most general reach, namely, singing, receives the least amount of earnest culture. Almost every individual in ordinary health possesses the means of singing, which consist simply of a voice that can produce musical tones, and an ear that is capable of guiding its inflections. The latter qualification is, it is true, not so common as the former; but in all probability the cases where the human ear is absolutely wanting in the discrimination of musical pitch are extremely rare. Yet out of this great mass of mankind what a small proportion actually sing; and of those who do, what a still smaller proportion even aim at singing well!

Let us consider for a moment how the case stands in regard to that small fraction of mankind who attempt to sing in some fashion or other. The great majority of these never *learn* at all; they sing by the light of nature, using their voices in any way that will produce the notes their ears guide them to; and, no doubt, with naturally good voices and naturally good ears, music may sometimes result, which is quite tolerable, though infinitely inferior to what it might be made. But many persons do "learn to sing," and instruction of this kind forms a tolerably large professional avocation. What, then, does this imply? In most cases, unfortunately, little or nothing, so far as the true art is concerned. If a girl who finds she can sing a little asks for some lessons from an ordinary teacher, we know pretty well what will be done: there may be, just as a matter of form, a few exercises given; but the great aim will be to teach her the notes of certain songs, so as to provide her with a small repertory for social exhibition. This, however, is rather teaching *music* than singing, and the same may be said of the large number of classes for vocal performance in parts, where nothing is attempted beyond attention to the pitch of the notes used, and the time they are sung in. If we go a little further and include the cases where the teachers endeavour to give their pupils some idea of style, we about exhaust the category of vocal instruction which is common in private circles, and we need not wonder at the fact that, to educated judges, ordinary amateur singing, when it is not offensive, is at all events wretchedly poor. To learn to sing in the proper sense of the word is quite a different thing from learning songs; the voice is an instrument, the capabilities of which, in many respects, transcend those of any other known, and the cultivation of the voice, and of the singer's power over it, so as to use it to the best advantage, requires not only careful and judicious training, but long, hard, and laborious practice. It is consequently only among the professional ranks that we are accustomed to expect thoroughly good singing, and even here, whether from deficient education, imperfect powers, or defective taste, it is not often that what we expect is really found.

We might extend these remarks, in some measure to speaking. Although the natural use of the voice suffices for common practical purposes, there are cases where considerable art and education are required to employ it to the best advantage, and yet little or no attention is paid to the matter, as is evidenced by the miserable attempts at untrained elocution we are so often doomed to listen to, in preaching, reading, and public speaking. The stage is an exception, as there the artistic management of the voice is indispensable, a fact at once perceived when amateur acting is compared with that of the members of the dramatic profession.

Undoubtedly one of the great causes of the evil in both these cases is the general ignorance as to the nature of the voice and the manner in which it admits of management; and we welcome with pleasure the appearance of a work which sets forth these and kindred topics in a way that cannot fail to be largely useful. Although written by a man who is fully conversant with all the technicalities of his subject, it is yet essentially popular in its style, and may be studied with advantage by all who are interested in the cultivation of the voice for any object whatever.

The introduction and the first chapter are devoted to an Historical Review of the Origin and Progress of Vocal Culture, and to an explanation of the general nature of musical sounds. These are somewhat lengthy, occupying one-fourth of the book; but one may fairly allow for the author's wish to render his treatment of the subject complete. In the remainder of the work he is more clearly on his own ground. Chapter II. is devoted to a description of the anatomical construction of the vocal organs, and Chapter III. to an investigation of their physiological mode of action. Both these are admirably treated of, and are illustrated, where necessary, by copious figures. The author gives, under the latter head, an interesting survey of the various theoretical attempts that were made to explain the vocal phenomena before the great invention of the laryngoscope in 1854, by Manuel Garcia, gave the power of actually observing the processes at work. By the aid of this ingenious apparatus, the explanation became comparatively easy. There are, however, some points, particularly connected with the falsetto voice, which are yet somewhat obscure.

Chapter IV. is the one to which, probably, the greatest importance is to be attached; it treats of "The Physiological Principles of Vocal Culture." The author says:—

"The cultivation of the voice amongst civilised nations has for its object the complementary development of the powers of organs which have already attained a high degree of perfection in the performance of their functions. Through the exertion of influences acting from without, and not directly controlled by the will, man proceeds instinctively and intuitively as a mere agent to the evolution of speech and language. But here, as in many other of his relations, beyond a certain point the unerring guide of nature leaves or only follows him with a perpetually widening interval, and his further advance is made voluntarily and with self-consciousness of his aim. . . . Hence we may recognise two grades in the employment of the voice—the first necessitated by the conditions of social life as a means of intercommunion, and the second undertaken with a view to the æsthetic observation of the listeners.

"The technical training of the voice lies immediately in the hands of teachers of elocution and singing. On their taste and genius, as well as on the aptitude and natural vocal gifts of their pupils, depend in the greatest measure the success obtained and the perfection of the result. But whatever methods be adopted, the base of operations is vital organisation and action, of which the true apprehension and normal guidance must lead most directly and certainly to the desired end."

This, we take it, is the great aim, and the most useful tendency of the book, namely, in the first place to make known to those who desire to excel, either in singing or in elocution, that something more is necessary than they can obtain by the mere light of nature; and secondly, to enunciate the important truth that the art of using the voice to the best advantage can only be effectively taught by the aid of a competent knowledge of the nature and capabilities of the natural organ—matters of which great numbers of those who profess to teach have absolutely no idea at all. The value, therefore, of such information as is conveyed in this work, both to teachers and learners, can scarcely be overrated. It is not possible here to enter into details; suffice it to say that the chapter treats fully of vocal force, timbre, compass, and execution; of the modes of development; of the management of respiration; of the vibrating elements, the resonance apparatus, and the articulation; and it adds some useful data as to the treatment of that troublesome vocal defect—stammering.

The last chapter is devoted to a subject of vital interest to those who have to make public use of the voice, namely, vocal *hygiene*. The maintenance of the vocal powers is a matter of no less importance than their cultivation; but there is much ignorance and misunderstanding on this point, and the advice the author gives, coming as it does from one having authority, is most valuable.

WILLIAM POLE

THE COPPER-TIN ALLOYS

Preliminary Investigation of the Properties of the Copper-Tin Alloys. A Report, Edited by Prof. R. H. Thurston, of a Committee on Metallic Alloys, Presented to the United States Board (Washington: Published at the Government Printing Office, 1879.)

IT is not a little remarkable that the study of the metallic alloys has been so generally neglected. Alfred Riche observes that this may in part be due to the fact that the characteristics upon which we rely in ascertaining the constitution of bodies are usually inapplicable to alloys. It is difficult for instance to determine with accuracy such physical constants as their melting points, for in many cases molecular rearrangement takes place when the alloys are heated, and, again, the properties of alloys are often greatly altered by the presence of impurities in such small quantities that it is impossible to estimate them by the balance.

Systematic efforts to clear up the obscurities with which the structure and nature of alloys are surrounded have, however, not been wanting. Thus, not to mention the well-known experiments of Hatchett, published in 1803, in 1855 Calvert and Johnson communicated to the British Association the results of a series of experiments, and in 1862 this body requested the late Dr. Matthiessen to continue his experiments on the chemical nature of alloys, the result being a report which certainly modified the views concerning them that had to that time prevailed. England then has certainly not been behind other countries in actual advance in metallurgical processes, but it is nevertheless true, as was pointed out by Abel in an address as president of the Chemical Section of the British Association in 1877, that the comparative ease with which triumphs may be won in the field of organic research has led the younger chemists to underestimate the importance of rigorous analytical work by which their science has been built up.

With regard to France the researches of Levol and of Alfred Riche will always hold a high place in scientific history; and in Germany there are many classical researches, such as those of Karsten and of Wertheim.

The volume before us affords abundant evidence that the Americans are not unmindful of the importance of metallurgical investigation. It appears that a committee, consisting of Prof. Thurston and Messrs. L. A. Beardslee and David Smith, was appointed in 1877 by the Government of the United States, to "assume the charge of a series of experiments on the characteristics of alloys," and the first result of their labours is an octavo volume, edited by Prof. Thurston, of nearly 600 pages, illustrated with photographs of fractures, and plates of curves representing the various physical constants of the alloys of copper and tin. The committee hope soon to present a similar report on the alloys of copper and zinc, and a third report on the triple alloys of copper, tin, and zinc will follow. They state that "the whole field has now been explored and the useful alloys are proved to occupy but a limited portion of its great extent, and it has now been shown that a comparatively narrow band, extending from ordnance bronze on the one side of this triangular territory to Muntz metal on the other, contains all the best of the alloys that are generally useful."

The necessary researches were conducted in the mechanical laboratory of the Stevens Institute of Technology, and the committee trust that this preliminary work will prove "to have been so satisfactorily done that its repetition may never be required, and that in future attention may be confined to matters of detail which have been shown to be of most promise." The committee did not seek to determine the character of chemically pure metal, but endeavoured to ascertain the practical value of commercial metals, melted in the way that is usual in the preparation of alloys in the foundry. The purest metals that could be obtained in commerce appear, however, to have been selected, the greatest care being taken to ascertain by a minute analysis the amounts of impurities in the metals employed and the composition of the twenty-seven alloys forming the subject of the Report.

After carefully noting the characteristics as to fracture, colour, and hardness of each alloy, their resistance to transverse stress was examined. Tests by tensile stress then follow, and the results agree, in general, very closely with those given by transverse stress. The alloys were then submitted to torsional stress in a machine devised by Prof. Thurston, and, if the autographic strain-diagrams given by the machine are compared with the curves representing resistance to transverse and tensile stress, a marked similarity will be evident. Experiments proved that the maximum resistance to compression is given by the alloy containing 69·84 per cent. of copper, and the minimum by pure tin. A second series of alloys was then prepared, the mixtures of the constituent metals being made without reference to the chemical equivalents or the atomic weights of the metals, but a constant difference of 5 per cent. being maintained between each two alloys in the series. An attempt was made to obtain the temperature of pouring of this series by a well-known calorimetric method, but the results, of course, only profess to be approximate and relative, as the specific heats of the alloys are deduced from the mean specific heats of the constituents, and are assumed to be the same in the liquid as in the solid state. The numbers given, however, differ widely from those usually accepted, the "temperature of casting" of copper, for instance, being given as 1,909° C., while M. Violle (*Comptes Rendus*, t. lxxxix. p. 702) considers its melting point to be 1,054° C. It is probable therefore that the metals were poured at temperatures considerably above their points of fusion. The tests by transverse stress were repeated on this series of alloys and the results led the committee to conclude that they "do not seem to corroborate the theory given by some writers, that peculiar properties are possessed by alloys which are compounded of simple multiples of their atomic weights or chemical equivalents. . . . It does appear that a certain percentage composition gives a maximum strength, and another certain percentage a minimum, but neither of these compositions is represented by simple multiples of the atomic weights. Besides, there appears to be a perfectly regular law of decrease from the maximum to the minimum strength which does not seem to have any relation to the atomic proportions, but only to the percentage composition."

These conclusions are of the utmost interest and are certainly somewhat startling; it may be well to point out therefore incidentally that, since the report was published, it has been shown in this country that in the curves representing the induction-balance effect and the electrical resistance of the tin-copper alloys two critical points are occupied by alloys in which the constituent metals are combined in the very definite atomic proportions represented by the formulæ $SnCu_3$ and $SnCu_4$ respectively.

In summing up the results, the committee point out that the curves of resistance to tensile and torsional stress agree very closely, the curve of transverse resistance being similar, but the compression-curve is very unlike either of the others, the maximum compressive resistance being "reached by one of the brittle alloys, the tensile strength of which is not far from the minimum. It appears, therefore, that the tensile and compressive strengths of the alloys are in no way related to each other; that the torsional strength is closely proportional to the tensile strength, and that the transverse strength may depend, in some degree, upon the compressive strength as is indicated by the approach of some portions of the transverse curve to the compression curve, but is much more nearly related to the tensile strength, as is shown by the general correspondence of the curve of transverse with that of tensile strength. From the curves of transverse, tensile, and torsional strengths it is seen that the strengths of the alloys at the copper end of the series increase rapidly with the addition of tin, until about 4 per cent. of tin is reached.

The specific gravities obtained by the committee are corrected for temperature and are reduced to the standard of water of maximum density. The results obtained by Mallet, Alfred Riche, and other experimenters are plotted side by side, but it is much to be regretted that those of the committee are only represented by a mean curve which at first sight is rather misleading.

The appendix to the volume contains several reprints of important monographs on alloys. There is also a valuable bibliography which might, however, have been more complete, and should surely have contained references to such important work as Mallet's on the density of metals in the fluid state, to some of the metallurgical researches of Eliot and Storer, and to Knox and Macgregor's on the thermo-electric properties of certain alloys.

Viewing the results as a whole there can be no question that metallurgists have reason to be grateful for the collection of facts which have been so laboriously gathered, and we trust it will not seem ungracious to express the wish that the work had been undertaken in this country.

W. CHANDLER ROBERTS

OUR BOOK SHELF

The Spiders of Dorset, with an Appendix containing Short Descriptions of those British Species not yet found in Dorsetshire. By the Rev. O. Pickard-Cambridge, M.A., C.M.Z.S., &c. From the *Proceedings* of the Dorset Natural History and Antiquarian Field Club. Vol. i., pp. 1-235, with Three Plates, 8vo. (Sherborne: L. H. Ruegg, 1879.)

ALTHOUGH this book has been in our hands for several months, we have hitherto refrained from noticing it, hoping the second volume might come to hand, and thus have enabled us to give a more complete analysis. In the meantime the importance of the work deserves at least a preliminary examination.

Mr. Pickard-Cambridge's reputation as an arachnologist is a sufficient guarantee that any work written by him will be carefully executed. He states that his first idea was simply to give a list of the species found in the county in which he has so long been resident. Subsequently it was determined that the work should be monographic so far as the Dorsetshire species are concerned. It was then found that the species of the county included over two-thirds of those that occur in Britain, and it was decided to give diagnostic characters of the remainder, thus rendering the work a Handbook of British Spiders. There was urgent need for such a work. With the exception of a semi-popular outline sketch there has been nothing claiming to be monographic since the now venerable Mr. Blackwall published his magnificent Ray Society Monograph in 1860-63. This work noticed 304 species. Mr. Cambridge states that 510 are now known to him as British, and that 358 of these have been found in Dorsetshire. Considerable discrepancy exists in the nomenclature used as compared with that of Mr. Blackwall. This has mainly resulted from the well-known labours of Dr. Thorell, who, in his "Synonyms of European Spiders" (notable as a work in the English language published in Sweden), was the first to bring about tolerable uniformity in this respect. But very little inconvenience arises therefrom. Mr. Cambridge's handbook cannot supersede Mr. Blackwall's work with its magnificent coloured plates. Both must be in the hands of all students of *Araneidea;* the former elucidates and supplements the latter.

Mr. Cambridge commences with a copious "Introduction" of forty-two pages, written in a pleasing and popular style, so far as is compatible with a due explanation of the anatomy, &c., and very readable to all so far as his general remarks on the habits, means of capture, preservation, &c., are concerned. Some of his remarks we hope to analyse more particularly hereafter, when we have the complete work before us.

Two important suggestions present themselves to us, as tending to render the book more useful. The first of these it is now impossible to apply. We think it would have been far better had the author intercalated the diagnoses of those British species not found in Dorsetshire amongst the descriptions of the others; this no doubt would have been done, but for the original indecision in the plan of the work. It is not yet too late to consider the other suggestion, viz., that a table of the family and generic characters be given at the end of the second volume. The expression at p. xxxvii. of the introduction, to the effect that "the subject of classification being practically exemplified in each of the ensuing descriptions, need not be further gone into here" is not in keeping with the popular aims of the work, and is not fair to those students who have not already acquired a considerable amount of that knowledge possessed by the author.

The three plates are excellent, and in Mr. Cambridge's usual analytical style. The work reflects great credit upon the local Society that issues it, which deserves the support and hearty thanks of all (we fear but few) who are interested in British Spiders.

Studies on Fermentation; the Diseases of Beer, their Causes, and the Means of Preventing them. By L. Pasteur, Member of the Institute of France. A Translation, made with the author's sanction, of "Études sur la Bière," with Notes, Index, and original Illustrations by Frank Faulkner and D. Constable Robb, B.A. Oxon. (London: Macmillan and Co., 1879.)

We thoroughly agree with the following sentence from the English edition of Pasteur's important work: "The debt which English brewers owe to M. Pasteur can hardly be over-estimated;" but, further than this, we believe that the debt which biologists of all countries owe to him for his researches is also a very large one, for it is by a study of these low and simple forms of life that they may expect to learn something of the very beginnings of life itself.

On the appearance of the original work a very elaborate notice of it appeared in these pages (NATURE, vol. xix. p. 216); we need, therefore, now only call attention to this excellent translation, which contains many notes supplementing the facts mentioned in the original edition, several original illustrations, which cannot but be of great value in the microscopical study of the changes in the liquids with which the brewer has to deal, and an excellent index, which immensely facilitates the using of the volume.

This book may be, in the first place, one of special interest to the practical brewer, but it has a nearly equal interest for every careful student of nature, and it is so clearly written, with all the technical expressions so well explained, that we doubt not that the ordinary reader who takes it up will not put it on the shelf again without a perusal. The chapter on the physiological theory of fermentation is one we would specially commend to the general reader, to whom it may open up a quite new field for thought.

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.*]

Ice-Crystals

I do not know whether any satisfactory explanation can be given of the different forms assumed by ice-crystals on the different substances on which they may be formed. These forms are very various. During an intense frost some years ago I observed upon the handrail of a wooden bridge a perfect forest of ice-crystals very closely resembling the form of ferns, standing upright, or rather at right angles with the surface from which they sprang, with stems, midribs, and fronds, the only difference being the prominence of rectangular arrangements.

Everyone has seen the variety of forms assumed on window-panes, where the crystals do not take erect positions as they did in the case last mentioned, but lie flat upon the surface of the glass.

My object, however, now is to direct attention to another form assumed by ice-crystals which is comparatively rare, and which seems to me to indicate the action of forces of a very peculiar kind.

When frost occurs suddenly as a change from a mild atmosphere highly saturated with moisture (which is common in the climate here), a peculiar form of ice-crystal is often formed upon rotten branches lying on the ground under trees. This form is that of long silky filaments, from two to three inches long, like finely spun glass. These seem to effloresce from the rotten wood, and form plumes of the most exquisite delicacy and whiteness, often curling towards the ends, and lying over the branch from which they spring.

It is curious that this form of ice-crystal seems never to be attached to any rotten branch of which the bark is unbroken; but whenever the bark upon such branches has been split, broken, or exfoliated, then from the exposed ligneous surface in certain stages of decay, these lovely plumes of ice rise up, pushing their way from underneath the projecting bits of bark, then bending round them and curling over them.

What is it in rotten woody fibre which determines this peculiar form of the ice-crystal? The phenomenon seems to be due to some special "lines of force" connected with this special material under special conditions.

During the last two nights we have had sharp frost succeeding some very mild and very damp days. In the mornings it appeared as hoar frost upon the grass, but during the whole day, long after all hoar frost had disappeared, there were scattered, under all the old woods, shining spots of snowy whiteness, and on going up to these one found invariably that they were bits of rotten branches, with exfoliated bark, and bearing these peculiar plumes.

If any of your contributors can give any scientific explanation of this phenomenon, they would much oblige. ARGYLL

Inverary, January 13

Re-Reversal of Sodium Lines

The notice of the *Proceedings* of the National Academy of Science in NATURE, vol. xxi. p. 143, misrepresents, of course unintentionally, certain remarks of mine upon "dark" spectrum lines. I have not, and never have had, the slightest doubt that the dark lines of the solar spectrum are true absorption lines. The lines in question, which I am inclined to think may not be due to absorption, are only those produced in certain peculiar cases. If, for instance, a sodium flame be "urged," by increasing the intensity of the flame and the quantity of metallic vapour present, each of the two D-lines becomes double, as is well known, widening out and showing a dark stripe down the centre. Hitherto this dark stripe has been universally ascribed to the absorption produced by the envelope of colour-vapour surrounding the flame. But if a lime-light be placed behind the flame, then, as I have found by repeated experiment, this central dark stripe *re-reverses*, and we have the sodium lines quadruple, and dark upon a light ground. The experiment is rather delicate. The bead of fused sodium bicarbonate in the flame of a Bunsen burner is placed some two inches from the slit of a spectroscope of sufficient dispersive power to separate the sodium lines about a degree; then the incandescent lime is set four or five inches behind the flame, and so as to bring the edge of the shadow of the bead just on the slit.

Now it seems to me that this re-reversal shows that the dark stripe which appeared before the lime-light was placed behind the sodium flame, could not have been a mere *absorption*-line, but must have been due to a real doubling of the line, the substitution of *two* maxima of radiation for a single one; I am unable to see how, on the contrary supposition, the centre of the line should have less absorptive power than the two pairs of lines which show black when the lime is brought into action.

May I mention in this connection a very pretty experiment which shows that the *ordinary* dark line is simply due to absorption? Put into the spectroscope, in place of the micrometer wires, an opaque diaphragm of tinfoil with two narrow slits in it at right angles to each other, thus ⊥. Put the sodium flame alone in front of the collimator slit, and by a little management one of the bright lines can be brought to shine through the vertical slit in the diaphragm, while it can also be seen as a sort of star in the horizontal one below. Now bring the lime-light behind the flame; the brightness of the vertical slit will at once considerably increase, but the horizontal slit below exhibits what was before the star, as an intensely *dark* spot in the midst of the bright continuous streak of colour, showing very strikingly that the apparent darkness of the line when no diaphragm is used, is a mere effect of contrast.

The paper referred to in the report as a discussion of "the want of achromatism of the ordinary achromatic object-glass," was a comparison of the secondary spectrum of a glass of the usual form and of great excellence, formerly used by me at Dartmouth College, with that of the instrument now used here. The latter is of the Gauss form, and is found to be decidedly superior in its colour corrections, while it is inferior in no other respect. C. A. YOUNG

Princeton, N.Y., January 5

Death of Captain Cook

ON reading a paper reprinted from the *Memoirs* of the Boston Society of Natural History, vol. i. part 3, entitled "Notes on the Volcanoes of the Hawaiian Islands," by William T. Brigham, A.M., I find at page 370 the following strange paragraph: "Starting from the western coast at Kealakeakùa Bay—the memorable scene of Cook's *punishment*—the island may be described," &c.

With writers accustomed to the correct use of the English language, the word punishment infers crime. Its use here by Mr. Brigham may be only a bilious outpouring of New England puritanism, but as it stands on the face of a grave scientific paper, it is a permanent accusation against Capt. Cook, whose reputation and memory as one of our greatest navigators and geographical discoverers, deserve the reverence of every Englishman. If there be any charge against Capt. Cook's reputation or moral character, which can justify the slur gratuitously cast upon his character by Mr. Brigham, in the above passage, let it be substantiated by one of his countrymen in your pages or elsewhere, but if there be no grounds on which this grave slur is justifiable, then let it not stand unchallenged by your permitting this letter to appear in the pages of NATURE.

London, January 14 ROBERT MALLET

Electricity of the Blowpipe "Flame"

I HAVE discovered what I believe to be an important fact, viz., that the blue pyrocone produced by the blowpipe from an ordinary gas-burner is not merely magnetic, but possesses polarity, for its point *attracts the north pole of a compass, and repels the south pole.* W. A. ROSS

Acton House, Acton, W., January 17

Suicide of Scorpion

I MUST crave a bit of your space to beg Dr. Hutchinson (*vide* NATURE, vol. xxi. p. 226) to look to *facts* when he would refute anything based upon *facts*, and not trust to *inferences*.

My experience concerning *scorpion suicide* points to the *fact* that the "*central temperature*" of a circle of glowing charcoal embers (*i.e. glowing* when first placed on the ground in the open air, and left to die out gradually), one foot inner diameter, was never greatly in excess of the summer heat, often above 40° C. in the shade in these parts, and no doubt greater at Peshawar. I keep no record of this, but I have just made a circle of *glowing* embers of the size of walnuts, one foot in diameter, on the kitchen floor, before the open window, suspending immediately a Casella standard in the centre and one inch from the ground, and a highly graduated Secretan, two inches from charcoal and one inch from the floor, both bulbs free, the result being:—

Centre.—After three minutes, 49°·50 Cent.; at five minutes it had fallen to 46°, and continued to fall gradually.

Two inches from charcoal.—The heat declined gradually from 76° C., to which it rose quickly in the beginning; general temperature of kitchen = 15°·25 Cent. So much for Dr. Hutchinson's *glowing inference!* which points to little short of stupidity on my part.

The *fact* is that so far from being cruelly *scorched*, the scorpions I have watched did not appear out of their element, except when they tried to escape; then they quickly receded before burning themselves, and it was after many such attempts that they "pierced their head with their sting and died," as I have stated.

As to your correspondent's theory that "the *heat kills* the scorpion," it does not follow from the experiments as I conducted them; and as for his *defying* any one to *prove* that the insect dies in consequence of the self-inflicted sting, for my part I am no entomologist, and consequently am unable to make the necessary post-mortem examination. I simply state what I saw several times with a very good pair of eyes, though not, of course, "patent double-million-magnifying gas microscopes of *hextra* power." I now confirm the statement, and submit that if Dr. Hutchinson's paternal solicitude for *his* scorpions (which feeling, mind, I respect) prevents him making such cruel (?) tests, he should be content to doubt, and not pit unsound *inferences* against tangible *evidence*, much less hurl defiance at the heads of practical men. F. GILLMAN

Prov. Jaen, Linares, Spain, January 12

The Fertilisers of Alpine Flowers

A FEW years ago I stated my belief in this journal that lepidoptera are far more frequent visitors and fertilisers of flowers, and that from this cause by far more flowers are adapted to cross-fertilisation by lepidoptera, in the Alps than in the lowland. But it was then impossible for me to give a sufficient number of facts. Now, therefore, having continued my observations in the Alps during six summers, and being about to prepare a detailed work on "Alpine Flowers, their Fertilisation by Insects, and their Adaptations to them," I will here give a statistical statement of all visits of insects on flowers which I have observed (1) in the lowland, (2) in the Alps generally, (3) above the boundary of trees; the numbers under 1 being extracted from my work, "Die Befruchtung der Blumen durch Insekten, &c." (Leipzig, 1873).

Tabular Statement of the Visits of Insects to Flowers, observed by myself

	1. In the Lowland.		2. In the Alps generally.		3. Above the boundary of trees.	
	a. Species of insects.	*b.* Different visits to flowers.	*a.* Species of insects.	*b.* Different visits to flowers.	*a.* Species of insects.	*b.* Different visits to flowers.
Coleoptera	129	463	83	337	33	134
Diptera	253	1,598	348	1,856	210	930
Hymenoptera... ...	368	2,750	183	1,382	88	519
Lepidoptera	79	365	220	2,122	148	1,190
Other insects	14	49	7	15	3	6
Total	843	5,231	841	5,712	482	2,779

Hence of 1,000 different visits to flowers (differing either by the species of flower or by the species of insect) those by—

	1. In the Lowland.	2. In the Alps generally.	3. Above the boundary of trees.
Coleoptera are	89·66	59	48·22
Diptera ,, ...	305·49	324·93	334·65
Hymenoptera ,, ...	525·71	241·95	186·76
Lepidoptera ,, ...	69·77	371·50	428·31
Other insects ,, ...	9·37	2·62	2·16
	1000·00	1000·00	1000·00

Lippstadt, January 10 HERMANN MÜLLER

"Ideal" Matter

IN NATURE, vol. xxi. p. 185, you published a letter from Herr v. Nudeln, in which he alluded to the researches of Professors Hans and Lobwirmski respecting ideal matter of various degrees. Can you inform me whether any English publications have appeared on this subject, and if not, what foreign works would be best suited to give an insight of the results that have been arrived at to one who can devote but a limited time to such investigations?

Surely the conclusion suggested by your correspondent (viz., that the moon in its composition closely resembles caseine) is intended only as a joke; for, assuming the equation given,

$$M = C_m N_n O_p H_q,$$

and even granting that the quantities $m\ n\ p\ q$ are in such proportion as to make the right-hand member of the above equation assume the form of the chemical formula for caseine, there is surely no reason why the mass of the moon (which your correspondent has chosen to denote by C) should be interpreted as carbon, nor its direction of motion N as nitrogen, nor its velocity O as oxygen. PERCY R. HARRISON

Sun-Spots

IN the "Life of Charlemagne," written by Eginardus, one of the Emperor's household, and afterwards Abbot of St. Bavon's, in Ghent, occurs the following passage:—

"Per tres continuos vitæque termino proximos annos et solis et lunæ creberrima defectio, ac in sole macula quædam atri coloris septem dierum spatio visa."

"In three successive years nearest to his death [there were] very frequent eclipses of the sun and moon, and in the sun there were seen certain spots of a black colour, for the space of seven days."

This life, written between 814 and 843, and referred to by the writer's contemporaries, has been collated with several MSS. by the Bollandists, who give it in full in their Acta Sanctorum under January 28. It is a curious, if not a valuable, contribution to the early history of sun-spots, and suggests questions which some of your correspondents may care to consider.

HENRY BEDFORD

All Hallows College, Dublin, January 15

A Clever Spider

IN a letter I have just received from my brother at Rondebosch, near Cape Town, he narrates the following, which I thought might interest some of the readers of NATURE:—

"On Friday I was much interested in watching a spider and male glow-worm. The spider was a common long-legged house spider who had a web in the corner of the room. It was an aristocratic spider, in fact. Presently a male glow-worm flew into the web, and in a few minutes the spider had wound him round and round till no Egyptian mummy was more securely housed. Just as this operation was being finished, a second glow-worm flew into the web, *a long way from the first*. Off goes the spider, and soon he, too, was encased in silk. Then I noticed that the spider went three times backwards and forwards between the head of glow-worm No. 2 and a main strand of his web. After this he went round cutting all the threads around the glow-worm until it hung by the head strands alone. The spider then fixed a thread to the tail end, and by it dragged the carcase in the direction of glow-worm No. 1 (presumably the larder). As soon as the rope attached to the head was taut, the spider made the rope he was pulling by fast to a strand of the web, went back, cut the head ropes, attached himself to the head, and pulled the body towards the larder, until the tail rope was taut. In this way, by alternately cutting the head and tail ropes and dragging the glow-worm bit by bit, he conveyed it to the larder, where it hung alongside mummy No. 1. Another presently flew in. After he was enwrapped in silk, the spider, whether on purpose or not I cannot say, cut the last thread by which he hung, and dropped him to the ground. Whether he thought that this morsel might get 'high' before he could eat it I cannot say. I should say that the prey was some twenty times the weight of the captor." LL. A. MORGAN

St. Thomas's Hospital, Westminster, January 12

Erratum in Paper on Tidal Friction

AN erratum has been pointed out to me in my article in NATURE, vol. xxi. p. 235, and I should be glad to correct it. The forty-second line of the second column of p. 236 runs:—"so that the earth will rotate faster than the moon revolves."

By a slip of the pen I here wrote "faster" instead of "slower." G. H. DARWIN

January 16

AFGHAN ETHNOLOGY

THE events now in progress on the north-western frontier of British India have for the third time in this century directed the serious attention of statesmen, historians, and ethnologists to the remarkable people who give their name, or rather one of their names, to the north-eastern division of the Iranian table-land. During the empire of the Sassanides the whole of this region, from Persia proper to the right bank of the Indus and from the Koh-i-Baba, Ghor and other western continuations of the Hindu-Kûsh to the Arabian Sea was known as Khorasan, that is, Khoristan, the Land of the Sun or the East. This term, with the gradual reduction of the Persian sway, has shrunk to the proportions of a province on the north-eastern frontier of the Shah's estates, and has been replaced further east by the ethnical expressions Afghanistan and Balochistan, the lands of the Afghans and Baloches. But these expressions, as so frequently happens, are so far misnomers and deceiving that the lands in question harbour many other peoples besides those from whom they are now named. In Balochistan, for instance, the most numerous, powerful, and influential element is not the Baloch at all, but the still unfathomed Brahûi, from which circumstance it has even been suggested that the country ought rather to be called Brahuistan. A similar suggestion could not certainly well be made with regard to Afghanistan, for here there is no other people who can for a moment compare with the Afghans in numbers or political importance. Still the subjoined rough estimate of the population according to nationalities will show that it is very far from being homogeneous:—

Afghans and Pathâns ...	Iranian stock	3,520,000
Tajiks	Iranian stock	1,000,000
Hindkis	Hindu stock	500,000
Hazaras and Aimaks ...	Mongolo-Tatar stock	600,000
Kataghâns	Tûrki stock	200,000
Badakshis	Galcha stock	100,000
Baloches	Iranian stock	100,000
Kizl-Bashes	Tûrki stock	75,000
Kohistanis and Siah Posh	Galcha stock	50,000
		6,145,000[1]

It will be noticed that in this table are included all the races forming part of the present Afghan political system taken in its widest sense, whose northern frontier is now marked by the upper course of the Oxus. Before dealing with the Afghans proper, with whom we are chiefly concerned, a few words may be devoted to each of the minor elements, all of whom continue to keep aloof from their neighbours, seldom or never intermarrying, and mostly retaining their own national customs, dress, religion, and speech. No general amalgamation has, in fact, yet taken place of these heterogeneous ingredients, so that we cannot speak of the Afghan in the same sense as we do of, for instance, the Italian, French, or English nations. The Afghan race, though by far the most numerous, has been politically predominant only since the death of Nadir Shah (1747), and its rule has been far too checquered by intestine strife and foreign troubles to have allowed time or opportunity for the slow process of

[1] This figure exceeds by about a million that usually given as the total population of Afghanistan. But recent exploration has shown that many of the tribes are much more numerous than had been supposed, and as our knowledge of the country increases, it will probably be found to contain even a greater population than that here given.

absorption to have made any perceptible progress. Next to them by far the most important are—

The Tajiks, who, here, as elsewhere in Central Asia, represent the old civilised Iranian communities, co-extensive with the former limits of the Persian empire, but since the ascendency of the Tûrki, Mughal, Afghan, and Brahui races, now forming politically the subject, socially the settled, trading, and agricultural elements in these regions. Persian, or some variety of it, is still everywhere their mother-tongue; hence, in Afghanistan they are collectively known either as Parsivân, *i.e.* Persian-speaking, or Dehgân, *i.e.* peasants or agriculturists. "The Tajiks are Iranians, a remnant of the old Persian population subdued by the Afghans, but still speaking Persian and retaining the Persian type of features" (F. von Stein, in *Petermann's Mittheilungen* for March, 1879); religion, Sunnite. Remotely allied to them are—

The Hindkis, of Hindu stock, who have been long settled here chiefly as traders, forming numerous communities, especially in the eastern districts, said to be mostly of the Shatri caste; religion Brahminical, speech Hindustâni.

The Hazaras and Aimaks, occupying the northern highlands between Bamian and Herat, the former in the east, the latter in the west, are undoubtedly of Mongolo-Tâtar stock, though now speaking rude Persian dialects. They claim descent, some from the Toghiani Tûrks, some from the Koreish Arabs, others from the old Kibti race, but seem really to be military colonists settled here by Jinghis Khân, Manku Khân, and Timûr. The Aimaks (the term simply means horde, tribe, clan), are of the Sunni, the Hazaras of the Shiah sect, and are consequently fiercely opposed to each other. Owing to this circumstance they have often been regarded as of different races, but "there seems no reason to doubt that the Aimaks and Hazaras are the same people, though separated . . . by the different sects they have adopted" (Col. C. M. MacGregor, "Afghanistan," p. 246); type, high cheek bones, with small grey eyes, scant beard, and low stature. The Aimaks occupy the Ghôr highlands, which must have been almost uninhabited when they settled there, for we read in the *National Chronicle* that about 1190 A.D., Sultan Shêhab-ed-dîn removed all the Afghan tribes from the Ghôr to the Ghazni highlands, "in order to become the bulwarks of the seat of empire and hold in awe the infidels of Hindustan." Of the Aimaks there are four main divisions, the so-called "Char Aimak" ("Four Hordes"): Taemûris, Taemûnis, Hazara-Zeidnats, and Suris, with a total population, according to some authorities, of about 450,000, including those now settled in Khorassan. The Hazaras, numbering at least 150,000, occupy the region stretching for 250 miles west from Kâbulistan, and are divided into thirty-eight main branches with numerous subdivisions, under chiefs bearing various titles, such as Khan, Sultan, Ikhtiar, Vali, Mîr, Mettar, and Turkhan, and hitherto practically independent of the Durâni Amîrs. Akin to them are—

The Kataghans, a main branch of the Uzbeks, forming the bulk of the population in Kunduz and Balkh, that is, the region now known as Afghan Turkestan, stretching from the northern slopes of the Hindu-Kûsh to the left bank of the Upper Oxus. They take their name from a legendary Kata, from whom they claim descent in two main streams, the Beth-bula and Cheguna, with five and eleven sub-divisions respectively, each named after one of Kata's sixteen sons. Most of the tribes occupy the country south of the Oxus, but 7,000 families are now settled north of that river, consequently in Bokhara territory; religion Sunnite, speech Tûrki; type, small stature, broad face, high cheek bones, sparse beard, small oblique eyes. Are now mostly settled agriculturists and traders.

The Badakhshis, or natives of Badakhshan, in the extreme north-east, beyond Kunduz, and abutting on the Pamir table-land, are a pure Aryan race, intermediate between the Iranians and Hindus, and of the same stock as the highland Tajiks, whom Ch. de Ujfalvy groups under the collective name of Galchas.[1] Chief divisions, Darwazi, Roshâni, Shugnâni, and Wakhi, or Wakhâni; religion Sunnite, speech Aryan, with Persian and Indian affinities. The Wakhi is a distinct variety, retaining many old Sanskritic elements, hence R. Shaw thinks it may be a relic of a primitive organic Aryan language current here before the race issued from the Pamir, or divided into Vedic and Zendic. It would be interesting to compare it with the Jagnôb, which de Ujfalvy tells us is unintelligible to the other Galcha tribes of Ferghâna. A Galcha skull which has found its way to Paris, has been examined by P. Topinard, who pronounces it to be identical with those of the early Keltic Aryans. If their speech also should prove to be of an organic Aryan type, as constituted previous to the dispersion, de Ujfalvy's view might be unreservedly accepted that "Ces pays mystérieux recèlent sans doute le secret de l'origine de notre race."[2]

The Baloches, of Iranian stock, and regarded by the Afghans as their brethren, are represented in Afghanistan chiefly by a number of hill tribes in the south-east corner, and by some nomads in the south and west along the Lower Helmand. Most of them belong to the Rind section of the Baloch race, the more important being the—

Kasrânis and Bozdars, on north-west border of Dera Ghazi Khan: numerous sub-divisions, the Bozdars alone with sixty-four septs (Major Minchin).

Khosahs, south of Sanghar Pass towards Shikarpur; four divisions: Kalulani, Bakiani, Toniani, Sariani.

Laghâris, overlooking the Sakhi-Sawar Pass, Dera Ghazi frontier; four divisions: Aliani, Hadiani, Boglani, Habtiani; fifty-six sub-divisions.

Gurchânis, south of the Laghâris, about Chachar Pass.

Maris, Sham district, east, north, and north-west of Kachi; four divisions: Ghazani, Loharani, Bijarani, Mazarani; twenty-two sub-divisions. The Mazarani have separated from the rest, and are now settled west of Sebi and north of the Bolan Pass.

Bûgtis, south of the Maris; two divisions: Firozani, Zarkâni; thirteen sub-divisions.

Kayânis, Seistân, former rulers of that country; by some said not to be Baloches, but Kâkar Afghans.

Religion, Sunnite; speech, a rude, uncultivated variety of the old Persian; type, regular Caucasian features, light or brown complexion; hair often chestnut and even fair; eyes light grey and sometimes blue, especially in centre and north. Of the many forms of the national name, Baloch, Biloch, Belûch, Balûch, Bilûch, &c., Baloch is the best, coming nearest to the true pronunciation, as Pottinger assured his French translator, M. Eyriès.

The Kizl-Bashes, or "Red Heads," known collectively as Gholam-Khani or Gholam-i-Shah, "servants of the King," are of Tûrki stock, and have been settled in Herat, the Gulkoh Mountains, but chiefly in Kâbul since the time of Nadir Shah. The term was originally applied by Shah Ismaîl to the Nikâlu, Jawânsher, and four other trusty Tûrki tribes to whom he owed his successes. But since then they have become a sort of brotherhood "much akin to the Beyyadîyah or 'White Boys' of Oman, and bearing some analogy to the Mormons" (W. G. Palgrave, "Report on Province Trebizond," 1868). Those of Kâbul form three divisions: the Jawânsher, originally from Shîsha, the Afshar, Nadir Shah's tribe, and the Morâd Khani, composed of all the other Tûrkis who have from

[1] "Le-Badakchân est également habité en grande partie par des Tadjiks montagnards" (*Bull.* de la Soc. de Géo., March, 1879, p. 250). But Robt. Shaw ("High Tartary") says that physically they approach nearer to the Kashmirians and other Aryans of Northern India. This is borne out by their speech, which is more akin to the Sanskritic than to the Iranic family.

[2] *Loc. cit.* p. 252.

time to time removed from Persia to Kâbul; religion, Shiah, with secret rites; speech, Persian, and amongst themselves, Tûrki; are a very fine race, very fair, with an evident mixture of Iranian and Tâtar blood.

The Kohistanis and Siah Posh ("Highlanders" and "Black Clothes") forming the bulk of the population in Kohistan, Swat, Kafiristan, Chitral, and generally of the southern slopes of the Hindu-Kûsh down to the left bank of the Kâbul river, are of pure Aryan stock, allied to the Kashmirians, but probably more closely to the Badakhshis and Wakhis. The Kohistanis are Moslem, the Siah Posh still mostly pagans, hence called Kâfirs, or Infidels, by their neighbours, and their country Kafiristan. Their speech, of which there are ten distinct varieties (Major Tanner), is described as neo-Sanskritic, akin to Dardu and Lughmâni. But it has never been critically studied, and may possibly prove to be pre- rather than neo-Sanskritic; is in any case of great philological interest, having been isolated from the kindred tongues since the eruption of Islâm in the tenth century; type, regular features, blue and dark eyes, hair varying from light brown to black, broad open forehead, tall and well-made. But General A. Abbot ("Correspondence," edited by C. R. Low, 1879) distinguishes between a fair type with blue eyes, the aristocracy "descended of the Greeks"(?) and a very dark type, the aborigines. The Kohistanis north and north-west of Kâbul, C. R. Markham says, are mainly Tajiks (*Proc.* Geo. Soc., February 2, 1879, p. 117); but they are more probably of the kindred Galcha stock, for those of Swat are represented as closely akin to the Siah Posh whom I take to be of this race. They form two main sections, the Torwals and Garwis. They took a large share in the recent events about Kâbul and have just been reduced by the British. The Safis, who have also lately been heard of in the same neighbourhood, are simply Siah Posh converts of the Tagao valley, Kunar district, north of Kâbul; three divisions: Wadin, Gorbaz, and Mûsawîd; speech Pashae, closely allied to Lughmâni and Kohistani of Swat.

We come now to the Afghans proper, whose original home seems to have been the Kâbul valley, whence they spread westwards to the Ghôr country, southwards to the Suleimân mountains, and more recently down the Helmand and Arghandâb valleys to Kandahar.[1] They call themselves Bani-Israel, "Sons of Israel," claiming descent either from Saul or from the ten tribes, for on this point they do not seem to be quite clear. But this is of the less consequence that both claims are alike inadmissible. Notwithstanding a certain Jewish expression, which they have in common with the Armenians and other races of the Iranian plateau, they are beyond all doubt an Aryan and not a Semitic race, so far as these terms can be at all used as racial rather than linguistic designations. And here it may be well to remember that both Aryan and Semite belong equally to one ethnical stock, conventionally known to anthropologists as the Caucasian or Mediterranean, and that they can often be distinguished one from the other only by the test of language. We have the same phenomenon in Europe, where but for their speech no one would ever suspect that the Basques of the western Pyrenees were other than a somewhat favourable specimen of the Aryan race. This test, however, is abundantly sufficient to sever them from that connection, and the same test must suffice to remove the Afghans from the Semitic to the Aryan group.

Their most general and apparently oldest national name is Pukhtûn or Pakhtûn, as it is pronounced by the Khaibarîs, and which has been identified with the πάκτυες, of whom Herodotus heard through Scylax (509 B.C.) as situated about the junction of the Kôphes (Kâbul) and Indus. Their country they still call Pukhtûn-khwa, which is equivalent to Watan-khwa, or "Home Land"; their language is always called by them the Pukhtû, softened in the west to Pushtû, and from Pakhtâna, the plural of Pakhtûn, comes the form Pathân by which they are known throughout India. This word has been connected with the root Pukhta, a hill, so that Pukhtun would mean Highlander. But such derivations are seldom trustworthy, and it may be questioned whether any people have ever called themselves *Hill-men*, though often enough so named by their neighbours.

The alternative national name, Afghân, by which they are exclusively known in Persia and Europe, has been regarded by some as synonymous with Pukhtûn, both meaning "set free;" but by others it has been connected with Açvakan, the Açvaka, or "Horsemen," of the Mahâbhârata, who are supposed to be the Assakani, or Assekenes, of the later Greek historians. The natives themselves draw a distinction between the two names, so that although all Afghans are Pukhtâna, not all Pukhtâna are true Afghans. The latter term is properly restricted to the descendants of a legendary Kais, one of the first apostles of Islâm (ob. 662), from whom, through his three sons, Sarabân, Batân, and Gurgûsht, are supposed to spring the 277 Afghan khels (tribes) proper. Of non-Afghan khels there are reckoned 128, making 405 Pukhtâna khels altogether. Of these 105 are Sarabâni (from Sarabân), 77 from Batân, in two divisions; Batanai 25, and Matti 52, these last being known as Ghilzae; 223 from Gurgûsht, also in two divisions; Gurgûshtai 95, and Karalânai 128, these last being the non-Afghan or Pukhtâna khels as above. In this traditional account of the national genealogies the distinction between the true Afghan and non-Afghan tribes is already obscured, for the latter are made to descend from Gurgûsht, one of the three sons of Kais, who is elsewhere represented as the ancestor of the true Afghans alone. But the confusion becomes intensified when it is added that the very word Pathân, specially applicable to the non-Afghans, and which we have seen is merely the Indian form of Pakhtâna, is explained to be a corruption of Pihtan, "rudder," a title said to have been conferred on Kais by the Prophet himself. Altogether the distinction, though still maintained and recognised by the various sections of the people, cannot at all be regarded as racial. The true Afghans occupy mainly the western, central, and north-eastern districts—Herat, Seistân, Kandahar, and the Kâbul basin, as far east as Peshâwar. The non-Afghans, or Pathâns proper, are found almost exclusively in the Sufed-Koh and Suleimân highlands, as far south as the Kaura or Vahû Pass, opposite Dera Fatah Khan. A line drawn from about the parallel of Multân, through this point, westwards to Tal through the middle of the Derajât, will very nearly form the boundary in this direction of the Pathâns on the north, and the Baloches and Brahuis on the south. This relative geographical area suggests a possible explanation of the distinction between the two great divisions of the race. From their more westerly position it is obvious that the true Afghans must have been the first to adopt Islâm, and they may have thus come to look upon their pagan brethren of the Suleimân highlands as Kâfirs, undeserving to rank as genuine Afghans, the distinction thus originated naturally surviving their subsequent conversion.

In the subjoined table an attempt is made to give, for probably the first time, a complete classification of all the main sections of both divisions, with their chief sub-branches, approximate number of khels, geographical area, and population. The difficulty of the subject, occasioned mainly by the minute tribal sub-divisions, may be concluded from the fact that a complete genealogical tree of, say, the Afridis or the Vaziris alone, would occupy about two pages of NATURE.

[1] Till the time of Sultan Babur, founder of the Mughal empire (beginning of sixteenth century) the Afghan language was still confined to the north-eastern and western highlands, Persian being elsewhere current, as it still is mostly in the lowlands.

TABLE OF AFGHAN AND PATHÂN TRIBES.

Main Sections.	Chief Subdivisions.	Total No. of Khels.	Geographical Position.	Population.
I. Durâni or Abdali ...	1. *Zirak*:—Popalzae, Alikiozae, Barakzae 2. *Panjpao*:—Murzae, Alizae, Ishakzae	135	Mainly in the tract between Herat and Kandahar, 400 miles long, 80 to 150 broad; also in Kâbulistan.	800,000
II. Khugiâni...	Vaziri; Khairbûn; Sherzad	32	Chiefly in the Jalalabâd district, between Surk-âb and Kâbul rivers. Seem to have been originally a branch of the Panjpao Durânis.	50,000
III. Ghilzae or Ghilji ...	1. *Turân*:—Ohtak, Sakzae, Tunzae 2. *Bûran*:—Chin, Chalo, Zabar, Ali, Sulimân	140	In the country bounded N. by the Kâbul river, E. by the Suleiman Mts., W. by the Gulkoh Mts., S. by Khalat-i-Ghilzae and Poti; 300 miles long, 100 miles broad. A branch at Khubes and Nurmanshahr, Persia.	600,000
IV. Yûsafzae	1. *Mandân*:—Usmân, Utmân 2. *Yûsaf*:—Isâ, Iliâs, Mali, Rani	130	The hills N. of Peshâwar district and in the Yusafzae division of the Peshâwar district.	700,000
V. Mohmandzae or Mahmandzae	Tarakzae; Halim; Baizae; Khwai; Utmân	63	The hills N.W. of Peshâwar between Kâbul and Swat rivers; chief town Lalpûra.	40,000
VI. Kâkars	Jala; Musa; Kadi; Usman; Khidar; Abdula	45	Extreme S.E. corner Afghanistan proper.	200,000
VII. Khataks	Tari; Taraki; Bolak	70	S.E. part Peshâwar district, and S. and E. of Kohat; some also now amongst the Yusafzaes.	100,000
VIII. Utman Khel	Asil; Shamo; Mandal; Ali	33	The hills N. of Peshâwar between the Mohmands and Yûsafzaes.	80,000
IX. Bangash	Miranzae; Baizae; Sâmalzae	20	Miranzae, Kohat, and Kûram valleys; said to be originally from Seistân.	100,000
X. Afrîdis	Kuki; Malikdîn; Kambar; Kamr; Zakha; Aka	180	Lower and easternmost spurs Sufed Koh Mts., W. and S. of the Peshâwar district, with Bara valley and parts of Chura and Tira valleys.	90,000
XI. Orakzae or Wurukzae	Daolat; Utman; Sipah; Ishmail; Rabia; Isa	70	The Tira highlands, N. and W. of Kohat.	30,000
XII. Shinwâris or Shanwâris	Sangu; Ali Sher; Sipâi; Babur; Lohargae	30	Parts of Khaibar Mts., E. valleys of Sufed Koh and on borders of Bajâwar. *Note.*—X., XI., and XII. are collectively known as the *Khaibarîs*.	50,000
XIII. Tirâes	Shibdwani; Seh Paî	8	In the Kot valley of the Shinwari country, but distinct from them.	7,500
XIV. Jaduns or Gaduns ...	Salâr; Matkhwa; Mansur	10	S. side Mahaban Mts. and Hazara district, Peshâwar; said to be Kâkars originally, though now with the Yûsafzaes.	5,000
XV. Tarins	*Spin*:—Shadi, Marpani, Lasrani *Tor*:—Bateh, Haikal, Mali	20	N. frontier Biloch province Kachi.	20,000
XVI. Povindahs	Lohani; Nasar; Niazi; Daotani; Kharoti; Miani	120	From head of Gomal S. to head of Lora river along W. Suleiman range, their territory forming a triangle hemmed in between the Ghilzaes, Vaziris and Kâkars.	50,000
XVII. Vazîris or Wazîris ...	1. *Utman*:—Mahmud, Ibrahim 2. *Ahmad*:—Shin, Sirki, Umur 3. *Mahsud*:—Ali, Shahman 4. Gurbaz; 5. Lali	320	Suleiman Mts. from Thal to Gomal Pass, 30°-32° N. lat. A branch now with the Khugianis (II.)	250,000
XVIII. Shirânis	1. *Chua*:—Yahîa, Bairam 2. *Sen*:—Ahmad, Yahia 3. *Uba*:—Ahmad, Mann	130	Suleiman Mts. from the Shekh Hidar Pass southwards to the Ramak.	35,000
XIX. Bâbars	Mahsud; Bahâdin; Musa; Ahmad; Mardân	15	In the Koh-i-Daman of the Dera Ishmail district, opposite the Sangâo and Dahina Passes; same stock as the Shirânis.	20,000

TABLE OF AFGHAN AND PATHÂN TRIBES (*Continued*).

Main Sections.	Chief Subdivisions.	Total No. of Khels.	Geographical Position.	Population.
XX. Turis	Gundi; Ali; Mula; Mastu; Firoz; Maru	52	Kuram valley. (See *Note* under XXI.)	30,000
XXI. Jajis	Maidan; Danni; Isteah; Algarh; Ada; Lehwanni; Ali; Ahmed; Bian, Shamu	50	Kuram valley, mostly about River Ariab and from the Shutar Gardan to the Paiwar Pass. *Note.*—XX. and XXI. are not regarded as true Pathâns, being traditionally sprung of two Mughal brothers, Tor and Jaji. Edwardes says they are Khatar Hindkis from Rawalpindi.	4,000
XXII. Zaemûkbts	1. *Khwaidad*:—Bâbakar, Hasn 2. *Mahamad*:—Wati, Manatu, Mandan	33	In the hills between Mîranzae and Kûram.	25,000
XXIII. Dawaris	1. *Tapi*:—Haidar, Idak 2. *Mâlâi*:—Darpa, Amzani	6	Dawari valley, 32° 57′–33° 7′ N. lat.	20,000
XXIV. Khostwâls	Ishmail; Matûn; Mandu; Shamal	10	Upper Khost valley, adjoining Kûram and Zurmat.	12,000
XXV. Mangals	*Lajhwar*:—Fattakeh, Agar, Andaz, Miral, Khajuri, Zab	14	On Lajhi river, Kuram valley, and parts of Zurmat; are supposed to be of Mughal descent.	25,000
XXVI. Jadrans[1]	—	—	East of Zurmat, E. side of Suleiman Mts.	15,000
XXVII. Ushtarânas	1. *Gagal*:—Shaho, Musa, Ako, Shamo 2. *Ahmad*:—Ibrahim, Kadr, Mashar	42	The hills opposite extreme S. part Dera Ishmail district. Are disowned by the Afghans, though apparently of Lohani (Povindah) stock.	8,000
XXVIII. Esots	1. *Noh*:—Ahmad, Zado, Jahan, Chado 2. *Mûlâ*:—Ado, Khidr, Painda, Khadi	15	The hills west of Dera Ishmail Khan. Are said to be of Kâkar origin, though now distinct; Troglodytes.	5,000
XXIX. Jafars	Ramdani; Mohra; Rajâli; Rawâni	12	Between the Bûj spur of the Suleimân Mts. and the Bozdar Biloches.	5,000
		1,790		3,521,000

Of the main sections in this table, Nos. I. to XII. inclusive are recognised as true Afghans, and of these, Nos. I. and III. (Durânis and Ghilzaes) are by far the most important and influential. Since the time of Nadir Shah, the Durânis have been the ruling tribe, the Popalzae division till 1818, the Barakzae from that year to the present time. They were formerly called the Abdali or Avdali, a name which has been traced to the Ephthalites and Abdela of the Byzantine writers of the sixth century. But it was changed to Durâni from the title of Durri-Durân, "Pearl of the Age," assumed by the Sardar Ahmad Khan, of the Saddozae branch of the Popalzaes, when he usurped the supreme power at Kandahar on the death of Nadir Shah in 1747. The seat of government was removed from Kandahar to Kâbul by his successor, Taimûn Shah (ob. 1793), and this dynasty became extinct in 1818, when it was succeeded by the Barokzaes in Kâbul, though various descendants of Ahmad Khan continued and still continue to assert their claims to the sovereignty in Herat.

Although mentioned in the national genealogies, the right of the Ghilzaes to be considered as Pukhtûns at all, much less genuine Afghans, has been questioned. There certainly seems to be a flaw in their escutcheon, and they themselves, who always call themselves *Ghilji*, and not *Ghil-zae*, claim Tûrki descent. The national tradition is that they entered the country in the tenth century under a certain Sabaktakin, of the Kilich Tûrki tribe "anciently situated on the upper course of the Yaxartes"[1] (Syr Darya). But, however this be, they are now entirely assimilated in habits, dress, religion, and speech, to the other Afghan tribes, with the exception of a few who are still nomads.

None of the other sections call for special remark except the Povindahs, who are at once agriculturists, traders, and warriors, their armed caravans yearly fighting their way through the intervening hostile tribes down to the markets of the Panjâb and Sindh. The name is supposed to derive from the Persian Parwinda, a bale of goods, and seems to be indifferently applied to the Lohanis, Waziris, Kâkars, Ghilzaes, or any other tribe temporarily or permanently forming part of this singular "trades' union." By far the most important section are the Lohanis, the oldest and most numerous members of the association, and one of the most promising elements for the future pacific settlement and material prospects of the country.

Physically the Afghans may be described as, on the whole, a fine race. Their features, though often coarse and ugly, are regular in the European sense of the term, with the occasional Jewish cast above remarked upon.

[1] I have not yet succeeded in obtaining the subdivisions of this section, and will feel obliged if any reader of NATURE will kindly communicate them, together with any other omissions or rectifications that may occur to him.

[1] H. W. Bellew, "Afghanistan and the Aghans," 1879.

Type, long, oval face, arched nose, head mesaticephalous, that is, intermediate between the round and the long, measured horizontally, with cranial index 79;[1] fair complexion, thick beard, hair and eyes generally black, but light blue or grey eyes and brown hair common amongst the Rohillas,[2] as the Suleimân highlanders are often collectively called.

The great bulk of the people are Sunnites, which is one of the causes of their profound aversion to the Persians, who are mainly of the Shiah sect. Yet the nobles and upper classes, especially amongst the Durânis, usually converse and always correspond in Persian. The consequence is that the Pukhtu, or national language, has remained a somewhat rude idiom, seldom employed in literature, and in refined society regarded as little better than a provincial patois. Its importance philologically is considerable, for though usually grouped with the Iranian branch of the Aryan family, Dr. Ernest Trumpp (Grammar, 1873), gives it a more independent position as intermediate between the Iranic and Indic, while Prof. Haug, of Munich, now regards it as a separate member of the family. It is very harsh and spoken with considerable dialectic variety everywhere in Afghanistan proper except the Hazarajat, and also in the Peshâwar district of British India. The most marked dialects seem to be the Kandahari, Dir, Tirhai, Peshâwari, Khaibari, Tarni, Vazîri, and Ushtarâni. The Pashae and Laghmâni, sometimes included in the list, are not Pukhtu at all, or even Iranian, but distinctly Sanskritic, closely allied to the Siah Posh and Kohistâni.

A. H. KEANE

THE METEOROLOGY OF SOUTH AUSTRALIA[3]

MR. CHARLES TODD sends us a well-written and eminently practical paper on the rainfall of Adelaide during 1878, illustrated with a map showing the positions of the 115 stations for the observation of the rainfall of that part of Australia and their rainfall for the year. Along with the monthly rainfall for 1878 there are printed the monthly means of forty-three of the stations at which the rainfall has been recorded for at least eight years. Since these stations extend right across the continent from Palmerston in the north to Cape Northumberland in the south, we are now, through this boldly designed system of observation, obtaining just notions of the agricultural and pastoral capabilities of the colony, in so far as these depend on that prime factor of climate, the rainfall.

The rainfall of South Australia depends, on the one hand, on the tropical rains, which extend from the north coast inland, and prevail from November to April; and on the other hand on the winter rains, which extend from the south coast northwards into the interior, and prevail for the seven months ending with October.

The tropical rains extend in a greater or less degree across the interior, as far as lat. 26 S., falling off very considerably, however, south of Daly Waters, in lat. 16° 15′. The breadth over which these rains spread southwards and their copiousness depend altogether on the strength and southerly dip of the north-west monsoon, and consequently in the years when this monsoon blows over Australia with diminished force, a large tract of territory becomes nothing but an arid waste.

A different state of things, however, prevails along the north coast and for a few hundred miles inland. There the summer rains fail not. At Palmerston, for example, the average of the past nine years gives a monthly fall for each of the four months, from December to March, of 12·38 inches; in April, October, and November, the monthly mean is 3·68 inches; in May and September it is small, and in June, July, and August no rain falls. Here, then, is a large region, doubtless with a great future before it as regards the supply of the markets of the world with fruits and other tropical produce, such as have long been shipped from the rich plains of India and Ceylon.

The winter rains occasionally extend well up into the interior, sometimes passing the centre of the continent; but generally they thin off about 100 miles north of Spencer's Gulf, and are heavy north of this gulf only along the Flinder's range of mountains. The area of minimum rainfall of the continent extends from the Great Australian Bight to the northern extremity of the Flinder's Range, over the plains to the east of this range up to latitude 25°, and spreads either way to within perhaps a few hundred miles of the east and west coasts.

The agricultural districts of South Australia are marked off by the method of distribution of these winter rains; and roughly speaking, they lie for some distance northwards along and in the immediate vicinity of the Flinder's Range, and thence southwards along the coast to Cape Northumberland. This broadish strip of territory constitutes, then, the granary of the colony; and looking at Mr. Todd's rain returns in connection with the broad physical features of the region, it is likely always to remain so.

The close connection between the average quantity of wheat reaped per acre and the rainfall is shown in a table, giving for each year beginning with 1861 the yield per acre and the monthly rainfalls deduced from the observations of rain made over the agricultural districts during these eighteen years. In 1878 the rainfall over the agricultural districts was nearly 3 inches under the average, and the yield of wheat was only 7 bushels 9 lbs., or nearly three bushels under the average. Still more instructive would the comparison be if, instead of lumping the districts together, their average rainfall and average yield of wheat were presented in a separate form.

The *Meteorological Observations* made at Adelaide Observatory, published monthly, show also the rainfall at all the rain stations with remarks, the appearance of which cannot but be watched with the liveliest interest by the Colonists. Thus in January, 1876, it is noted that the monsoon scarcely reached the MacDonnell Ranges, south of which, and as far as the east coast, drought prevailed; and in the following month the information is given that although 10 inches of rain fell at Port Darwin, the monsoon rains were comparatively light and barely reached the centre of the continent.

The observations at the Adelaide Observatory are made, printed, and discussed with extremely satisfactory fulness for an observatory not furnished with continuously recording instruments. Of special value are the comparisons made of each month's observations with the means of these months from past observations. The sorting of the wind observations into the directions for each hour of observation, viz., 6 and 9 A.M., noon, 3, 6, and 9 P.M., give most interesting results. These show for the summer months a shifting of the wind from a south-easterly direction in the morning to a south-westerly direction in the afternoon, a result doubtless due to the situation of Adelaide with reference to the heated interior of the continent, as that heating varies during the twenty-four hours.

The weak point of this system of meteorological observation is the total absence of barometrical and thermometrical observations at all the stations except Adelaide. Such observations were made at some half dozen stations during 1861–64, but since then we miss them from the reports. It would not be possible to exaggerate the importance, not only to the colonists themselves, but to

[1] Barnard Davis, "Thesaurus Craniorum."

[2] From *roh* = the Persian *koh* = mountain, whence also Rohilcund, in Northern India.

[3] "Meteorological Observations made at Adelaide Observatory during 1876–77–78," under the direction of Charles Todd, C.M.G., F.R.A.S. "Rainfall of South Australia during 1878" (with map), by Charles Todd, C.M.G., F.R.A.S. Adelaide, 1879.

the whole body of meteorologists over the globe, of the establishment of such a system of weather observation across this continent; and, moreover, the establishment of an efficient system of stations with their necessary equipment of instruments and observers, could not be in better hands than his whose resolute will and organising genius girdled Australia with the telegraph.

ALGÆ[1]

PROF. J. G. AGARDH has taken advantage of the leisure afforded by his retirement from the Chair of Botany which he has filled so successfully for many years at the Lund University, to compose another work on algology. This very interesting volume, which embodies the results of observations made by the Professor during a long course of years, on the Morphology of the Florideæ, has just appeared in the *Transactions* of the Scientific Academy of Stockholm. It is written in the Swedish language, and is illustrated by thirty-three coloured plates of rare and little-known algæ, and of microscopic details of many others, beautifully executed by Swedish artists. It treats the subject in an exhaustive manner, as will be seen from a specification of the contents. The work is divided into three parts, each part being copiously illustrated by reference to the plates, and to descriptions of different genera and species.

Part I. treats of the general aspect and outer part of the Florideæ—their development and growth; of the root and its different forms; of the stem, branches, and leaves.

Part II., treating of the structure of the Florideæ, describes the nature of the cell-membrane and of the cuticle; the contents of the cell under different conditions of development; the various layers or strata of which the thallus is composed; the connection between the different cells, and the manner in which this connection is effected; the various ways in which the cells are formed; their different positions, and the manner in which they are grouped and united with the several strata.

Part III. describes the reproductive organs, namely, the antheridia, the sphærospores, and the capsular fruit and cystocarp, and concludes with remarks on the so-called "double fructification." This third part will doubtless attract the attention of algologists who may be desirous of knowing whether the views of the Professor, in regard to the fertilisation of the fruit in the manner recorded by MM. Bornet and Thuret, have undergone any change since the publication of the "Epicrisis" in 1876. It will be seen from the present work, that although Dr. Agardh has made multitudes of microscopic observations on British and exotic algæ, at all periods of growth, and especially of the species which formed the subject of Bornet and Thuret's experiments, he has not materially changed his opinion. He says that the observations hitherto recorded are too few in number to determine the question, and that, as yet, he has seen nothing confirmatory of the views of the French algologists. For his reasons and remarks we must refer the reader to the work itself. It is to be regretted that Dr. Dodel-Port's very interesting observations on the fecundation of the Florideæ by Infusoria, of which an abstract was given in NATURE, vol. xx. p. 463, were not published before the completion of Prof. Agardh's work.

Among the verbal descriptions and illustrations are many which are especially deserving of the attention of British algologists. Among them will be found microscopic representations of the fruit, hitherto imperfectly described and figured, of many British algæ. The cystocarpic fruit of *Callithamnion cruciatum* is now, it is believed, figured for the first time. Among the whole figures of algæ is one of a species which, although found on our southern shores, is almost unknown to collectors. This species is *Nitophyllum litteratum* [Plate xxvii. Figs. 1-4], which may—but very rarely—be seen in collections under the name of *N. Hilliæ.* From this last-mentioned species it differs in form, being more lobed, and also in the fructification. The sphærospores, instead of being scattered over the disc as in *N. Hilliæ,* are located between the numerous veins which mark the lower part of the frond. Minor differences are shown in the microscopic details. The capsular fruit of this species does not appear to be yet known. It therefore adds another instance to the long list of Florideæ which hitherto have been found with sphærosporic fruit only.

There is some diversity of opinion as to the place in a general system of classification of certain algæ of a red or purple colour, namely, Porphyra, Bangia, and Batrachospermum. By some of the later algologists they have been placed among the Florideæ, but Prof. Agardh is of opinion that they do not belong to the red seaweeds.

There is another group of algæ, which really belongs to the Florideæ, whose position in the system still appears to be uncertain. We allude to the family, *Corallineæ.* We remember to have noticed that it is not included in the classification of the Florideæ in the Epicrisis. We are, therefore, the more disappointed that there is no notice of this interesting group in the present work. Dr. Agardh's observations with regard to it would be most welcome. Had the present very valuable work been written either in Latin or English, it would undoubtedly have been more serviceable; as it is, however, algologists who do not understand Swedish may learn a great deal from the carefully-executed plates. Should the work be republished, it would be desirable to add a table of contents and an index.

The "List of New Zealand Algæ" is a useful supplement to the "Flora Novæ-Zelandiæ" of Hooker and Harvey. It consists chiefly of species which have been brought home by Dr. Berggren. The names of Hooker and Harvey have been generally adopted; but all the species described have been re-examined by Prof. Agardh, and many of them re-named in consequence of such re-examination. The new species and varieties are about sixty in number. Descriptions are given of new species, and copious notes on such of the already known species as require this addition are appended. M. P. M.

[1] "Florideernes Morphologi." af J. G. Agardh. *Kongl. Svenska Vetenskaps Akademiens Handlingar*, Bandet 15, No. 6 (1879).
"De Algis Novæ Zelandiæ marinis." In supplementum "Floræ Hookerianæ," scripsit J. G. Agardh. Lunds Univ., Årsskrift. Tom xiv.

GAS AND ELECTRICITY IN PARIS

SINCE the Jablochkoff light was established for the first time in the Avenue de l'Opéra, it may be said that there has been in Paris a regular competition between gas and electricity. The "Compagnie Parisienne d'Eclairage et de Chauffage" by gas is certainly one of the largest in existence, as it possesses every gas-work in Paris, and almost every one in the vicinity. A system of subterranean pipes and valves connects all these establishments, so that gas generated in Courcelles can be sent to any part of the city and suburbs if required. All these different works were conducted as separate establishments before the fusion which took place in 1854, under the auspices of the then existing Imperial Government. Two of these establishments are worthy of note—La Villette, as being the largest, the site of experimental and chemical work, and Vaugirard, where the retorts are warmed by the Siemens' heat-generating process.

Each of the twenty arrondissements of Paris has its special gas office. The Company also sells gas-engines, and makes great efforts to develop the use of gas as fuel for warming and cooking in private houses and shops. The price of gas is dearer in Paris than in any other capital of Europe, and the arrangements are difficult to understand without an explanation of the French municipal institutions.

The cry for more light having been raised in consequence of the experiments conducted with electricity, a new gas burner has been invented by the Compagnie Parisienne, and placed experimentally in several large public thoroughfares, principally the Rue du 4 Septembre, the Place de la République, formerly place du Château d'Eau, and a pavilion in the Halles Centrales. The burners used in the Rue du 4 Septembre are the largest, and all the new burners have been constructed on the same principle. The ordinary wing burners consume about 120 litres of gas each hour. In these improved lanterns six burners, representing an hourly consumption of 1,400 litres, have been placed at the six summits of a hexagon. In the centre is a hole for facilitating the introduction of air and better consumption. The effect is really highly satisfactory, and the luminous effect is far greater than in proportion to the gas consumed. A large number of coffee-houses, theatres, and first-class shops have adopted the burners for exterior use. It is impossible to use them within any building except markets, owing to the immense quantity of heat radiated, which would be a nuisance, at least in summer time. A number of these improved gas lamps have been placed in the Lyons railway station (passenger department), and will be, within a few days, used for competitive experiments with the Lontin electric light.

Besides the hole for admission of air, a gas-pipe is placed in the central part of the lamp. The aperture has been disposed so that a small jet is always burning, and thus for lighting the lamp it is sufficient to open the valve of the gas pipe, and the six peripheral burners are lighted at once. After midnight the jets are extinguished and the central one opened, burning with a consumption of 120 litres per hour, or like an ordinary old gas-burner. The supplementary gas consumed by the city is paid for at a very cheap rate, about 1*s.* 6*d.* per thousand cubic feet. It must be said, moreover, that the Chambre Syndicale des Tissus and other commercial institutions have organised an agitation to oblige the Municipal Corporation to diminish the price of the gas. The Commission of the Municipal Council is at present deliberating upon that important question. A large factory, the Say Sugar Refinery, close to the Orleans Railway Station, built a private gas-work for its own use. They consume yearly about 6,000,000 cubic feet, and will turn their own gas-makers.

In electrical lighting the division principle is represented in Paris by the celebrated Jablochkoff candle, and a diversity of opinions have been expressed on the subject. The apparatus in itself requires no description, but it is necessary to explain the results which have been obtained.

The Jablochkoff light, placed in an opal globe is considered as perfectly suited to large shops and large public thoroughfares, although the diminution of light by the interposition of the globe may be valued at 45 per cent. The price of effective light is enlarged in the same proportion. This is the reason why many persons suppose that from an economical point of view it will never do except in large open places, as the Place de la Bastille, where semi-transparent globes are used without fear of any complaints from shopmen or street passengers. But even for illuminating these large places, it is supposed by many competent persons that other electric lights would be more successful, and at all events more economical. The only place where the Jablochkoff candles can be considered as unrivalled are large establishments like the Grands Magasins du Louvre, the Buttes Chaumont and the Ville de France, where the effect obtained is alone considered without much regard to the expense. The illumination of the Palais de l'Industrie during the evening sittings of the Exhibition of Fine Arts, was a success last summer. It was not attempted a second time during the Exhibition of Sciences Applied to Industry, owing to several circumstances, having nothing to do with the value of the system. At the Hippodrome the illumination is effected by a combination of gas lights and Jablochkoff candles, and ordinary regulators with luminous points carefully concealed. The general effect is quite satisfactory, but the expense in motive power is considerable.

Jablochkoff candles are used in the illumination of large works carried on at present on the Seine for repairing the Pont des Invalides. These works have been interrupted for the last month owing to the frosty weather, but the Jablochkoff light has worked admirably. The use of the Jablochkoff candles is progressing immensely in private establishments, although the Municipal Council will in all probability discontinue the electric lighting of the Avenue de l'Opéra, the Place de la Bastille, &c., from February 1, and keep it burning only on the Place de l'Opéra. This impending resolution is attributed to the prevalence of the gas interest.

In the first months of the Jablochkoff trial, many complaints were made against the irregularities of the light; now extinctions are almost unknown, and the red colour of the electric flame less frequent.

Extensive preparations have been made in the green room of the opera for a comparison between Jablochkoff and Werdermann candles, and will be completed in a few weeks. It is argued by Werdermann's opponents that his light is merely incandescent light, and that the loss of illuminating power is far greater than with the Jablochkoff system. M. Garnier, the architect, being intrusted with the task of reporting on the matter, it would be unbecoming to give an opinion before his verdict is published. M. Reynier has another incandescent light offering some analogy with Werdermann's, but the contact being more intimate, the loss in power is larger, and the public exhibition of it has been considered a failure. It is regarded as merely an apparatus for lecturers wishing to show their audience an electric light with few elements. The lamp is cheap, and its working quite regular.

It should not be forgotten that even naked Jablochkoff lights lose a part of their illuminating power. A quantity of electricity, which may be valued at 30 per cent., passes through the insulating caolin or plaster.[1] Consequently it must not be wondered at, if some inventors tried to dispense with insulating lamina.

M. Denayrouze, the former lessee of the Jablochkoff candle, has purchased the Jamin candle, in which the electric flame is directed by the attractive power of magnetism or electricity. Private experiments have been made, and they are preparing for an exhibition in one of the suburbs of Paris. M. Jamin having to lecture at the Sorbonne on January 17 it is probable that the large hall will be illuminated by his own light on this occasion. This light company has purchased a patent for gas engines, and will try to use the gas under the furnace as fuel, dispensing with it for illumination. They are said to contemplate a public issue of shares for a large capital.

It is known that the principal difficulties in the construction of regulators, has always been the absolute fixity of the luminous point in space. It has led M. Serrin to the invention of his excellent regulator. But the use of the Jablochkoff light proved that inventors had gone too far in the way of complication, at least for street illumination, and where no dioptric or catoptric arrangement is contemplated. M. Suisse was the first to start a lamp which may be regarded as a simplification of Serrin's original, and is working very well. The carbon is placed upwards, and descends in proportion as the negative is consumed. In order to diminish that consumption the diameter of the negative carbon has been enlarged.

A number of regulators have been tried in competition

[1] It shows that a Jablochkoff candle placed in an opaque globe is diminished (1) 0·70 by the loss of the caolin, and (2) 0·50 by the opacity of the globe, so that it gives only 0·35 of the original illuminating power.

or will be, but Suisse's is now the only one which works regularly at the Lyons railway terminus, in conjunction with a few of Lontin's regulators and with Lontin's generator. The results of the illumination are quite satisfactory, eighteen lamps being fed at an expense of 36 kilogrammes of charcoal per hour during fifteen hours every day, and with an expense of 9 francs per hour, including three francs of royalty for the Lontin Company. When this extensive space was illuminated by gas, the expense at 19 centimes per cubic metre was 6 francs per hour, and would have been nine francs if the gas were charged 30 centimes, or the full price. The economy for the Company results from the immense augmentation of the light distributed. They were enabled to diminish by 70 per cent. the number of hands engaged in night work, and the risks from fire are reduced to nothing. Lontin's system will be tried within a few days, in competition with improved gas, on the platform of the passengers department.

At the exhibition of the Palais de l'Industrie, Lontin's machine is working regularly every day from two to the closing hour, which varied according to the hour of sunset. No accident has been recorded. Siemens's machine has been very seldom at work, owing to several circumstances which prevented the public from making a direct comparison. The engineer of M. Siemens's factory having been selected as one of the jurymen, Siemens's machine was *ipso facto* out of competition; consequently we will not risk giving any definite opinion at present, confining ourselves to known facts. We visited Siemens's light at the works established by the universal firm at Passy, and we were very much satisfied with the effect which we witnessed. The illuminating power and regularity were out of question.

All the work of the Jablochkoff candle is done with Gramme machines, which have been fitted with a current inverter.

Lontin, Suisse, and other regulators are worked with continuous currents, which is considered as more advantageous.

Three different magneto-electric generators are before the public: Gramme, Lontin, and Siemens, based on similar principles, having a strong similarity in many respects, each of them claiming priority. We cannot presume to give a definite opinion on their special value, or on the value of their respective claims. The question can only be settled by the city or the Government deciding for the illumination of some part of the city or of some large public buildings.

We can state, at all events, that the Meritens Company has started new machines, which we witnessed working with regularity at the Continental Hotel on the occasion of a great ball; that the Alliance machine, although excellent for lighthouses, has proved too heavy, too expensive, and too cumbrous for ordinary purposes. The Lontin machine is rotated at a rate of 200 or 250 turns per minute, and its rival from 700 to 800, which is a decided advantage in its favour.

It is not our province to adjust the claims relating to the manner of exciting almost any number of currents with a single generator and an electro-magnetic divider. But all the visitors to the Palais de l'Industrie have been astonished by the regularity of the Lontin light and its facility of combining the several arcs.

The other day the Ouest Railway Company established in the terminus of La Rue Saint Lazare three rival lights: Lontin, Parisian Company's improved lights, and Jablochkoff candles.

We decline to give a definite opinion of the respective merits of the Lontin and Jablochkoff systems before the moment when the numerous measures officially taken with a new photometer and the expenses in coals, electric carbon, and oil will be made public; but we can say that gas-light seems to be one-third dearer, and one-half only in general intensity.

Some of the great expectations raised when the Jablochkoff light was first exhibited have proved groundless. The shares of the gas companies have recovered from their depression, and reached at least their former value. But it cannot be said gas has conquered electricity, as electric lighting, with all its variety of origin and regulation, is gaining ground daily. Siemens's agents are at present fitting a large factory at Meaux with their regulators and generators. The works of installation of the Senate and Chamber of Deputies would have been impossible without the help of the electric light. A new influential daily paper, *Gil Blas*, has opened on the Boulevard de l'Opéra an "Halle aux Nouvelles," with no less than eight Jablochkoff candles. There is no part of Paris where electric lighting has not been exhibited, and its appearance is no longer a novelty, which is an all-important thing for its propagation.

In the meantime there are other inventors trying to generate electricity by new means. M. Beaudet has started a bichromate battery which he calls *unpolarisable*, perhaps without any real ground, but which, at all events, keeps in tolerable regulation for many days. M. Clamond has continued to produce a real electric light out of a series of thermal elements, which was considered as a mere impossibility a few months ago. We cannot say if the scheme of lighting by electricity out of a stove which warms an establishment, or a furnace which creates steam, is a Utopia, but we witnessed during some hours a light generated by the Clamond process, and a large workshop uses no other lighting process during the present winter.

The Municipal Council of Paris should open a public competition for lighting a large place or building, and invite all inventors of regulators and magneto-electric machines to place their apparatus in the hands of a competent commission, otherwise the question of electric lighting will remain in the dark for years, as it will be impossible for private individuals to decide which is the cheapest light produced and the best regulator.

W. DE FONVIELLE

NOTES

We regret to have to announce the death of Mr. George Wharton Simpson, the editor of the *Photographic News*, which took place at Catford Bridge on the 15th inst. He was well known to the large circle of amateur and professional photographers as an able chemist, a lucid writer, and a careful experimenter. As one of the very earliest followers of photography, he was fully acquainted with all the many phases through which that technical science has passed, and we believe that very rarely, if ever, did he err in a matter of photographic history or technology. There existed between the readers of his journal and himself a feeling of almost personal friendship, as no question was too trivial to be answered in his notices to correspondents, and the answer given was always of a kindly and helpful nature. To Mr. Simpson we owe, amongst other things, the perfecting of the collodio-chloride process, a process which for delicacy and permanency is up till now unrivalled. Mr. Simpson was also an occasional contributor to various daily and other journals, and some of these articles we hope may be reprinted, since they are really succinct histories of progress in the art-science with which he was so greatly bound up. He will not easily be replaced in his editorial position, since there are few, if any, who have lived through the stirring times which have made photography what it is, and have followed it with the attention which he bestowed upon it. The large gathering of literary men and photographers at Abney Park Cemetery on Tuesday last evinced the high esteem in which he was held.

It is rumoured that Dr. William Ogle, Fellow of Corpus Christi, Oxford, and Examiner in Natural Science in the

University, has been appointed to succeed Dr. Farr in the Registrar-General's Office.

SIR JOSEPH FAYRER, K.C.S.I., has been appointed Examiner for the Medical Service of the Army in Anatomy and Physiology, *vice* George Busk, F.R.C.S., who has resigned the appointment.

THE first meeting of the Society of Telegraph Engineers will take place on Wednesday, the 28th inst., when Mr. Preece, the new president, will deliver his introductory address.

M. DUMAS, who is the Chancellor of the French Academy, pronounced the speech in answer to M. Taine, the new member. Everybody was struck by the spirited delivery and eloquence of the venerable perpetual secretary of the Academy of Sciences. The house was so full that even academicians were unable to find room on their benches.

MR. CROOKES has been exhibiting his wonderful experiments on radiant matter in Paris at the École de Médecine, on Thursday, January 8, and on Saturday, the 11th; at the Observatory on Thursday, the 15th; and at the Société de Physique on Friday, the 16th. On all these occasions Mr. Crookes met with great success. M. Salle, a well-known physicist, spoke in the name of Mr. Crookes, who superintended the experiments. M. Gambetta and the Ministers of Public Works and of War were present at the Observatory, as well as the most influential members of the Institute.

THE *Times* Philadelphia Correspondent telegraphs on Sunday that the Edison electric lights in Menlo Park were still burning to the extent of about eighty lamps. Mr. Edison, finding that defective vacuums have developed in a considerable percentage of the lamps, has for several days been experimenting to improve the mechanical construction of the glass globe containing the light so as to insure a permanent vacuum. Mr. Edison's friends report that he is able to overcome the difficulty. Meanwhile, the manufacturing of additional lamps has been delayed, while no arrangements have yet been made practically to use the light in New York.

THE correspondent of the *New York Herald* has interviewed M. Dumas, M. Niaudet Breguet, Mr. Crookes, and M. Fontaine, the president of the newly established Syndicat d'Électricité. The object of the interviews was to obtain the opinion of these gentlemen on the Edison light, and the results have been telegraphed to America. We can state that they are not against the possibility of the success of Mr. Edison.

WE notice an important communication which was made by Prof. Kessler at the annual meeting of the St. Petersburg Society of Naturalists on January 8, on the "Law of Mutual Help," as one of the chief agents in the development and progress of organisms. Prof. Kessler, although an able follower of Darwinism, thinks that the struggle for existence would be insufficient to explain the progress in organic life, if another law, that of sociability and of mutual help did not powerfully work for the improvement of the organisms and for strengthening the species. M. Severtsoff warmly supported this view, quoting several examples which prove that the unsociable birds are in a state of decay; so, for instance, although the system of robbing is ideally organised by the hawks, nevertheless the species is in a state of decay precisely because of its want of sociability.

ON January 10 the Russian Physical and Chemical Society held at St. Petersburg its annual meeting. After the reports of the secretaries Prof. Mendeleeff gave an interesting address on the resistance of fluids; he gave an historical sketch of the subject, and, pointing out how little it has hitherto been investigated, and how important it is, he invited Russian physicists to give special attention to that part of hydrodynamics. Prof. N. Beketoff, from Kharkoff, read a paper on the dynamics of chemical reactions, and explained the electro-dynamical theory he proposes to explain them. Prof. Lentz made a communication on electrolysis, and M. Jablochkoff exhibited his new galvanic element.

M. LE BON, in rendering an account of the progress of his observations on the comparative mean weights of male and female skulls (*Bull.* of Paris Anthrop. Soc. t. v. fasc. 5) has explained the precautions which he had taken to avoid errors arising from considerations of the differences, bodily stature, age, race, and social or civilised status. After taking all these conditions into account, he finds a difference of 172 grammes in favour of the skulls of men over those of women. He asserts that while a newly-born girl has a heavier brain than a newly born boy—an advantage which she rapidly loses—the women of inferior races are relatively superior to those of highly civilised races, in other words, woman does not advance, and consequently, the differences between her and man are constantly augmenting. If M. le Bon's assertions are to be accepted as facts, they would undoubtedly seem to point to the necessity of bringing the opportunities of intellectual culture more closely within reach of women, but the learned doctor predicts that the abomination of desolation will fall on society if women be removed from the happy ignorance of their domestic hearths. Apart from his avowed preference for women with the cerebral capacities of savages, M. le Bon's memoir will be found of great use to the student of craniology, by helping him to determine the mathematical relations of different parts of the head, and their bearing on other parts of the body. We are glad to learn that the great value of his work in elucidating various obscure questions of general anthropology, have secured for it the award of the Godard prize for 1879.

AT Vienna a "Verein für Höhlenkunde" has been formed, with the object of investigating caves. Everybody taking an interest in this subject may become a member. The subscription is only 5 florins per annum. Dr. Franz von Hauer is the president, and Prof. Ferdinand von Hochstetter the vice-president of the new Society.

THE next German Anthropological Congress will be held at Berlin early in August next, and will be accompanied by an exhibition, illustrating prehistoric times in Germany. It will be closely followed by a Geological Congress to be held in the same city.

A MONUMENT of the late eminent naturalist and horticulturist, Freiherr von Siebold, will shortly be erected in his native town of Würzburg.

THE Japan papers record the fact that an enormous piece of coral was lately dredged up near Tosa. It is stated to have five branches, the stem being 15 inches in circumference and 5 feet in length.

THE Section of the Society of Arts formed in 1874 for the discussion of subjects connected with practical chemistry and its applications to the arts and manufactures, has been this year enlarged in its scope that it may include applications of physics as well as chemistry. At the six meetings of the present year the following papers will be read. The meetings are on Thursday evenings at eight o'clock, and the dates have been selected so that they do not clash with those on which the meetings of the Chemical Society are held:—January 22, "The Teaching of Technical Physics," by John Perry, late Professor of Engineering, Japan; February 12, "Gas Furnaces and Kilns for Burning Pottery," by Herbert Guthrie, C.E.; March 11, "The Noxious Gases Bill," by Dr. S. K. Muspratt, F.C.S.; April 8, "On Recent Improvements in Benzine Colours," by F. J. Friswell, F.C.S.; April 22, "On some Recent Advances in the Science of Photography," by Capt. Abney, F.R.S.; May 13, "On some Physical Applications of Light," by Prof. W. G. Adams, F.R.S.

THE *Thunderer* gun experiments were continued at Woolwich last Friday, the object on that day being to test what is known as the "wedging" theory—the supposition that the tilting or displacement of the wad had to do with the bursting of the original gun. The experiments on Friday tended clearly to disprove this theory.

THE Public Works Department at Yedo have just published the *Reports of Progress* for 1878 and 1879 of the Geological Survey of Japan under Mr. B. S. Lyman.

THE Indian papers state that experiments are about to be made in Cyprus to test the possibility of cultivating mango seeds, as well as the seeds of other Indian fruits and vegetables.

EARTHQUAKES are reported (1) from Weisskirchen, where on December 22 at 5 A.M. a violent shock was felt; (2) from St. Blasien, in the Black Forest, where a shock was noticed on the same day at 10 P.M.; (3) from Idria (Carniola), where a subterranean explosion took place at 8.30 P.M., combined with a violent shaking of the ground and a cannon-like report. Several shocks were felt at Churwalden (Switzerland, canton of Chur) on January 7, between 2 and 4 A.M.; the last shock was accompanied with a noise like that of thunder, so that people were awoke and dogs howled. In the Domochleg and at Savagnino only two shocks were felt, at 3h. 45m. and at 4h. 30m. The shocks had the direction from north to south.

AT Freiburg, in Breisgau, the beautiful and rare phenomenon of the fata morgana was observed at noon on December 16. While the sun was shining the fine pyramid of the Cathedral tower showed itself reflected above, of course with the point downwards. The reflecting stratum of air was almost at the level of the summit of the tower, thus producing a most peculiar effect.

WE are glad to see that the Epping Forest Field Club has been successfully formed, under the presidency of Mr. R. Meldola. From the tone which prevailed at the meeting of January 10, we should think the Club is likely to do good work. The original list of members is a pretty large one, and contains several well-known names.

THE continuation of frosty weather has produced unprecedented effects on the Lower Loire round Saumur. The bed of the river having an extent of about 1,000 yards, and the depth of water being very shallow, the Loire was entirely frozen and the flow of water towards the sea was almost entirely stopped. The consequence was that the level of the water was raised, and the walls protecting the low lands in danger of being submerged. It was necessary to employ dynamite to open a channel for the water. Unfortunately a part of the stream has found its way into the low lands. New ice is coming from the high lands, and the military have been ordered to work under the orders of civilian engineers.

AN ascent of Mount Hekla was made last summer by a lady, Miss Th. Petursson, daughter of the Bishop of Reykjavik, for the purpose of geological investigations. According to her observations the temperature at the bottom of the larger craters has of late risen considerably, while dense white columns of steam were rising from crevasses and holes which were hardly visible. The sulphurous odour of this steam was stronger than usual. The observations seem to indicate an approaching eruption of the volcano.

AN interesting archæological discovery has been made near Lehmke (in the district of Oldenstadt) consisting of some 1,200 mediæval metal plates, so-called *bracteæ*. Most of them bear the stamp of a lion in varying positions, others that of a figure with sword and standard, and a horizontal key below. The objects in question are now in the possession of the "Kreishauptmann" of Oldenstadt.

THE German Postmaster-General, Herr Stephan, and Dr. Siemens, have succeeded in constituting an electro-technical society, which has for its objects the furtherance and development of the technical application of electricity, the progress of the knowledge of electricity by means of its technical appliances, and the establishment of a place of meeting for German technical electricians, whose scientific and commercial interests will, of course, be greatly benefited by such mutual intercourse.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. F. C. Grosvenor; two Bankiva Jungle Fowls (*Gallus bankiva*), two Starred Tortoises (*Testudo stellata*) from India, presented by Mr. W. Dunn, C.E., C.M.Z.S.; a Bar-tailed Godwit (*Limosa lapponica*), a Grey Plover (*Squatarola helvetica*), six Knots (*Tringa canutus*), thirteen Dunlins (*Tringa cinclus*), European, presented by Mr. F. Cresswell; three Chinchillas (*Chinchilla lanigera*) from South America, a Grey Struthidea (*Struthidea cinerea*) from Australia, a Red-throated Amazon (*Chrysotis collaria*) from Jamaica, purchased; two Fulmar Petrels (*Procellaria glacialis*), North European, deposited.

OUR ASTRONOMICAL COLUMN

THE ORION-TRAPEZIUM.—The following letter has been addressed to us by Prof. Holden, of the Naval Observatory, Washington:—

"In NATURE vol. xxi. p. 117, there is a note on a seventh star in the Orion-trapezium, which is 636 of G. P. Bond's Catalogue. It is there rated as mag. 13·3. Two other stars, 612 and 618 of Bond's catalogue are as near one of the larger stars as 636 is, and if it is intended to extend the nomenclature of seventh star, eighth star, &c., to these stars (which seems inadvisable), they should be included. Their positions from θ^1 Orionis are:—

	Mag.	Δα (1857·0)	Δδ (1857·0)
612	13·5	− 16″·4	+ 24″·6
618	13·1	− 10·4	+ 24·6

The magnitudes are too faint for Argelander's scale extended, but serve to compare with that of 636 viz. 13·3.

"As tests for large telescopes, quite a number of small stars discovered by Bond may be mentioned, whose positions are given in *Annals* of the Harvard College Observatory, vol. v. All of these really exist, as they have been repeatedly seen with the 26-inch refractor of this Observatory. They are Nos. 595 (13·9m.), 601 (15·6), 608 (14·3), 621 (15·6), 625 (15·6), 631 (14·3), 666 (13·9), 677 (14·8), 676 (13·1), 642 (15·6), 675 (15·2). The faintness of these stars (which are much better seen with a low power than with a high one) speaks well for the diligence of the late George Bond, whose search in this region was very thorough. Other small stars exist in the neighbourhood as follows:—

"1. Rosse, No. 56, near G.P.B. No. 581.

"2. A star, s.p., G.P.B. No. 724.

"3. A double-star, n.f., G.P.B. No. 685.

"(2 and 3 were discovered by Lassell.)

"4. Three stars in or near the region bounded by the lines 641 to 663, 663 to 652, 652 to 641.

"5. A star or mass of nebula which is not yet three years of age, has developed itself in the middle of the dark channel half way between 669 and 642. The star (?) itself is, roughly, equally distant from 669, 641, and 642.

"There are no stars within the trapezium.

"Cooper reports a star following G.P.B. 516 a few seconds. I cannot find it.

"Any observations on these stars or on the celebrated variable 654 (frequently observed here) will be gladly received by me, and I shall be happy to have such for insertion in a paper now nearly ready on the Huyghenian region of this nebula."

For the convenience of such observers as may not have ready access to the "Annals of the Astronomical Observatory of Harvard College, vol. v.," which contains G. P. Bond's elaborate memoir on the nebula of Orion, the following differential positions of the stars mentioned by Prof. Holden, with reference to θ^1 Orionis, are extracted:—

	Diff. R.A.	Diff. Decl.		Diff. R.A.	Diff. Decl.
	"	"		"	"
No. 516	... −276·0	... − 29·5	No. 652	... + 30·2	... +171·6
581	... − 76·1	... −159·1	654	... 33·2	... + 10·0
595	... − 46·9	... − 15·0	663	... 55·5	... +147·1
601	... − 36·0	... − 31·0	666	... 59·7	... −195·8
608	... − 23·7	... − 18·0	669	... 63·3	... +100·0
621	... − 8·0	... − 36·0	675	... 74·5	... − 93·4
625	... − 4	... − 28	676	... 78·5	... − 27·6
631	... + 3	... − 42	677	... 78·6	... −201·4
641	... + 11·9	... +111·2	685	... 97·7	... − 95·0
642	... + 13	... + 48	724	... +183·3	... −176·0

It will be remarked that Prof. Holden states there are actually no stars within the trapezium. Mr. Burnham's experience with the 18½-inch refractor at Chicago is to the same effect.; in the notes to his last catalogue of double stars, he writes: "Several observers have seen, or believe they have seen, other minute stars in the trapezium, most of them using comparatively small apertures. While making the measures given above, and at other times, under very favourable conditions, the interior of the trapezium and the vicinity of the principal stars were carefully examined. There was not the slightest suspicion of any additional stars. If the sixth star itself had been double, with a distance of 1"·0, it could not have been overlooked. I have very little faith in the real existence of these suspected stars after the failure of this and other large refractors to show them." And he considers it is wholly improbable that they should all be variable in such manner as to render them at all times invisible during the last few years. Telescopes were not so perfect forty years since as they are now, and we might be perhaps justified in attributing to optical illusion the supposed existence of the three stars within the trapezium, recorded by De Vico in 1839, and the star, near the "fifth," detected by Struve, which Gruithuisen claimed to have discovered about the same time, and which he says Schwabe had also seen with a 6-feet Fraunhofer. But what are we to say to the observations of Dr. Huggins, as detailed in vol. xxvi. of the *Monthly Notices* of the Royal Astronomical Society? They appear to point to something more than optical illusion, and notwithstanding the negative testimony as to the actual existence of stars within the trapezium, to render it desirable that a protracted examination of this region should be instituted with telescopes of suitable capacity. One of Dr. Huggins's stars is not far from the position of a star in De Vico's diagram (see *Memoria intorno a parecchie Osservazioni . . . in Collegio Romano, l'Anno* 1839, plate I., and Gruithuisen's *Astronomisches Jahrbuch*, 1841, p. 143.

The Total Solar Eclipse of January 11.—A Reuter's telegram brings intelligence of the successful observation of the total phase in this eclipse on the Santa Lucia mountain, California, with the important addition that an intra-Mercurial planet has been again seen. In the longitude of this mountain the duration of totality upon the central line, employing the elements of the *Nautical Almanac*, would be only 38 seconds, with the sun at an altitude of 12°; if the semi-diameters adopted for eclipses in the American ephemeris are used, the duration would be even less—hardly 27 seconds. Under such circumstances it must have required very minute and skilful preparation and considerable smartness of execution to insure the results announced.

GEOLOGICAL NOTES

The MSS. of Sartorius von Waltershausen, descriptive of Etna, have been placed, we understand, in the hands of Prof. von Lasaulx, of Breslau, with a view to publication. They will complete the colossal pile which the veteran geologist erected to the glory of his favourite mountain.

Another distinguished and venerable vulcanologist, Dr. Abich has gone to Vienna to prepare his petrographical descriptions of the Caucasian region, in which he has been so long at work. The facilities for the most delicate analyses of rocks and minerals at Vienna have likewise attracted thither M. Renard, of Brussels, who has been entrusted with the chemical and microscopic investigation of the abyssal deposits brought by the *Challenger* from its great ocean survey. M. Renard is at present in this country arranging with the *Challenger* Commission as to the prosecution and publication of his labours. His beautifully drawn plates which illustrate the more remarkable facts brought to light by the *Challenger* dredgings, are being exquisitely reproduced by chromolithography in Vienna.

In a recent number of the *Bulletin* of the United States Geological and Geographical Survey of the Territories (a publication still continued for a while, though the Survey itself has ceased to exist), Dr. F. V. Hayden describes the Two Ocean Pass which has for some years been known to separate the head waters of the Yellowstone from those of the Snake River. He confirms and extends previous accounts of this interesting locality, showing that it is a flat meadow-like depression cut by erosion on the watershed. During wet weather this marshy ground becomes a lake which drains both ways, one branch finding its way into the Pacific, and the other into the Atlantic, by one of the longest routes for running water on the surface of the planet.

Prof. Marsh continues his descriptions of the fossil treasures continually arriving to increase the already ample stores at Yale College. He remarks that while the Mosasauroid reptiles are so rare in Europe that the type-specimen described by Cuvier still remains the most perfect yet discovered here, and the only one from which important characters have been made out, in North America the group attained a marvellous development, and was represented by several families with numerous genera and species, of which the relics of not less than 1,400 distinct individuals are contained in the museum at Yale.

Dr. Michel Mourlon of Brussels has in preparation a work on the geology of Belgium. It will form an octavo volume of at least 500 pages, containing full descriptions of the different geological formations, with unpublished plates of the microscopic structure of rocks, copious lists of fossils, and an account of the industrial resources of each formation, and will be followed by a complete bibliography of the geology, palæontology, and lithology of Belgium. The re-issue of Dumont's beautiful and most trustworthy geological map of Belgium naturally suggests the desirability of some general guide to the public in perusing the map or travelling through the country, for the admirable *prodrome* of M. Dewalque can hardly now be procured. Dr. Mourlon's position as one of the Conservateurs of the Royal Museum of Natural History, and his experience as a field geologist both before and since his connection with the Geological Survey of Belgium, give him exceptional advantages for the preparation of such a work, which will no doubt be as duly appreciated by his fellow-countrymen as it will be welcomed by students of geology abroad.

PHYSICAL NOTES

Observations of phosphorescence phenomena in high vacua of the nature described by Crookes and Maskelyne have been lately made on a variety of substances by Herr Stürtz of Bonn, in company with Herr Müller (*Wied. Ann.* No. 11). The following substances gave phosphorescence (those marked with an asterisk were made red hot before being brought into the tube; in the ordinary state they showed little or no phosphorescence):—Brucite,* magnesite,* phosphate of magnesia, pitch-blende, wolframite, cerusite, adularia, orthoclase,* kaolin,* axinite,* silicate of zinc,* zinc-spar,* double spar, apatite, franklinite, azure spar, fergusonite,* apophyllite,* dolomite, cœlestine,* red spinelle, cobalt-glance, stannite, baryta, chromate of iron, lazulite, lepidolite, zinnwaldite, ankerite, greenockite, pectolith, borax, cinnabar, leucite, sanidin, and Java meteoric stone of 1869. A few luminous points were observed in crystals of arsenical iron and antimonite. Pieces of a phosphorescent substance made red hot are luminous with a different colour from that of pieces of the same not made red hot. In cerusite the phosphorescence is lost through heating. The authors give a list of substances which do not phosphoresce.

A system of electrical storing, considered to be free from the disadvantages of other systems, is described by Professors Houston and Thomson in the Franklin Institute *Journal* for December, 1879. They use a saturated solution of zinc sulphate in a suitable vessel, having at the bottom a plate of copper, to which is connected an insulated wire. At or near the top of the vessel, and immersed in the solution, is placed a second copper plate or one of hard carbon, or metal unchanged by contact with zinc sulphate solution and less positive than metallic zinc; this is also connected with a wire. A current from a dynamo-electric machine is sent in the direction from the lower to the upper plate, the result being deposition of metallic zinc on the upper plate and the formation of a dense solution of copper sulphate overlying the under plate. The cell, after charging, constitutes a gravity cell, and continues a source of electrical current till reconversion of all the copper sulphate into zinc sulphate, with deposition of copper on the lower plate and removal of zinc from the upper. The cells, in charging, may be arranged in multiple arc or in series, and differently from that in discharging, according to the object. The authors believe it possible to store and recover 50 per cent. or more of the 50 or 60 per cent. which good dynamo-electric machines realise in external work of the power used in driving them. Thus 25 per cent. of the original power may be given out secondarily as electric current. Assuming that in the best steam engines 20 per cent. of the heat energy of the coal may be utilised, then about 5 per cent. of the heat energy, it is thought, may be recovered after storage as current; but even with this small percentage the economy would be much superior to the use of zinc and other materials in the ordinary battery in production of current.

In a recent paper to the Vienna Academy, by Prof. Exner, on the theory of inconstant galvanic elements, proof is offered that there is no so-called galvanic polarisation in elements, but that the phenomena referred thereto are attributable to the oxygen dissolved in water. The electromotive force of an element with only one liquid appears accordingly as a constant which is in no way affected by any polarisation of the negative pole. It is further shown that the force of a Smee element is not altered when its platinum is replaced by some other metal, provided only this do not itself give rise to chemical processes.

GEOGRAPHICAL NOTES

Dr. Emil Holub will read a paper before the Royal Geographical Society next Monday evening on his journey from the Diamond Fields through South Central Africa to the upper waters of the Zambesi. Dr. Holub, we understand, has for some time been exhibiting at Prague a small museum of zoological and ethnographical curiosities collected during his various journeys in Southern Africa, which has attracted much attention, and he is coming to England to attend this meeting at the special invitation of the Council of the Geographical Society.

The *Colonies and India* reports the return of Mr. Alexander Mitchinson after some years spent in Africa. He appears to have arrived on the Gambia in 1876, and to have journeyed with a small number of followers into various parts of Africa. Following the course of the Niger, he visited the waterfalls, and returning to the west coast, made excursions into the country in various directions. After a brief rest his travels were again resumed, and from the Gaboon country Mr. Mitchinson made his way into Angola, and from Benguela proceeded *viâ* Bihé to Lake Ngami, returning to the coast at Walfisch Bay at the end of 1879. The notes which he made in the course of his travels, are said to contain much interesting matter.

In the current number of the *Tour du Monde* M. Désiré Charnay, the well-known archæological explorer of Southern Mexico, Yucatan, and Madagascar, has commenced an account of what he saw during the six months he recently spent in Australia. His observations on the aborigines, their legends, customs, and traditions will no doubt be interesting, and his story will certainly be well illustrated. M. Charnay, who returned to Europe not long since, had, previously to his visit to Australia, spent some time in the East Indian Archipelago.

Dr. Benjamin Bradshaw, who was met by Major Serpa Pinto, during his famous journey near the Zambesi, and who was also with the late Mr. Frank Oates when he died near the Tati settlement on his way from the Victoria Falls, arrived in Capetown a short time ago, presumably to make another trial of the ways of civilisation. Dr. Bradshaw has spent a long time in the Matabele country and other parts of the Zambesi basin, living the life of the natives and making zoological collections for his own amusement and benefit. During his wanderings he has acquired a considerable amount of information respecting the less-known parts of the Zambesi and some of its tributaries, which, we have reason to hope, may be made public before long.

A correspondent in the *Glasgow Herald* advocates the formation of a geographical society in that great commercial centre, the second most populous city in the kingdom. We have on several occasions pointed out the advantages of the formation of such societies in our chief ports, by means of which much useful information might be tapped that otherwise would not see the light. No better field could be found for such a society than Glasgow.

Prof. Nordenskjöld and his staff evidently do not consider that their work was finished when they got outside Behring's Strait in the *Vega*. During the brief stay of the ship at Galle they made excursions into the island to examine its mineralogy and natural history. Great preparations have been made for the reception of the *Vega* at Naples. The King of Sweden desires that the professor and the captain should visit Rome, Brussels, Paris, and London, and join the vessel again at Copenhagen, to be ultimately received at Stockholm.

Dr. Otto Finsch left Honolulu on July 30 last, on board the barque *Hawaii*, and arrived at Dshaloot, on the island of Bonham (the principal island of the Marshall group) on August 21. He intended to investigate this island thoroughly, as it appears that this has never before been done in a scientific manner. From Bonham Dr. Finsch will proceed to the islands of the Radak group.

News from Dr. Stecker, the well-known companion of Dr. Gerhard Rohlfs, stated that he was going to leave Benghasi at the beginning of the present month, in order to procced to Bornu by way of Fezan.

A French Company intends to cut a canal through the Isthmus of Corinth. Steps have already been taken to obtain the permission of the Greek Government.

The German residents of Sydney have founded a branch of the Berlin Central Union for Commercial Geography.

Mr. im Thurn, of the Georgetown Museum, whose labours in British Guiana have been referred to in Nature, arrived in England last week.

THE SIXTH CONGRESS OF RUSSIAN NATURALISTS

The Sixth Congress of Russian naturalists began at St. Petersburg on January 1, by a public meeting in the great hall of the University. The number of members present was very large—1,200—of whom 500 were from the provinces, and thirty-eight were ladies. Prof. Kessler was unanimously elected President, but the bad state of his health not allowing him to fulfil this function, he was made honorary president, Prof. Beketoff being elected as the active one.

At the first public meeting, Prof. Wagner gave an interesting address on the "Means of Solution of the complicated Problems of Natural Science," and after a brilliant sketch of the methods of science, he drew the attention of naturalists to the necessity of the study of physiological chemistry, and especially of the problems connected with albuminous matters.

Two proposals were then discussed:—On the scientific exploration of Bulgaria, and on the necessity of making complete botanical collections of Russian plants.

The second public meeting of the Congress, held on January 7, was opened by an address by Prof. Timiriazeff, on the physiological significance of chlorophyll in the life of plants, on the absorption by it of solar rays, and on the limits of the productivity of the soil. After this the president proposed that the several projects of scientific inquiries approved by the Congress be transmitted to a special committee, which would remain as a permanent institution after the Congress, and see to the carrying out of these projects; the proposal was unanimously accepted by the Congress, and will be accomplished, if the Ministry of Public Instruction does not oppose, as it has done hitherto, the creation of a permanent scientific association of all Russian naturalists. Prof. Mendeleef proposed the publication of a popular description of Russian colonies, being a sketch of their climate, soil, flora, fauna, and economical conditions; the proposal was approved. Prof. Dobroslavine gave an address on the relations between natural sciences and hygiene. The latter has only one point in common with medicine—general pathology—whilst any progress in the department would be impossible if it were not for the collective work of those who labour in the wide field of natural science, all most important advances in hygiene, being made by the researches of eminent specialists in natural science. Finally, Prof. Mendeleeff made the proposal to publish a new scientific periodical.

At the last public meeting of the Congress, Professors Sokhotsky and Kovalsky made a proposal to found a Russian Astronomical Society, and Prof. Tchebysheff proposed to solicit from the Government pecuniary help to the Moscow Mathematical Society; both proposals were agreed to. M. Severtsoff gave a very interesting lecture on the orographical structure of Central Asia and on its influence upon the geographical distribution of animals. Prof. Andreieff developed the idea as to the necessity of giving instruction in natural sciences in primary schools, and M. Gerd gave an address on the impulse which could be given to the study of nature in Russia, its flora, and fauna, by the teachers of the primary schools; he demonstrated by numerous facts that this help would be very effective, as a great number of teachers would be very glad to work on that field; therefore, he proposed to draw up good programmes for these studies, as well as simple manuals of the necessary elements of science. Both proposals were met with the warmest cheers of the numerous auditory, but we fear that they will meet, as have former proposals of that kind, with strong opposition from the actual Ministry of Public Instruction. After an address by Prof. Wagner, on the sociability of animals, the Congress closed its sittings; the next Congress to be held at Odessa.

In the Section of Astronomy and Mathematics we notice the following communications:—By Prof. Davidoff, on a new method for the exploration of functions, which method enables us to deduce various theorems from one general principle; by M. Preobrajensky, on the integration of Laplace's equation by means of quaternions, the communication having given rise to very animated discussion; and by M. Tchebysheff, on parallelograms, being a brilliant exposition of their importance in mechanics, together with a discussion of several points of theoretical importance. An interesting memoir was read by Prof. Bougaeff, on subtraction in the theory of numbers, which deals with several important philosophical points of mathematical investigation. Other communications were by MM. Markoff, Joukovsky, and Vasilieff, on Bernoulli's equation.

In the Section of Physics and Meteorology we notice the following communications:—By M. Ziloff, on the magnetisation of liquids; by M. Collin, on the luminous properties of electrodes; by Prof. Oettinger, on electricity; by M. Pantioukhoff, on the meteorology of Bulgaria as compared with South-Western Russia; by Dr. Woeikof, on the various causes of perturbations in the diurnal changes of temperature; and by Baron Wrangel, on changes of level in the Black Sea. This level has continuous fluctuations; it is always lower during the night, and reaches its maximum at mid-day in all sea-ports of the northern and the eastern coast; it is also at a minimum in October and a maximum in May, the difference between these two levels being 18 inches. The following communications of general interest were also made in the Section of Physics:—Dr. Woeikof exhibited a new map, showing the distribution of rainfall in all parts of the world; M. Borgmann made a communication on the influence of the inductive currents on the development of temperature during magnetisation; Prof. Lemström (Helsingfors) expounded his theory of terrestrial magnetism; Prof. Tchebysheff read a memoir on centrifugal regulators, and exhibited two of his invention; and M. Tchikoleff, on electric lighting.

In the Section of Geology and Mineralogy we notice communications by Prof. Lentz, on the level of the Amu-Darya; by Prof. Fr. Schmidt, on recent formations on the shores of the Gulf of Finland; and by M. Armatelsky, on diluvial formations in the Government of Chernigov.

In the Sections of Botany and Zoology we notice the communications by M. Tikhomiroff on the bacteria which cause disease of the bladder, and on the artificial production of these bacteria; by Prof. Ganin, on the development of fishes; and by M. Sidoroff, on the insects destroying corn in Russia.

A most interesting communication was made to the Section of Physiology by Prof. Setchenoff, on the absorption of oxygen and nitrogen by blood. Besides, we notice communications by Prof. Goloubeff, on the vibratile epithelium; by Dr. Tsiboulsky, on a new method of determining the amount of blood in animals; by M. Wedensky, on the innervation of the respiratory motions of the *Rana temporaria*; and by Prof. Tarkhanoff, on the amount of blood of man.

In the Section of Anthropology were the following communications:—By Prof. Stid (Dorpat), on the relation between the indexes of the skull and that of the head; by Dr. Lubinsky on the sight, being the result of numerous observations upon the crews of the Russian navy, which observations establish a certain connection, difficult to explain, between the power of sight and the breadth of the chest. The communication by M. Dokouchaeff, on the pre-historic man of the downs of the Oka river, deals with a subject of great interest, as he affirms that the range of downs which we see along the whole of the course of that river must afford a great amount of pre-historic remains, as is the case with the downs of Volosovo and Lviniy, both having yielded thousands of such remains. Prof. Inostrantseff discussed at length the various sub-divisions of the stone period, and M. Anoutchin gave an interesting note on the frontal suture, which seems to appear most frequently in races of a higher degree of civilisation.

An interesting feature of these Russian congresses is the existence of two special sections, those of scientific medicine and of hygiene; the latter section has assumed a great importance, thanks to the energy of several eminent hygienists, as Drs. Erisman, Dobroslavine, Vyrouboff, and others. A question being raised about the hygiene of railways, the section of hygiene had two special sittings on this subject, and a committee was appointed to draw up a programme of investigations on the dress of railway *employés*, the number of hours of work, the sanitary state of railway stations, and of dwellings of *employés*, accidents, the transport of cattle, &c. A great number of other questions, as to the disinfection of dwellings, epidemics, &c., were discussed, and we hope that the work of the section will be of great importance for this kind of investigation.

Several other important communications were made in the Physical Society, and in the St. Petersburg Society of Naturalists, which both have had their annual meetings during the Congress.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—On February 3 the question of the Natural Science Degree will again come on for discussion in congregation. Last term, it will be remembered, the proposal to grant a special natural science degree was defeated after a close division, the principal opposition to the motion coming from the scientific members of congregation. It was thought that a separate science degree, not carrying with it the privileges of the master of Arts Degree, would be regarded as an inferior degree, and tend to lower the position of science in the University. A clause is now proposed by an influential body of residents—including Prof. Odling, Dr. Mark Pattison, Rector of Lincoln, A. Vernon Harcourt, Prof. Green, Prof. Lawson, and Prof. Nettleship—to the following effect:—"Every person who shall have been admitted to the degree of Master of Natural Science, shall also be admitted to the degree of Master of Arts."

At the University Museum Prof. Clifton will continue his course on Statical Electricity and Magnetism; Dr. Odling will continue his lectures on Organic Chemistry on Mondays and Fridays at noon, instead of on Mondays and Thursdays as heretofore. The examination for the Radcliffe Travelling Fellowship will begin in the Museum on Tuesday, February 10, at 10 A.M. Candidates are requested to send in their names to Dr. Acland, at the Museum, on or before February 1.

At Christ Church Mr. Vernon Harcourt will form a class and lecture on Quantitative Analysis; Mr. Baynes will lecture on Thermodynamics and Electrodynamics.

M. ROUGET, Professor of Physiology in the Faculty of Medicine at Montpellier, is nominated Professor of General Physiology in the Museum of Natural History of Paris, in succession to the late Claude Bernard.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 12, 1879.—Analogies between fluidity and galvanic conductivity, by O. Grotrian.—On the magnetisation of iron rings, by A. v. Ettingshausen.—The ball-shaped electro-dynamometer, by J. Fröhlich.—On gradual passage of the band-spectrum of nitrogen into a line-spectrum, by A. Wüllner.—On Stokes's law, by S. Lamansky.—On a bi-constant dispersion formula, by E. Lommel.—On the dichroitic fluorescence of magnesium-platinum-cyanide; experimental proof of the perpendicularity of the light vibrations to the plane of polarisation, by E. Lommel.—On a small alteration of the Bunsen grease-spot photometer, by A. Toepler.—On the refraction of sound-waves, by K. W. Schellbach and E. E. Boehm.—On the specific heat of water according to Dr. Baumgartner's experiments, by L. Pfaundler.—Reply to the observation of O. E. Meyer, by L. Boltzmann.—On the application of the telephone to measurements of resistance, by F. Niemöller.—On the motion of glaciers, by K. R. Koch and F. Klocke.—On hailstones with ice-crystals, by Ed. Hagenbach.—On hailstones of uncommon size, by P. Merion. (In a paper prefixed to this number, Prof. Clausius defends himself against some aspersions, by Herr Dühring, regarding his relations to Robert Mayer, *à propos* of the mechanical theory of heat.)

THE *Sitzungsberichte der naturwissenschaftlichen Gesellschaft Isis in Dresden* (1879, January to June) contain the following papers of interest:—On the recent geographical and geological investigations of the United States of America, by Dr. Geinitz.—On the coal flora of the Lugan coal-pits, by H. Krone.—On the constitution of dichlornitrophenol, by Dr. Schmidt.—On a new form of the influence machine, by Dr. Töpler.—On the action of chloride of lime upon absolute alcohol, by Dr. Goldberg.—On a gas-stove with arrangement for oxidation, by Dr. Hempel.—On a new dye, by Dr. Schmitt.—On the isomerism of ethanes, by Dr. Goldberg.—On the tension of threads and Poggendorff's fall machine, by Dr. Amthor.—On a discovery from the later stone period made in Bohemia, by W. Osborne (with 5 plates).—On the prehistoric centres of culture in Schleswig, by Herr Michelsen.—On some objects found by Dr. Schliemann in his excavations in Greece and Asia Minor, by Dr. Fiedler.—On a discovery of urns at the Hradischt, near Stradonic (Bohemia), by W. Osborne.—On the occurrence of *Castanea vesca*, L., by Dr. Friedrich.—Various smaller botanical papers of minor interest.—On the theory of Watts's centrifugal regulator, by Dr. Ritterhaus.—On some galvanometric methods of multiplication, by Dr. Töpler.—Remarks on Wallengren's work concerning Linnæus's species of the genus *Phryganea*, by M. Rostock.—On the Neuroptera of Saxony, by the same; a most elaborate treatise with complete list and catalogue.—On the Hemiptera fauna of Transcaucasia, by Dr. von Horvath.—Obituary notices of Dr. Eduard Lösche and H. G. Ludwig Reichenbach.

Reale Istituto Lombardo di Scienze e Lettere, vol. xii. fasc. xvii.-xviii.—This number contains a survey of the year's work, announcements of prizes awarded (with abstracts of memoirs), and of prize subjects, &c.

Fasc. xix.—Stratigraphic observations on the precarboniferous formation of Valtellina and Calabria, by S. Taramelli.—On the dilatation of the heart in disorders of the ventricle, by Prof. de Giovanni.

Journal de Physique, December, 1879.—We note here the following:—Measurement of the wave-length of obscure calorific rays, by M. Mouton.—Displacement between oxygen and the halogen elements united with metals, by M. Berthelot.—A spectroscope for studying the phenomena of fluorescence, by M. Lamansky.

Journal of the Franklin Institute, December, 1879.—On a new theory of the retaining wall, by Prof. Du Bois.—A system of electrical storage, by Professors Houston and Thomson.—Steam boiler explosions, by Messrs. Corbin and Goodrich.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 15.—"On Chemical Repulsion," by Edmund J. Mills, D.Sc., F.R.S.

While engaged in some researches on the propagation of chemical change, I have incidentally encountered a new order of phenomena, which the title "chemical repulsion" may serve provisionally to designate. A brief outline of the experiments is given in the following paragraphs.

Upon a glass plate, laid in a horizontal position, is poured enough solution of baric chloride to cover it completely to a considerable depth. On this solution is placed another glass plate, provided with a small central perforation; when the two plates are firmly pressed together with the hands, most of the solution is extruded, and only a very thin layer of it left between the plates. All excess of the solution having been removed from the outer surfaces of the plates as well as from the perforation, some dilute hydric sulphate is now introduced into the perforation. This reagent attacks the baric chloride, throwing down a white precipitate of sulphate; and, proceeding partly by diffusion, partly by flow, does not cease to widen in every direction its figure of advance, until the edges of the plates are attained. If the perforation is circular, the figure of advance is circular; in other words, the chemical development of a circle is a circle.

Let us now suppose the two plates to be square and equal, and let the upper one have two circular perforations, equidistant from the centre of the square, and situated upon its diagonal. Let also two circular developments of baric sulphate be caused to proceed, as before, from the two perforations simultaneously. At first nothing remarkable is observed, but in a short time, the two growing circles begin to exercise a visible retardation on each other's progress; so that the figure of advance is no longer circular, but oval. [This retardation is of course observed only between the perforations; and not outside them, where the motion is entirely free.] As the development of the figures continues, so also does the retardation at their neighbouring edges increase; the final result being (however long the experiment may be prolonged), that the other diagonal of the square is completely and permanently traced out in a line of no chemical action.

The above experiments are of fundamental importance, and they obviously admit of endless variety. Of this, a few illustrations may suffice.

If the upper plate have three perforations, situated on the points of a central equilateral triangle, there are three repulsion lines; these end at the centre of the triangle, where they form a trilocular point, and traverse its sides midway at right angles.

When the upper plate has four perforations, situated on the points of a central square, there are four repulsion lines; these end at the centre of the square, where they form a quadrilocular point, and traverse its sides midway at right angles.

A very beautiful modification of the preceding experiment consists in simultaneously developing a circle from a (fifth) central perforation. This last circle has no means of escape from the surrounding four. The result is, that it eventually forms a square figure bounded by repulsion lines, and having four symmetrically situated repulsion lines at its corners.

It is easy to demonstrate that the chemical repulsion in these experiments does not depend upon flow. Two superimposed triangular plates, for instance, in neither of which is any perforation, give three repulsion lines on immersion in dilute hydric sulphate. From each corner a line proceeds midway (if the triangle be equilateral) to the centre. In this effect diffusion is alone concerned.

In addition to hydric sulphate and baric chloride, other pairs of reagents may be used with success; and I anticipate no difficulty in obtaining results in which precipitation is not concerned. A beginning has also been made with experiments in tridimensional development.

The complete explanation of what I have termed "chemical repulsion" will probably demand a varied and considerable amount of experimental work. From some incidents of the investigation, so far as it has hitherto proceeded, I am disposed to believe that the motion in any plane chemical figure is not along the radius, but at right angles to the radius; and this supposition will, if verified, explain the repulsion. The existing results afford proof of the following propositions, viz.:—(1) *Chemical action can take place at a distance*; and (2) *Two or more chemical actions, identical except in position, completely exclude one another.*

Chemical Society, January 15.—Mr. Warren De La Rue, president, in the chair.—The following papers were read:—On the effects of the growth of plants on the amount of matter removed from the soil by rain, by Dr. J. H. Prevost. Soil 3 inches deep was placed in two glazed earthenware pans 17 inches in diameter on July 21; 4 grm. of white clover seed was sown in one, the other being blank. The pans were exposed till October 4. The drainage-water was collected and analysed; that from the clover soil contained 48·1 grains of solid matter per gallon, the other 220. The author concludes that rain removes much more matter from an uncropped than from a cropped soil.—Mr. Wynter Blyth described a simple apparatus for the treatment of substances in open dishes to volatile solvents. The dish is placed inside a cast-iron pan, and covered with a glass bell-jar, with condenser attached, the joint between the bottom of the pan and the bell-jar being made tight with mercury.—On dibromanthraquinones, by Mr. W. H. Perkin. By heating bromine with anthraquinone, α dibromanthraquinone is formed, melting at 245° C.; by boiling tetrabromanthracen with chromic acid, dissolved in a large excess of glacial acetic acid, an isomer β dibromanthraquinone is obtained, melting at 275° C. By the action of caustic alkalies on these bodies, alizarin is formed in both cases. The author discusses the formation of this substance. In the case of the α body, two other colouring matters were formed with the alizarin, one dyeing mordants, the other not. The author is investigating these bodies. He appends a note in which he concludes on further examination that Auerbach's isopurpurin is a mixture of flavopurpurin and anthrapurpurin, and is not identical with anthrapurpurin.—Mr. Warington contributed some notes on some practical points connected with his laboratory experience. He has used with great convenience the indiarubber joint covered with mercury, which was proposed by Dr. Frankland as a substitute for the steel blocks connecting the laboratory and measuring tubes. At first the indiarubber wore out rapidly; this was prevented by tying it above the conical stopper as well as below He recommends the coating of laboratory benches, &c., by heating the wood and then rubbing in paraffin; the wood is thus protected from the action of acids. In the determination of nitrates by Frankland's process, the author suggests the addition of a drop of dilute hydrochloric acid, to ensure a complete reaction between the mercury and the nitric acid. By means of a solution of diphenylamine in strong sulphuric acid, the author has detected by the blue coloration produced $\frac{1}{10000}$th of a milligram of hydrogen as nitric acid.—On the melting and boiling points of certain inorganic substances, by T. Carnelly and W. C. Williams.

Zoological Society, January 6.—Prof. Flower, F.R.S., president, in the chair.—Prof. Newton, M.A., F.R.S., V.P., exhibited, on behalf of Mr. G. B. Corbin, a specimen of *Acanthyllis* (sive) *Chætura caudacuta*, the Needle-Tailed Swift, shot near Ringwood, in Hampshire, in July, 1879, remarking that it was the second example of this Siberian species which had been obtained in England.—Mr. John Henry Steel, F.Z.S., read a series of preliminary notes on the individual variations observed in the osteological and myological structure of the Domestic Ass (*Equus asinus*).—A communication was read from Mr. E. W. White, C.M.Z.S., containing notes on the distribution and habits of *Chlamyphorus truncatus*, from observations made by the author during a recent excursion into the western provinces of the Argentine Republic, undertaken for the purpose of obtaining a better knowledge of this animal.—Dr. John Mulvany, R.N., read a paper on a case which seemed to him to indicate the moulting of the horny beak in a Penguin of the genus *Endyptes*.—Mr. O. Thomas, F.Z.S., read the description of a new species of *Mus*, obtained from the island of Ovalau, Fiji, by Baron A. von Hügel, and proposed to be called *Mus huegeli* after its discoverer.—A communication was read from Mr. R. G. Wardlaw Ramsay, F.Z.S., containing a report on a collection of birds made by Herr Bock, a naturalist employed by the late Lord Tweeddale, in the neighbourhood of Padang. Three species were described as new and proposed to be called *Dicrurus sumatranus*, *Turdinus marmoratus*, and *Myiophoneus castaneus*.—Dr. Günther, F.R.S., read a description of two new species of Antelopes, of the genus *Neotragus*, *N. kirki*, from Eastern Africa, and *N. molaris*, from Damaraland.

Geological Society, January 7.—Henry Clifton Sorby, president, in the chair.—Edward Bagnall Poulton was elected a Fellow, and Prof. A. E. Nordenskjöld, Stockholm, and Prof. F. Zirkel, Leipzig, Foreign Members of the Society.—The following communications were read:—On the Portland rocks of England, by the Rev. J. F. Blake, F.G.S. The author gave a general account of the relation of the several Portland rocks in the areas of their development to each other, and hence deduced the history of the Portland "episode." The name is used on the Continent in a wider sense than in England, and this use was shown to be unjustifiable. After giving an account of his observations on the rocks at Portland itself, and dividing the limestones into the building-stone and flinty series, the author showed that the so-called "Upper Portlandian" of Boulogne corresponds to the latter, and the upper part of the "Middle Portlandian" to the Portland sand. He then endeavoured to prove, by the proportionate thickness, the indications of change in the lithology, and the distribution of some of the fossils, that the rest of the so-called "Middle" and the "Lower Portlandian" are represented by integral portions of the Upper Kimmeridge, which are thus the "normal" form corresponding to what the author calls the "Boulognian episode." The series in the Vale of Wardour has been made out pretty completely. The Purbeck is separated by a band of clay from the Portland, and is not amalgamated with it. The building-stones and flinty series are here seen again; and a fine freestone occurs at the base of the latter. The representatives of the Portland sand were considered to be older than those of other districts. The relations of the Purbeck to the Portland rocks at Swindon were very carefully traced; and it is shown that, while the upper beds of the latter put on here some peculiar characters, the former lie on their worn edges. The upper beds of the Portland, which have been referred to the sand, correspond to the freestone and the base of the flinty series of the Vale of Wardour; hence the Purbecks of Swindon may be coeval with the upper beds of the Portland to the south. At the base of the great quarry and elsewhere in the neighbourhood are the "*Trigonia*-beds," beneath which is clay, hitherto mistaken for the Kimmeridge clay; and beneath this are the true Portland sands, with an abundant fauna new to England. The limestones of Oxfordshire and Bucks were considered to represent the "*Trigonia*-beds" only; and, as the Purbecks here lie for the most part conformably, it was suggested that they were formed in a lake at an earlier period than those at Swindon, which are of a more fluviatile character. Hence the Portland episode, considered as marine, was at an end in the north before it was half completed in the south.—On the correlation of the drift-deposits of the north-west of England with those of the midland and eastern counties, by D. Mackintosh, F.G.S.

Anthropological Institute, Jan. 13.—John Evans, D.C.L., F.R.S., vice-president, in the chair.—Dr. Hack Tuke read a paper on "The Cagots." The author showed that the popular etymology of the word Cagot, from "Canis Gothi," is probably inaccurate, and accepted the suggestion of M. de Rochas, that Cagot is derived from the Celto-Breton word *cacod* (leprous); it is easy to see how readily this would assume the form of cacou (as it is in Brittany actually applied to these people), and so the French Cagou or Cagot. The conclusions at which the author arrived as to the origin of the Cagots were as follows:—1. The Cagots are not the descendants of the Goths; they are not a distinct race, but a despised class among the people of the country in which they live. 2. They are not more subject to goitre or to cretinism than the inhabitants of the adjacent district—in short, cagotism and cretinism are in no way allied. 3. The present representatives of the Cagots are now recognised by tradition, and not by their features, and are not distinguished by any peculiar mental or physical disorder. 4. Although nothing like leprosy, or leucoderma, has for a long time affected the Cagots, and no one on the spot regards them in this light, there is evidence to show that they were originally either lepers labouring under a particular variety of leprosy, or were affected with leucoderma, the form of the affection accounting for their being regarded as in some respects different from ordinary lepers, though shunned in the same way. 5. Many were, no doubt, falsely suspected of leprosy in consequence of some slight skin affection; others, again, in later centuries, were members of families in which the disease had died out.—The Director read two papers by Mr. Alfred Simson, on the Jivaros and the Canelos Indians. The tribe of the Jivaros is a large one, and one of the most distinguished, independent, and warlike in South America. They speak a language of their own, Jivaro, and occupy the country generally from the Upper Pastassa to the Santiago, both rivers included, down to the Pongo de Manseriche, on the Marañon. They are hospitable, and their houses are large and built of palms. They have a most perfect method of scalping, by which the victim's head is reduced to the size of a moderately large orange, maintaining tolerably well all the features: the skin is cut round the base of the neck, and the entire covering of the skull removed in one piece. This is then dried gradually b means of hot stones placed inside it, until the boneless head shrinks to the required size. They also wear their slain enemies' hair in long plaits round the waist. Great festivities take place when a child, at three or four years of age, is initiated into the art and mysteries of smoking. The Jivaros of the Pintue have the habit of vomiting nearly every morning by the aid of a feather, arguing that all food remaining in the stomach overnight is unwholesome and undigested, and should therefore be ejected. Canelos, the once attractive Spanish settlement, but now forlorn Indian village, is situated on the left bank of the Bobonaza, one of the most important, if not the largest, of the tributaries of the Upper Pastassa, and is inhabited by a mixed tribe of Indians in whom the chief element is Jivaro, though some of the better traits of these seem to be wanting in them. Their language is Quichua. Their fighting is done entirely with the lance, which is their inseparable companion, and all the author's attempts to induce any of them to part with his weapon were fruitless.

PARIS

Academy of Sciences, January 12.—M. Edm. Becquerel in the chair.—M. Daubrée presented the second part of his Synthetic studies of experimental geology; it treats chiefly of the chemical and mechanical phenomena of meteorites (which are compared with the deeper rocks).—On meteorological observations in May at Zi-ka-wei, in China, by M. Faye. Storms go from China to Japan, following a like course to that of storms coming to Europe from the Atlantic. They are independent of the prevailing monsoon, and conversely, neither preventing the other. M. Faye finds support for the theory of gyratory movements propagated downwards.—On the kinematic geometry of deformations of bodies, elastic, plastic, or fluids, by M. De Saint Venant.—Some observations on a note of M. Wurtz (*C. R.*, December 22, 1879), by M. Sainte-Claire Deville.—Evolution of the inflorescence in Gramineæ (first part), by M. Trécul. He considers here (1) the formation of the primary axis; (2) the order of appearance of the branches; (3) that of their growth.—Influence of the nature of carbons on the electric light, by M. Du Moncel. In 1855 he called attention to the advantages of using carbons of *vegetable origin* for the electric light. In 1859 he produced an electric candle with plates of charcoal in a tube.—On the disaccord apparent between the heights recently observed on the Seine and the previsions of the hydrometric service in the passage through Paris, by MM. Lalanne and Lemoine. M. Belgrand's empirical laws apply only to the natural state of the river, but ceased to apply in the early days of January, owing to the effects of the abnormal freezing of the Seine (which occurs several times in a century). M. Dumas and Gen. Morin made some remarks, the General pointing out that the breaking up of the ice sometimes proceeds up the river, sometimes down; in the latter and more dangerous case explosives and other means should be promptly used to open the block.—On the photographic spectra of stars, by Dr. Huggins.—State of the tunnelling operations of St. Gothard, by M. Colladon. The works have been retarded. From November 11 to January 1 (fifty-one days) the advance of the north gallery was only 34·90 m against 173·10 m. in the forty-nine days previous. This was due to pressure of an unresistant rock met with, which crushed the strongest wood-work. The perforation will likely be complete in the end of February or beginning of March.—On treatment of phylloxerised vines, by M. Marès.—On glycogenesis in infusoria, by M. Certes. Treated with iodised serum, they present similar effects to those whereby M. Ranvier, with this substance, proved the presence of glycogen in lymphatic cells. (The effects on several organisms found with infusoria are also indicated.) The vitality of animalcules is an important factor in glycogenesis.—Resistance of pucerons to severe cold, by M. Lichtenstein. Phylloxera and others successfully resisted cold of 11° and 12° below zero in December.—Determination, by M. Gylden's methods, of the motion of the planet Hera (103), by M. Callandreau.—On the polygons inscribed in a conic, and circumscribed on another conic, by M. Darboux.—Solar cyclone, by M. Thollon. Observing a peculiarly dark spot on January 3, he perceived two opposite deflections of the line C, corresponding to velocities of 60 and 137 km. respectively, in the vast cyclone.—On the thermal laws of the electric sparks produced by ordinary partial discharges of condensers (second note), by M. Villari. The galvanometric deflections caused by incomplete discharges are proportional to the quantities of electricity forming the discharges. The heat generated by the spark is directly proportional to the quantity of electricity forming the spark.—Variations of the magnetic declination deduced from regular observations at Montcalieri in the period 1871–78, by M. Denza. These agree in the main with observations at other Italian places, and at Prague, Christiania, Munich, and Greenwich, pointing to cosmical causes.—On the Thomson galvanometer, by M. Gaiffe. The scale-indications are not proportional to the values of the currents measured, the angles of deflection of the needle being doubled by reflection of the mirror. This source of error he seeks to correct by using a bifilar suspension formed of two cocoon-fibres.—On the potash contained in the clay of arable soils, by M. Perrey. Clay constantly contains potash varying ordinarily from 2 to 5 per cent., sometimes from 1·8 to 7·3 per cent.—On the tension of dissociation of hydrate of chloral, and on the vapour-tension of anhydrous chloral, by MM. Moitessier and Engel.—Effects of intra-venous injections of sugar and gum, by MM. Moutard-Martin and Richet. Sugar injected into dog's veins always causes polyuria and glycosuria, and does not affect the blood-pressure. Gum has an opposite effect; it diminishes the polyuria previously produced by sugar, and at length completely stops the secretion of urine; it also increases notably the tension of blood in the arteries.—On the phenomena arising from ligature of the inferior vena cava above the liver, by M. Picard.

VIENNA

Imperial Academy of Sciences, October 23, 1879.—The earthquakes of Carinthia and their lines of shock, by Prof. Hoefer.—On the histiogenesis of sclerosis of the posterior fibres of the spinal cord, by Dr. Weiss.—On the forces operative on diamagnets, by Prof. Bolzmann.—Determination of path of the planet Bertha (154) by Herr Anton.

November 6, 1879.—The long-haired common guinea-pig (*Cavia Cobaya longipilis*), by Dr. Fitzinger.—Fish-fauna of the Cauca and the rivers in Guayaquil, by Dr. Steindachner.—Shell-fish fauna of the Galapagos Islands, by Herr Wimmer.—The von Müller collection of Australian fish, by Dr. Klunzinger.—On the humour passages of hyaline cartilage, by Dr. Spina.—Magnetic measurements in Kremsmünster in July, 1879, by Herr Liznar.—On compounds from animal tar: III. Lutidine, by Prof. Barth and Herr Herzig.

November 13, 1879.—Researches on the development of the central nerve-tissue, by Herr Stricker and Dr. Unger.—On the action of the safety-valve in steam boilers, by Herr von Burg.—Firing under water, by Herr Lorber.

November 20, 1879.—The following among other papers were read:—The sporogon of Archidium, by Prof. Leitgeb.—Contributions to a knowledge of the hen's germ at the commencement of brooding, by Herr Koller.—On the last multiplier of differential equations of higher order, by Prof. Winckler.

December 4, 1879.—On the striction line of the hyperboloid as rational space-curve of fourth order, by Herr Migotti.—On processes of degeneration and regeneration in uninjured peripheric nerves, by Prof. Mayer.

December 11, 1879.—On waterspouts observed near Canea, by Herr Miksche.—Researches on the course of conduction in the spinal cord of the dog, by Dr. Weiss.—A contribution to the theory of urine-secretion, by Dr. Gärtner.—On a new isomer of gluconic acid, by Herr Hönig.—On the theory of inconstant galvanic elements, by Prof. Exner.

CONTENTS

THURSDAY, JANUARY 29, 1880

THE FUNDAMENTAL DEFINITIONS AND PROPOSITIONS OF GEOMETRY, WITH ESPECIAL REFERENCE TO THE SYLLABUS OF THE ASSOCIATION FOR THE IMPROVEMENT OF GEOMETRICAL TEACHING

I DESIRE to offer some suggestions respecting the form and arrangement of the elementary definitions and propositions of the Euclidian geometry. It has appeared to me that the recent German textbooks upon the subject have made a great improvement upon the older system, as developed in the works of Euclid and Legendre. I have but recently obtained the "Syllabus of the Association for the Improvement of Geometrical Teaching" and compared it with the corresponding parts of a summary of my own, the latter still in an inchoate state.

I now take the liberty of making some remarks on a few points on which I should be greatly pleased to know the views of those interested. In making them, however, no attempt will be made to go below the fundamental conceptions of the subject which are taken for granted in ordinary textbooks. It may be assumed that there is a general agreement that these conceptions are to be taken for granted, and that the only question is respecting their form and arrangement. One general remark may not, however, be out of place. The aim of elementary geometry is to present its definitions and propositions in a perfectly logical arrangement, so that each definition shall be a complete description, and nothing more, and each proposition be founded strictly on definitions and axioms. It may be doubted whether this perfect ideal is attainable. It might be claimed that our elementary conceptions of relations in space have been derived from experience by processes of abstraction and generalisation, in which no logical order was followed, and that it is impossible to arrange them with that perfect unity which logical method aims at. However this may be, it will, I think, be conceded on all sides that all our systems have hitherto been mere approximations to an ideal which no one has actually reached.

In framing a geometrical definition three different objects may be aimed at.

1. To express our fundamental conceptions of the thing defined in the most accurate form possible.

2. To specify those qualities which most completely differentiate the thing defined from all other things.

3. To describe its axiomatic properties, or those which are subsequently used in demonstrating propositions relating to it.

We thus have three tests which we may apply to a definition and which may lead to different judgments of it. In most cases the same definition will be reached which ever object we have in view. The only concept the definitions of which can be separately classed under all three heads is, so far as I have noticed, that of a straight line. The fundamental quality of a straight line as we conceive of it is, I think, that of symmetry, or similarity of properties with respect to space on all sides of it. A line which is throughout its whole length perfectly symmetrical, having no properties on one side which it does not equally possess on all other sides, is a straight line. A curve is concave on one side and convex on another. The definition of Simpson's Euclid that a straight line lies evenly between its extreme points, may be considered as an attempt to formulate this conception of symmetry.

The definition which most completely differentiates a straight line from all others is that of some editions of Euclid and Legendre as the shortest distance between two points. It is to be remarked, however, that neither of these properties is directly made use of in demonstrating the subsequent theorems of geometry. The axiomatic definition of a straight line, if I may be allowed to use the expression, is that of Playfair's Euclid, as being lines which must coincide throughout if they coincide in two points.

Quite similar to that is Definition V. of the Syllabus. This class of definitions, or the axioms in which they are embodied, include the only ones which serve as a basis for the subsequent theorems of geometry.

It is to the definition of plane figures given in the Syllabus that the attention of those interested in this subject is especially asked.

The following are extracts from the Syllabus:—

"Def. VII.—A plane *figure* is a portion of a plane surface inclosed by a line or lines.

"Def. VIII.—A *circle* is a plane figure contained by one line, which is called the *circumference*, &c.

"Def. XXII.—*A plane rectilineal figure* is a portion of a plane surface inclosed by straight lines.

"Def. XXVIII.—*A triangle* is a figure contained by three straight lines."

These definitions agree with those of the old geometry in defining plane figures as inclosed portions of a plane surface. It seems to me that in no part of geometry is greater reform needed than in this.

Figures on a plane surface should, it seems to me, be defined as lines simply, and not as portions of the surface. The following are some of the objections against the old and in favour of the new system of definition:—

1. By Definition VII., as quoted above, an ellipse is a plane figure because it incloses a portion of a plane surface, but a parabola or hyperbola is not. Three straight lines may form a figure, but two cannot. But if we form a figure of three straight lines we must cut off all those portions of each line which lie outside of its intersection with the other two as forming no part of the figure.

2. In the modern synthetic geometry figures are considered in a more general way as formed of lines. A triangle, for instance, is a combination of three indefinite straight lines. To this we may, if we please, add the restriction that no two shall be parallel, and that all three shall not pass through a point. The quadrilateral is a combination of four such indefinite lines, to which again, if necessary, may be applied the restriction that no three shall be parallel or pass through a point; the circle also becomes the line, not the inclosed space. Therefore when the student, whose ideas of such figures are only those of the elementary geometry, passes to the study of the higher geometry, he is obliged to form a new set of conceptions for the same terms; so great a change, for instance, as substituting the conception of three indefinite straight lines for that of a triangular piece of paper. He reads of

the intersection of circles, and must understand that it is something radically different from any intersection of the two round planes which he has been taught to consider as circles.

The same change must be carried into space of three dimensions. Studies of what in the elementary geometry have been termed solids, when made by modern mathematicians, are not studies of solids but surfaces. An ellipsoid in modern mathematics is not a solid but a surface. Of course we cannot reject the conception of an inclosed area, but this area must be regarded as something distinct from the figure itself, just as we regard the perimeter as something different. I do not see that anything but good will result from the change here proposed.

In Definition XI. the idea of a "straight" angle is introduced to express the angle of 180° between two lines emanating from a point in opposite directions. I should like to submit the question whether the term *flat angle* is any better. The converse of straight is bent or crooked, terms which can hardly be applied to an angle. But the converse of flat is sharp or obtuse, terms which can be so applied. Thus, before seeing the syllabus, the term "flat" appeared to me better than "straight." The introduction of this angle must be regarded as one of the greatest improvements in elementary geometry, but it does not seem to have been introduced into the subsequent theorems of the syllabus in which the old designation of two right angles has been retained without essential alteration. Intimately associated with the fundamental definition of angular measure are the theorems relating to right angles and to the impossibility of straight lines having a common segment; the following three propositions are in fact closely connected.

Two straight lines cannot have a common segment.

All right angles are equal to one another.

If a straight line stands upon another straight line it makes the adjacent angles together equal to two right angles.

The treatment of these propositions by Euclid seems extremely unsatisfactory, and the order in which they are given in the syllabus a great improvement.

Euclid takes the equality of all right angles as an axiom and afterwards proves from it that two straight lines cannot have a common segment. But it seems evident that the equality of right angles depends upon and presupposes the impossibility of a common segment. It must first be self-evident that two straight lines cannot have a common segment before it can be evident that all right angles are equal.

The third of the propositions just quoted, as considered both by Euclid and Legendre, seem to me unnecessary and circuitous courses of reasoning carried through solely to avoid the conception of the sum of two right angles being *itself an angle*. This circuit is all the more readily taken from the fact that neither of them has considered it necessary to give a general definition of what shall be meant by the sum of two angles. The syllabus gives this definition and from it alone, without any reasoning whatever, it follows that the sum of the two angles referred to is a flat angle.

As an additional illustration of the simplicity introduced by the consideration of the flat angle we may take Theorem XXVI. of the syllabus, that the interior angles of any polygon, together with four right angles, are equal to twice as many right angles as the figure has sides. In the new notation we would say that the sum of the interior angles of the polygon is equal to a number of flat angles two less than the polygon has sides, an obvious simplification.

With reference to Definition XII. I would suggest the question whether it would not be better to reserve the term "adjacent angles" for the pair of angles which a straight line makes with another at the point of meeting. We might call these supplementary angles, but the term is suggestive not simply of an arrangement of the two angles but of any pair of angles, wherever or however situated, which together make a flat angle. We certainly need some term to correspond with the *Nebenwinkel* of the Germans, and I know of none in our geometry.

In Theorem VI. of the syllabus, which is the same as as Proposition V. of Euclid, namely, "The angles at the base of an isosceles triangle are equal to one another," the syllabus suggests a different demonstration from that of Euclid. The extreme complication of the demonstration given by Euclid is very striking, and it will be interesting to see how it arose. Apparently Euclid wished to avoid the conception of turning a figure over and applying it to itself. But the validity of this turning over is presupposed in the demonstration of the theorem, for without it the equality of two triangles having two sides and the included angle equal would be true only for triangles in which the two sides are similarly situated. This question is of especial interest when we apply it to the corresponding case of two equal solid bodies which are mutually obverted or in other words each of which is represented by the image of the other seen in a looking-glass. Are we entitled to assume that two such bodies are identically equal when it is impossible to bring them into coincidence? The only reason why we cannot bring them into coincidence is that our space is confined to three dimensions. Could we open out a fourth dimension in space the one body could, by simple rotation through 180°, be brought into the form of the other and thus made identically equal to it. A man by turning a properly directed somersault in such space would come back into our natural Euclidian space, turning right side left without the mutual arrangements of the parts of his body, even to the minutest atoms, undergoing any change whatever in their relative positions; and therefore without any change, so far as we could see, in the performance of the vital functions. But as a fourth dimension is necessary to the actual performance of such an obversion, so in plane geometry, the third dimension is necessary to the obversion of a plane figure. The syllabus, and so far as I know all the elementary geometries in English are silent on the validity of this process.

The question whether Theorems X. and XI. that the greater side of every triangle is opposite the greater angle, and the greater angle opposite the greater side, should be regarded as independent and demonstrating in entirely different ways is interesting. Since only one side and one angle can be in the relation of opposition how is it possible that the one theorem should be true without the other? Does not one theorem follow from the other by the rule of identity, and can they not be combined into the single theorem that the greater side and the greater angle are opposite each other?

SIMON NEWCOMB

THE SCIENCE OF STATESMANSHIP

POLITICAL science and politics are two very different things; some progress has been made in methodising the facts and inductions of political economy, but politics is still little more than a chaos of party prejudices and personal invective. Yet there is surely no reason why political action, the conduct of the State, should not be guided by scientific method quite as much as the conduct of a scientific exploring expedition such as that which has so recently sailed over the North-East Passage. Prof. Nordenskjöld's feat is one of the finest instances of scientific prediction based on ascertained data that we know of, and we would recommend it to Sir William Harcourt's consideration when he contemplates taking part in another political "agitation." Sir William has succeeded in getting such a firm grasp of the real nature of scientific method, and he applied it so wittily and so well in his recent Birmingham address that we would advise him to follow out this line in real earnest. So thoroughly does he seem to understand the method of scientific research and scientific prediction, and so ably, although only in sport and to banter his opponents, did he expound it, that we think science has lost in him a successful worker. To this loss we could resign ourselves if Sir William would set himself to rescue politics from its present degraded position as a mere theatre for party strife, and to elevate it into something like a science of national life and progress. He must have taken considerable pains to obtain his knowledge of the method and uses of the *Nautical Almanac;* his natural mistake as to its editorship we can overlook. As to the truth of his application of the method of the almanac to the construction of a Conservative Almanac, "after a careful induction from the conduct of Tory government," we have nothing to do here; its ingenuity is amusing. With the following remarks, however, men of all parties cannot but agree:—

"Prediction in politics is not a matter of choice, but of necessity. If public men are not fatalists like the statesmen of our daring Islam, they are bound to foresee and foretell the consequences of their action by which the fortunes of the country are determined. As the predictions prove true or false so will they be judged, for political prophecy, founded upon correct observation and just inference, is nothing else but the science of statesmanship itself."

Here Sir William has struck a vein which might be worked out to the elevation of politics, and with real good to the country. It is, we believe, regarded as an incontrovertible axiom in British politics, that government by party is the surest method of securing the most efficient conduct of public affairs. This point we shall not discuss; but we venture to think that if our political leaders were to give their serious attention to the method indicated above, party differences would be fewer than they are, and party strife less bitter, while the objects supposed to be aimed at by all constitutional governments would be much more effectually and rapidly accomplished.

At present, to judge from the public utterances of our members of parliament and by the results achieved by which ever party may be in power, party government consists mainly in strenuous efforts made by each party either to keep or to obtain place and power; this is accomplished by means of what are called "agitations," the great object of which seems to be to agitate the people into the belief that the agitators are angels from heaven who have the good of the nation disinterestedly at heart, while their opponents are quite the reverse, the only object of the latter being, it is declared, to send the nation to the custody of the person whose emissaries they are.

There are one or two eminent men of science in parliament, but no one of either party ever seems to think of looking at any measure or any line of conduct apart from party bias, and solely as a matter for scientific consideration. It seems enough to damn a measure at once in the eyes of one party, that it originates with their opponents. This is both unscientific and irrational, and can never lead to the best results. The same laws that influence the development of the individual influence the real progress of the nation, and it is only by honest investigation on strictly scientific principles that these laws can be discovered. It is thus that they have been discovered and expounded by Mr. Darwin and his followers in the case of individual organisms, and we would commend to Sir William Harcourt the study of Mr. Darwin's works, if he really desires to arrive at the true principles of scientific statesmanship. One of the great charms of Mr. Darwin's works to the man of science is their perfect candour and fairness. Not only does he adduce all the arguments he can muster in favour of any position or hypotheses he may be considering, but with equal fulness and candour does he treat all, according to his lights, that might be adduced against it, balancing the one series of arguments against another, not in the style of a special pleader, but after the manner of a judge whose sole aim is to discover the truth. Here is a specimen of the method followed by Mr. Darwin, showing his ingenuity in imagining objections to his own theories and thus putting arguments into the mouths of his opponents. We quote from the "Origin of Species" (1860, p. 462):—

"As on the theory of natural selection an interminable number of intermediate forms must have existed, linking together all the species in each group by gradations as fine as our present varieties, it may be asked, Why do we not see these linking forms all around us? Why are not all organic beings blended together in an inextricable chaos? With respect to existing forms, we should remember that we have no right to expect (excepting in rare cases) to discover *directly* connecting links between them, but only between each and some extinct and supplanted form. Even on a wide area, which has during a long period remained continuous, and of which the climate and other conditions of life change insensibly in going from a district occupied by one species into another district occupied by a closely allied species, we have no just right to expect often to find intermediate varieties in the intermediate zone. For we have reason to believe that only a few species are undergoing change at any one period; and all changes are slowly effected. I have also shown that the intermediate varieties which will at first probably exist in the intermediate zones will be liable to be supplanted by the allied forms on either hand; and the latter, from existing in greater numbers, will generally be modified and improved at a quicker rate than the intermediate varieties, which exist in lesser numbers;

so that the intermediate varieties will, in the long run, be supplanted and exterminated.

"On this doctrine of the extermination of an infinitude of connecting links, between the living and extinct inhabitants of the world, and at each successive period between the extinct and still older species, why is not every geological formation charged with such links? Why does not every collection of fossil remains afford plain evidence of the gradation and mutation of the forms of life? We meet with no such evidence, and this is the most obvious and forcible of the many objections which may be urged against my theory. Why, again, do whole groups of allied species appear, though certainly they often falsely appear, to have come in suddenly on the several geological stages? Why do we not find great piles of strata beneath the Silurian system, stored with the remains of the progenitors of the Silurian groups of fossils? For certainly on my theory such strata must somewhere have been deposited at these ancient and utterly unknown epoch in the world's history."

Did we urge Mr. Darwin's method upon the members of our two great political parties, we fear we should only be laughed to scorn. And yet is not such an attitude in any body of men, most of all in those men whose duty it is to discover what is best for the welfare of the State, well calculated to inspire honest and thoughtful men with melancholy? Fancy Mr. Gladstone bringing before an audience during one of his great "agitation" tours, not only all that can be said against any of Lord Beaconsfield's foreign *coups*, but, on the other side, all that could be said in favour of them, and then striking a judicial balance. And would not Lord Beaconsfield be considered as indulging in a huge joke, if, after a Mansion House dinner, he should proceed to treat the conduct of his great opponent after a similar fair and judicial fashion. And yet this would be the true scientific method of arriving at the truth in public affairs, just as it is in the investigations with which physical and natural science deals. And it is really because our parliamentary agitators despise their audiences that they treat them to only one side of a question; and if these audiences were as intelligent as they ought to be, they would not listen to any public agitator who treated them so one-sidedly. By and by let us hope that the nation will be so far advanced that politicians will give and the public will insist on being told all that can be said both for and against any measure. "Agitation," however, is not the best atmosphere in which to carry on scientific work; quite the opposite. And we should advise those of our public men who are really desirous to discover the science of statesmanship, and to guide their public conduct by its principles, to leave the method of agitation alone for a period, and take to calm but rigid scientific research in their own department, and we are sure the results will surprise even themselves. Scientific method is peculiar to no section of phenomena; it is rapidly embracing many departments of research that at one time were thought to be beyond the pale of science; and we venture to think that in no department could it be applied with greater success than in that department which hitherto has been almost entirely under the sway of prejudice and blind party spirit. Sir William Harcourt has clearly shown what can be done in sport; let him and others now try as earnestly whether even greater success would not attend scientific political prediction in earnest.

In the case of individuals, if we know their constitutions and their circumstances, we can to some extent guide their development and influence its direction; we can to some extent help them in the struggle for existence, and enable them to comply with the law of the survival of the fittest. Whether or not these two laws would justify the recent conduct of foreign affairs by the present Government, it is not for us to say. That conduct we know is justified by many on these grounds; at all events, we believe that if scientific statesmanship, and not mere party prejudice, were the guiding principle in the conduct of public affairs, this nation would be more fitted than ever to survive and play the leading part in the affairs of the world.

Scientific retrospection is quite as important as scientific prediction; we must recognise all the causes and their interactions or we may go wrong; but Mr. Bright in his recent sketch of the progress of the country during the past fifty years, altogether ignored what we believe the most important factor—the results of scientific research. Even granting the value of all the political measures to which he referred, where would the country have been at the present day had it not been for the results obtained by the quiet workers in science? Some time ago he gave a great Free Trade speech, in which he dwelt upon the immense benefits which have accrued to the country from the line of policy indicated by that expression. He went on sketching the progress of free trade, and the concomitant progress of the country, as if no other cause could possibly have been at work, and as if such powers as science, railroads, penny posts, improved machinery, increased population, and the like—gave no greater impulse to the development of the nation than an annotated edition of an obscure classic by a still more obscure Oxford don. It is not for us to pronounce on the merits or demerits of free trade or protection, but we venture to think that all that can be said in favour of either the one or the other is small when compared with the services rendered to the country by science during the past fifty years. What about railways, and telegraphs, and the great results of engineering skill, and the application of science to manufactures and agriculture, improvements in navigation, the invaluable practical discoveries of chemistry, and a thousand and one other fruits of scientific research?

Of these the political partisan takes no account; his function, as compared with that of the true worker in science, seems to us pretty much like that of the organ-blower as compared with the organist. We have said that there are one or two really able men of science in parliament; but they are only one or two. Probably in no parliament in Europe is science so sparsely represented, and yet we do not advise our real scientific workers to seek admission into an arena that we fear would be little congenial to them. But is it not high time that all our members of parliament should be really well-educated men, know something about the principles and results of a department which has done so much for the nation and on which its real welfare and progress so largely depends? Sir William Harcourt has shown that there is no reason why this should not be done, and we trust that not only will he follow out the course he has so well begun, and do this not merely for a gibe, but that his example will stimulate other well-meaning members of parliament to do what they can to qualify themselves to conduct the legislation of the country on broader, more enlightened, and more scientific principles than have ever hitherto been brought into play. Meantime those who have the true welfare of our country at heart will use every means to get education in science introduced into all our schools and colleges without distinction, so that in future years rulers and people will be guided in their public conduct not by party prejudices but by the principles of scientific statesmanship.

NICHOLSON'S PALÆONTOLOGY

A Manual of Palæontology, for the Use of Students. With a General Introduction on the Principles of Palæontology. By H. Alleyne Nicholson, M.D., &c., Professor of Natural History in the University of St. Andrew's. Second Edition. (W. Blackwood and Sons, 1879.)

IT is a great pity that there should be any demand for a Student's Manual of Palæontology. The separation of the study of extinct forms of life from that of recent animals, which is implied in the term Palæontology, and which is unfortunately largely maintained in practical science, is much to be deplored. In nearly all great museums, as in the British Museum, the fossil series of animal remains are preserved and displayed in different parts of the museum from that in which the recent ones repose and are studied and taken care of by a separate staff of officials. The extinct corals, for example, are in the hands of one set of naturalists and the recent corals in the hands of another, the most closely allied or even identical species are widely separated from one another, and considerable labour and trouble are caused to any observer who wishes to bring them together for comparison. There are necessary gaps enough in the various zoological series from the imperfection of the geological record; in museum collections they should be rendered as small as possible.

Prof. Nicholson's book cannot take the place of such a work as Quenstedt's "Petrefactenkunde," which has a proper standpoint as being required by the geologist as a means of identifying fossils. The present work may be described as an attempt to teach students as much as possible about those forms of life which happen to be extinct, by means of the aid of as little knowledge of living forms as possible. The author writes in the introduction: "Palæontology may be considered as the zoology and botany of the past. Regarding it from this, the only true point of view, some knowledge of zoology and botany is essential to the prosecution of the study of palæontology, and such details of these sciences as may be deemed requisite will be introduced in the proper place." *Some* knowledge of zoology and botany is indeed required to make a man a successful palæontologist; the real fact is, that it is only the most skilful and deeply-versed zoologists and botanists who are capable of dealing with the problems of palæontology with any valuable result. Only those most intimately acquainted with living forms are qualified to deal with the fragmentary remains of extinct animals and plants. It would be well, indeed, if the term palæontology were abolished, and with it any pretensions of investigators to treat fossils from a separate standpoint. Botanists are full of complaints of the confusions introduced into their science by the operations of certain palæo-botanists, to use the present author's term, who manufacture genera and species wholesale from impressions of single leaves or even fragments of leaves, and there are plenty of confusions equally detrimental in the nomenclature of extinct animals. It is most illogical to separate the members of the animal and plant series for purposes of study into two groups: that containing those forms which exist at the present epoch, and that embracing those which have lived and mostly become extinct during the vast antecedent period of which record remains. The separation is a purely artificial one, productive of no good, illustrating no general scientific law, coinciding with no natural division of the biological series: and is, further, one especially likely to produce misleading impressions in the minds of students.

Throughout the book the author recurs again and again to the distinction of palæontology as a science from zoology and botany. He writes of palæontology as based on *the kindred sciences* of zoology and botany. "No satisfactory acquaintance with the former can be arrived at without the previous acquisition of some knowledge of the latter." "A few points of these sciences may be noticed as having special bearing on the study of palæontology." Further on, in an account of Prof. Huxley's now abandoned group, the Annuloida, which is retained in the present work, it is mentioned that "The sub-kingdom was proposed by Huxley as a provisional arrangement to include the two groups of the Echinodermata and Scolecida, and the following extraordinary statement follows: *Whether this arrangement be ultimately retained or not matters not at all to the palæontologist, as no member of the Scolecida is known in the fossil condition.* Could any teaching be more pernicious to a student?

After several very good introductory chapters on general geological subjects, Chapter VI. treats of the divisions of the animal kingdom and succession of organic types. The author, after treating of the development theory, concludes by patting the Darwinian theory complacently on the back "as an invaluable, indeed an indispensable, *working hypothesis*," but most unfortunately for the value of his book, he does not make use of the theory as a *working one*, but considers it "preferable to enter upon the study of the actual facts unfettered by præconceptions and unpledged to theories." He accordingly treats of the classification of the animal kingdom in most antiquated style. All animals may be classed under five or six "morphological types," and "no comparison is possible between an animal belonging to one sub-kingdom and one belonging to another, since their distinguishing characters are the results of the modification of two essentially different ground plans."

"We must abandon the idea that it is possible to establish a linear classification of the animal kingdom." But why suggest any such erroneous idea as this latter to the student at all? If only the *working hypothesis* had been adopted, the real meaning of modern scientific classification, as representing pedigree and being arborescent in structure might have been pointed out. As it is the impression to be gathered by the student must be that the whole classification is disjointed and artificial. The classification given is obsolete and imperfect in many respects. The Sponges are placed amongst the Protozoa notwithstanding all that is now known of their embryonic development. The Tunicata are placed with the Brachiopods and Polyzoa as composing the Molluscoida. The Sirenia are put next to the Cetacea between the Edentata and Ungulata, and the two are treated of in one chapter as if allied to one another. Finally, man, with his venerable but flattering specific title "sapiens," is placed in the old separate order Bimana, apart from the orang and the gorilla, whilst animals so widely different as the rhinoceros and sheep, nevertheless occupy the same order Ungulata. How perverted must be the conception formed by a student of the value of morphological facts, when the results of their study are presented to him in tabular form on so utterly unequal a scale as this.

A book so large as the present necessarily takes a long time in preparation, and consequently, as the author explains in the preface, many recent publications of importance were not available to him for use in the earlier part of it. Hence the "Tabulata" are still retained as a group amongst the corals, although they have been given up as such by the author in his recent monograph on the Palæozoic tabulate corals.

By far the greater part of the book is taken up by the description of invertebrata, and the vertebrata receive comparatively less attention. Prof. Nicholson gives his reasons for not treating the vertebrata with the same fulness as the invertebrata. "The fossil remains of vertebrates are, in many cases, of the highest interest, but they come much less frequently under the notice of the ordinary student than do the remains of the invertebrates." We should have thought that these would be precisely the reasons why these rarities should be described at length, but "no practical study of the fossil vertebrates can be carried on without a *considerable acquaintance* with comparative osteology." Who, then, is the "working palæontologist" for whose benefit, as we are told in the same paragraph, the present treatise is intended? We can understand the value to a *working geologist* of a book which shall enable him to determine with ease the names of fossils, that he may use them in the prosecution of his researches as so many counters; but the present book does not, like Quenstedt's, meet this requirement in any way.

Granting, however, that there are students who require a work of instruction such as the present, the book is not without many merits, and care has been taken to introduce some account of all recent discoveries of importance. The account of the vertebrata contains a great deal of interest, including an account of some of the most interesting of the discoveries of fossil vertebrata in the United States. A good woodcut of the large tooth-bearing diving-bird, *Hesperornis regalis*, is given, taken from Prof. Marsh's restoration of it. It was between five and six feet in height. Figures are also given of the skull of Prof. Marsh's *Dinoceras mirabile*, with huge canines and three pairs of horn-cores, and also of the feet of the same curious form, which is considered by Prof. Marsh as intermediate between the Perissodactyle Ungulates and the Proboscidea.

The elevation of the Platysomid fishes to the rank of a distinct division of Ganoids is adopted by the author, owing to a misunderstanding of certain manuscripts placed at his disposal by Dr. Traquair, who has disclaimed his concurrence in the matter in the *Annals and Magazine of Natural History*. In consequence of Dr. Traquair's letter a slip has been inserted in all but the earliest copies of the book correcting the error.

The book concludes with chapters on palæobotany, which term hardly describes the contents since they are geologically and not botanically arranged. A slight sketch is given of the floras of the successive geological epochs, the characteristic fossil plants being named and figured but without much account of the details of their structure. An antiquated classification of plants is adopted, the Conifers and Cycads being grouped with the dicotyledonous Angiosperms as Exogens or Dicotyledons, whilst the monocotyledonous Angiosperms are separated from the remainder as Exogens.

There is a glossary of terms at the end of the book in which the Greek words look curious as printed in Roman characters, especially as the long vowels are not marked as such in any way. The first word in the list is Abdomen, which is for some unexplained reason derived from the Latin *abdo*, I conceal, instead of given as itself a Latin word of the same sense as that in which it is used in science. It is surely also doubtful whether the word abdomen has anything to do with *abdo*. It is suggested in some dictionaries that it is a corruption of *adipomen*.

The book is sumptuously got up and contains over 700 woodcuts, most of which are very good, many being familiar as taken from D'Orbigny and elsewhere, but many also being new. Good lists of references to monographs are given at the ends of the chapters, and form a very valuable and important feature in the work.

SIZING AND MILDEW IN COTTON GOODS

Sizing and Mildew in Cotton Goods. By G. E. Davis, C. Dreyfus, and P. Holland. (Manchester: Palmer and Howe.)

THE application of a certain kind of science to a certain kind of commerce is rapidly producing a literature of its own. It is not long since that we had occasion to notice a work which treated of the manner in which silks could be "weighted" by chemical means, and the volume now before us is the second of its kind which is concerned with the relations of chemistry and mycology to the manufacture of cotton goods.

In order to explain the *raison d'être* of this book, it may be desirable to premise that in making cotton cloth it is necessary to "size" the longitudinal threads or warp in order that they may be able to withstand the strain in the loom. The size binds the individual fibres together in the thread, and by giving it an even surface, diminishes the fraying action of the reed in its motion to and fro after the passage of the shuttle. "Pure" size consists of a mixture of fermented flour, soft or curd soap, and tallow; or of sago and cocoa-nut oil in water. The yarn is occasionally sized in the hank by hand, but this method is rapidly giving way to the use of machinery, by means of which the warp is pulled in single threads through the sow-box, or vessel in which the sizing liquor is contained, and is afterwards dried by heated air or by passing round cylinders filled with steam. The amount of size in the so-called "pure" cloths varies from 5 to 7 per cent. In such cloths the quantity of fibre is from 92 to 94 per cent., the remainder being made up of mineral matter derived from the raw cotton. Now as one element in determining the value of cloth is its weight, it happened that at about the time of the "cotton famine" which followed the civil war in America, that certain unscrupulous manufacturers introduced the practice of "heavy-sizing"—that is, in plain terms, of substituting cheap mineral substances for cotton.

Some idea of the extent to which this adulteration is practised may be seen from the following analysis of a heavily-sized warp, published by the authors. It will be noticed that only about one-third of the substance is cotton fibre, the remaining two-thirds being made up of clay, flour, and fats, with certain mineral chlorides.

Cotton Fibre	Fibre	33·18	
	Natural moisture	2·65	35·83
Size	Moisture with size ...	7·81	
	Fats	3·04	
	Starchy matters	16·16	27·01
Mineral ...	Natural ash	1·00	
	China clay	32·07	
	Chloride of magnesium..	3·25	
	,, zinc	0·84	37·16
			100 00

Very large quantities of a variety of cloth known in the Manchester trade as an "eight-and-a-quarter-pound shirting" find their way to India and China. The general character of a very considerable proportion of this substance may be determined from the following numbers:—

	lbs.	oz.	
Warp	2	14	
Weft	1	12	
	4	10	Pure cloth.
	3	9	Size, &c.
Total	8	3	

To the general reader a word or two of explanation concerning the extraordinary complexity of the composition of a piece of modern grey cloth, as revealed by the foregoing analysis, may be desirable. It will be seen that the main weight-giving substance is China clay, which has to be suspended in a sizing liquor of pretty stiff consistency. In order to preserve the clay upon the fibre it is necessary to keep the fabric slightly damp; this is effected by the addition of some highly hygroscopic material to the size, such as the magnesium chloride, which is one of the most deliquescent substances known to the chemist. The constant presence of moisture, however, renders the fabric very liable to mildew, especially if the flour has not been properly fermented before it is incorporated into the sizing liquid; and it is in order to prevent this that some antiseptic is added, usually chloride of zinc.

There is no doubt that in the outset the manufacturers, as a body, set their face against the production of such stuff. Twenty years ago these fabrics had an evil reputation: they were made by tenth-rate manufacturers and sold by tenth-rate agents. But the heat of competition has changed all this. The immense quantities of these goods which found a market in India and China—indeed, they were mainly made for exportation—compelled the great majority of Lancashire manufacturers to respond to the demand for these combinations of China-clay and starch with a modicum of cotton, a demand which is very largely fostered by the numberless middle men who come between the manufacturer and the consumer. The usual result has followed: the very fact that numbers are engaged in it has given the trade an air of respectability. *Quæ fuerunt vitia, mores sunt.* The other day Mr. Consul Gardner reported from Cheefoo that a bad name attaches to Manchester goods among the Chinese, consequent on attempts "to sell glue as cloth," and it is highly amusing to read how the Manchester Chamber of Commerce waxed indignant, and how they requested Lord Salisbury "to prevent the publication of similar statements in the future"! It is rather significant, too, that whenever a book on the subject of cotton-sizing is put forth, it should be thought necessary by the authors to dwell upon the "moral aspects" of the question in entire obliviousness of the salutary caution that to excuse is too frequently to accuse. Some of the arguments in extenuation would be amusing if they were not grotesque, as in the book before us, where we read, on p. 99, that "no one, we suppose, will deny that for coffin linings, &c., a heavily-sized but cheaper cloth is not just as good as a purer but more expensive article. If this be granted, the existence of such a material is certainly a boon." How very grateful the undertakers ought to feel for such a boon!

It is hardly worth while to take up valuable space by noticing the merits or demerits of a book such as this, the object, or at least the tendency, of which is to show the manufacturer how, by the application of certain scientific facts and principles, he may seek to perpetuate a system which, we honestly think, is simply a gigantic fraud. Our authors comment adversely on the assertion of a certain county court judge, in a case which came before him, that the "warp-sizer and manufacturer, in receiving and giving the order for sizing some warp, had entered into a conspiracy to defraud the public," but it seems to us not improbable that the judge might be perfectly right. It is almost certain that such a system will not be perpetuated: people will not sheathe themselves with shirts of China-clay. The time was when Manchester made cottons for the world, but her supremacy is being rapidly undermined; and who shall say that her sins have not contributed to her downfall?

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.*]

The Intra-Mercurial Planet Question

I HAVE read, in NATURE, vol. xx. p. 597, your editorial on the above subject. To the language of that portion of it relating to my observations I take most decided exception. You have, unintentionally of course, done me not a little injustice, owing to a misconception of what I have written, and, strangely enough, you have changed my language, giving it not merely a different, but an opposite, meaning.

I regret that I cannot look at all charitably on your baseless charges that I have "made different statements, and exhibited a degree of hesitancy about it." I had thought that my meaning regarding this question could not possibly be misconstrued, but, perhaps, in going over so much ground in so short a letter, I may not have been so clear on every point as I supposed. My desire to divest the subject of all ambiguity, and to defend my observations, if not my character, from the grave charges you have made, is my only excuse for again appearing before the world. Now, if you will give me a little space in your widely-read journal, I will, as briefly as I can, endeavour to make the subject as plain as written language will allow. If in any person's mind there yet lingers the idea that I have made different and contrary statements, my first effort shall be to set him right. Surmising that in one of your charges (different statements) you refer to the estimated distance of 12′ between the two objects seen by me during the total phase of the eclipse, I answer by emphatically saying that I have never published such a statement. A little explanation, however, is here necessary for clearness of conception. As soon as I saw the two stars I was confronted with half a dozen questions which required immediate answers, for time was precious, viz.: 1. What stars are they? 2. How far and in what direction from the sun? 3. How far apart? 4. Of what magnitudes? 5. In what direction do they point? What star, in the clearest, darkest night, appears to the naked eye as bright as do these? In response to 3, my *instantaneous* impression was about 12′, but, as quickly thinking how wide of the mark I might be in the estimation of so large a distance, I chose to impress it on my mind, knowing that, after arriving at home, I could soon find two stars whose apparent distance would be sensibly the same. This I did, and have several times published to the world the result, viz., that they were a little over half that between Mizar and Alcor, or about 7′ apart. What I wrote in my note-book of the 12′ I discarded immediately, and all the time have said, in language too plain to be misunderstood, that it was of no value at all. Every published statement has been a reiteration of this, and where, I ask, is the excuse for any who have read my letters and reports to misunderstand this? The distance recorded in my note-book was merely for reference, to see how near the truth the guess would come out. I repeat that I have never published that they were 12′ apart, and your charge that I have made "different statements" falls harmlessly to the ground. Have I not adhered with unyielding pertinacity to the facts first published, that they were about 3° south-west of the sun? That they were exactly equal in brightness, and of the fifth magnitude? That the disks were large and red? That they were about 7′ apart? And that they pointed towards the sun's centre? In all I have written I have been as guarded as possible, knowing that the time might come when every word would possess a significance not now anticipated. How, then, with any kind of justice, can I be accused and published to the world as having made different and contradictory statements?

Perhaps you base your charge on the mathematical error made in reducing the estimated distance in arc to that of time, in order to show the near agreement in R.A. between Prof. Watson's star and mine, but does that come under the head of "different statements?" If all numerical errors are to be thus classed, who, without sin, can be found to cast the first stone?

I wish it to be distinctly understood that up to this time I supposed (and the fact was disputed by none) that one of my objects was θ Cancri, and the other Watson's planet (a), and I was extremely desirous, while it all was fresh in our minds, to settle the matter, so I wrote to him that I could not harmonise his observations—as published—with my own, though I did not tell him what changes were necessary to attain this result. He replied that after making the necessary corrections, the Dec. comes out + 18° 16′, while his previous statement, made before the corrections were applied, declared it to be but 18°. That 16′ helped matters very much, but still was only half enough, as the following facts will show. The Dec. of θ is 18° 30′ 20″, that of the sun at the time of the eclipse was about the same, and, as my two objects ranged with the sun's centre, my new one (his planet (a) as I then supposed) must have had a Dec. almost identical with both, but it is clear that no object with a Dec. of 18° 16′ could range with the sun's centre, or anything like it if one were θ. This is what I meant when, in my reply to Peters, I said, "our difference in Dec. was a source of solicitude to me."

To show that you did not clearly understand the matter you corrected me, inserting in parentheses after Dec. these characters (? R.A.), as though I had made a mistake. No, I made no mistake but meant just as I said. I had, at that time, but little anxiety about the R.A., supposing that the distance between us was not an irreconcilable one (being ignorant as yet of the error you afterwards pointed out), and this was the way I reasoned. The R.A. of θ was accurately known. I did not, however, know which was θ and which planet (a), but Watson wrote me the planet was nearest the sun, though he located it in R.A. 8h. 27m. 35s., which was too far east to agree with my observation. But I, with great reluctance, increased my estimated distance 1′, calling it 8′ instead of 7′, and, reducing this to time, erroneously called it 2m.; while it was really but 32s. This was as far east, or as near to him, as I could go without doing violence to my better judgment. Here arose the question, "Can I not bring Watson nearer to me?" He said: "I consider my observation trustworthy to within 5′ of arc." So I brought him 5′ farther west. Nearer to him I could not go, nor nearer to me could I consistently bring him, as he was certain no error had been made. After all, we were too far apart to harmonise things, and, after much reflection, I made another attempt to shorten the bridge over the chasm between us. I tried to imagine that the planet had just passed its inferior conjunction, and, during the five minutes that elapsed between our observations (mine being the later), it had retrograded a little. This was why I contended that it had just passed its inferior conjunction, and that the evidence adduced from their exceptionally large disks was inadequate to prove that it was approaching superior conjunction, when it would, of course, have a very large gibbous disk.

Up to this time the thought that I had seen anything else than θ and Watson's planet (a) had not entered my mind. Being unable to reconcile our difference in R.A., though I then supposed we were not far apart (having as yet no intimation of the above-named error), I turned my attention to the matter of difference of Dec., which I could see no way to reconcile, as it amounted to over 14′ as follows:—

$$\begin{array}{lrrr} & \circ & \prime & \prime\prime \\ \text{Dec. + Swift} = & 18 & 30 & 25 \\ \text{,, + Watson} = & 18 & 16 & 00 \\ \hline & & 14 & 25 \end{array}$$

The above Dec., as deduced by me, was published in NATURE, vol. xviii. p. 539, in which I also computed its R.A. to have been (erroneously, as before stated) 8h. 26m. 40s. Commenting on this letter, you pointed out the error of the reduction of the 8′ of arc to time. I instantly saw that 8′ was but 32s., and that we were really wider apart in R.A. than in Dec. Then I said in reply to Dr. Peters, "The scales fell from my eyes, and I was able to see my way clearly through the mystery, viz., that Watson's planet (a) and θ Cancri were not the objects seen by me."

Up to this point I have endeavoured to make the subject connected and plain, and if I have not then I despair of ever being able to do so.

I now return to your editorial, which, except what you say of myself, is a fair and candid one. Please allow me to quote a few lines from that part of it where you attempt to quote me in my reply to Peters: "He now writes that the difference in Dec. (? R.A.) shown by his own and Watson's observations had been a source of solicitude, and he could see no way to harmonise them till NATURE pointed out the error," &c. I said nothing of the kind, but something as different as the zenith is from the nadir. You, by inserting the characters in parentheses, make me say that I felt solicitude about the R.A. My concern was for the Dec. as I stated it, that of R.A. being nearly wiped out, as I then—unconscious as yet of the aforesaid mistake—supposed.

But the most curious thing of all is that you should interpret me as saying that Watson's and my own observations were harmonised by your detection and pointing out of the error, when just the opposite was the effect. It *dis*harmonised them, for it showed me that instead of our objects being quite near together in R.A., we were more than a half degree apart. This, coupled with our irreconcilable difference in Dec., caused, as I said, "the scales to fall from my eyes," &c. This matter, which at first sight might appear trivial, is a vital one in my defence, and I wish to make out a perfect vindication, hoping never again to be obliged to recur to it. If you will refer to my reply to Peters, you will see that I speak of our difference in R.A. and stop, coming to a full pause. I then take up the subject of Dec., and when through with that, make another period. Then I say, "Thus the matter rested until NATURE pointed out the error, &c." Is not your language about as unlike this as can well be? In response to your wish to be able to tell your readers "how this sudden illumination caused the scales to fall from my eyes," I hope the above explanation will prove full and clear to all.

Your second charge, "hesitancy about the matter," is a new one, and so at variance with truth that necessity, even at the expense of being prolix, compels me to refute it, and to show to the world that this charge is as baseless as the other. How long did I hesitate? I answer, from the time of the eclipse until just two minutes after my arrival at home, when, though very weary and ill, and before I was seated, I consulted "Webb's Celestial Objects" to see how far Alcor was from Mizar. Then and only then was I able to fix on a definite distance between θ Cancri and, as I then supposed, the planet Vulcan, viz., about 7′. I left Denver the next morning after the eclipse, coming homeward, both by night and day, as fast as steam could bring me, arriving at home on the P.M. of Saturday, before most of the astronomers had left Denver. I immediately despatched a messenger to the Editor of the *Rochester Sunday Morning Herald*, notifying him of my arrival. I was at once interviewed by him, and a full account was laid before his readers by daylight the next morning. Sunday P.M. I was interviewed by a reporter of the *Rochester Democrat and Chronicle*, which paper, the next morning, contained a long account of my observations, a considerable part of which was published in NATURE. As soon as possible I wrote the facts to the Astronomer-Royal, to the *Observatory*, to Admiral Mouchez, and made out my report to Prof. Colbert, of Chicago (the chief of the party to which I belonged), which, with those of the other members, was published in pamphlet form, also a more extended one to Admiral Rodgers, not yet published. Very little hesitancy in this I think.

I left Denver with Professors Colbert and Hough. On the way Prof. Hough asked me several questions regarding the distance between the two stars. I told him I was unable to give their distance in arc, neither could I think of two stars whose apparent distance was the same. I also said to him that the nearest approach to a resemblance which I could then recall were α^1 and α^2 Capricorni, but, not having observed them with such an object in view, would not say that they were sensibly the same. After they had left me—changing to another road—and before my arrival at Kansas City, and before night of the day of starting, the thought came suddenly to my mind that their distance apart was about equal to a little more than half that between Mizar and Alcor, whatever that might be, which could not be ascertained until my arrival at home

Since the eclipse I have made many observations of θ Cancri and regions adjacent, to see if my judgment would allow me to modify in any particular my observations as made and published. I have even gone to a part of this city where the streets run parallel with and at right angles to the meridian, as they did at our camp, in Denver, and then wait until an imaginary sun some 30′ west of δ Cancri had the same altitude and azimuth as had the real sun during totality. And, while I am not inclined to make any changes whatever, I will say that it cannot be denied that, as regards the distance and direction from the sun, they can only be considered as rough gues es, though this does not militate in the least against the existence of the new objects. That they are new I know, for they are not there now. I have never made a more valid observation, nor one more free from doubt regarding the genuineness of the objects seen, which, in my opinion, were circumsolar bodies, unquestionably intra-Mercurial planets. The view of them was as beautiful as it was unexpected, and it was with great reluctance that I could break away from the captivating scene. It must be borne in mind that my telescope was filled with a flood of light, with not an object for reference visible, and therefore, when I ran upon these two round red disks, equally bright, and so near together, it is not surprising that they made an impression upon my mind that never will be effaced.

The great field for future astronomical discovery will, without doubt, be the sun and his immediate surroundings. Let no man's prejudice deter him from taking part in such prospective discoveries, for the field promises rich rewards.

Though I have said above that I am not inclined to modify my published estimations, yet I am willing to say as follows:—If I were compelled to change the brightness of the two stars one magnitude, and say whether they were of the fourth or sixth, I should answer, the former. If I were compelled to change their distance from the sun half a degree, and say whether they were $2\frac{1}{2}°$ or $3\frac{1}{2}°$, I should say the latter. Again, if I were compelled to change their direction from the sun, and say a little farther south or north, I should unhesitatingly say the latter, or, as I said in my report to the Naval Observatory, south of west, instead of south-west. And, finally, were I obliged to change their distance apart, and declare whether they were 6′ or 8′, I should, without a moment's hesitation, say the former, or about the distance between α^1 and α^2 Capricorni. LEWIS SWIFT

Rochester, N.Y., December 10, 1879

The Transverse Propagation of Light

IN NATURE, vol. xxi. p. 256, appeared a paper by Mr. Tolver Preston, on which I wish to make a few remarks.

The author does not make himself very clear as to what he supposes the effect of the vibrating molecules of gross matter on the ether atoms to be. From what I can gather, the effect on a small plane receiving the light from an illuminated "point" would be of the following nature:—When the molecule of gross matter was not vibrating, there would be a more or less shaded spot on the plane, but if the molecule vibrated, then this shaded spot would also vibrate in the same time, which would be possible, since during one vibration of the molecule an extremely large number of ether atoms would impinge on it, and therefore, a large number at each portion of its vibration. In what follows I shall suppose that this is the manner in which the light is supposed to be propagated.

1. The atoms are very small; the free paths are very long. In order that the acceleration of the sun on all the planets must be inversely proportional to the squares of their distances, this mean path must be comparable with the radius of Neptune's orbit; and in order that the light of the stars may be visible, it must be comparable with the distance of the furthest visible star. Again, since, as Mr. Preston says, the automatic adjustment to equality of direction is "of such a rigid character, that if the atoms were imagined to be disturbed or made to move in the most chaotic manner, they would, when left to themselves, instantly correct the irregularity," it follows that the time of describing the mean free path must be very much smaller than the "instantly" small time in which they "correct the irregularity." Their velocity, therefore, must be enormous. They must move to the farthest visible star in a very small fraction of a second. That they have a very large velocity also follows from the smallness of the atoms and the magnitude of gravitation. Now the velocity of light on Mr. Preston's theory must be the velocity with which the atoms move, a velocity which, as has been shown, must be enormously greater than 200,000 miles a second.

2. The above supposes the velocity of all atoms the same, which would not be true. If they varied in the same way as in a gas composed of atoms which do not influence one another, then at a distance from the illuminated point, after a few vibrations of the gross molecule, the shaded spot would not vibrate, but would become an elongated shaded spot without motion, and there would be no light all.

3. The data of the theory are definite, and it therefore ought to be capable of explaining the laws of refraction and reflection, let alone those of diffraction. This it is incapable of doing; for the light that gets through must be carried by atoms which pass through without striking any of the molecules of gross matter; they must therefore pass through without change of direction or velocity, and therefore cannot be deflected.

These are three reasons, each of which by itself condemns the ingenious explanation offered by Mr. Preston.

W. M. HICKS

St. John's College, Cambridge, January 16

Mountain Ranges

IT is to be regretted that Mr. Trelawney W. Saunders should make confusion worse confounded by noticing imaginary discrepancies based upon a mistaken assumption of a natural agreement. In his paper "On the Mountains of the Northern and Western Frontier of India," published in NATURE, vol. xxi. p.

96, he takes geologists to task for not making their descriptions to fit in with his delineation of purely superficial features. He reproaches the authors of the "Manual of the Geology of India" with adopting an "antiquated theory" which had been disposed of by his demonstration of a second line of peaks in the Himalayan range. The omission to account for such apparent neglect of recent discovery was solely due to the perceptions of its almost irrelevancy to the matter in hand. The old familiar feature for which Mr. Saunders claims such geographical importance (which the writers were not concerned to dispute) happens to be of quite incidental significance in the mountain-structure, and much more in accordance with "the antiquated theory" than with the independent position Mr. Saunders would assign to it. Also, the fact that the great gneissic axis of the Himalayan range divides into several minor axes west of the Sutlej, and that these disappear under fossiliferous formations before reaching the Indus, will probably be held by geologists as sufficient reason for considering this ground as the natural termination of the range. On the other hand, the fact that there should be a continuous watershed between these terminal ridges and the contiguous ridges of a confluent system of disturbance, will be admitted by geologists as sufficient for a combined hydrographical delineation of the two systems, as proposed by Mr. Saunders. The points of view of the pure geographer and of the geologist are at present so wide apart that it is irrational to represent them as conflicting. H. B. MEDLICOTT

Calcutta, December 31, 1879

Ice Filaments

THE phenomenon alluded to by the Duke of Argyll in NATURE, vol. xxi. p. 274, is not at all of unfrequent occurrence. I remember having been struck by the beauty of these ice-filaments on dead branches in Epping Forest many years ago, and some friends of mine observed some beautiful specimens of such branches in Surrey some few weeks since. The explanation which I have been inclined to give is the following:—During the moist weather preceding the frosts, the dead branches on the ground become sodden with water; the interstices between the cells of the dead ligneous fibre get saturated by capillarity, and the branches become water-logged. Now if a certain amount of dry weather intervenes between the moist period and the frost, this absorbed water would have time to partially evaporate and leave the branches more or less dry. But if the frost *immediately* follows the moist period—as pointed out by the Duke of Argyll—there is no time for the drying of the branches, and the interstitial water becomes frozen *in situ*. Under these circumstances the expansive force of the ice would cause it to flow out from every available pore by virtue of its viscosity, and such I take it is the origin of the filaments observed. Those portions of the branches which are protected by bark are sheathed by the latter in such a manner that the ice is prevented from oozing outwards; but my friends who have recently observed the phenomenon inform me that where the bark was partly separated from the wood beneath it so as to leave a small intermediate space, this space was likewise filled with filamentous ice.

All physicists are familiar with the experiment of submitting fragments of ice to great pressure in a steel mould with an opening in it. The ice becomes consolidated by regelation, and flows out of the opening in a continuous thread. The state of affairs in frozen water-logged branches could thus be imitated by having a steel mould sufficiently strong to bear the pressure, completely filled with water and perforated by capillary holes, and then freezing the contents. The ice would, under these circumstances, flow out of the capillary holes in the filamentous form observed, and if a metal band were firmly fastened round the mould so as to sheath a certain zone of the capillary holes, no ice could appear in this zone, which would thus represent the portions of the branches protected by bark.

From the point of view of this explanation, which I venture to submit for the judgment of physicists, the Duke is hardly correct in speaking of this filamentous form of ice as an "ice-crystal." R. MELDOLA

21, John Street, Bedford Row, W.C., January 23

THE filamentous form of ice-crystal, described by the Duke of Argyll as occurring upon rotten wood when a frost sets in suddenly after moisture, is by no means uncommon also upon chalk and other porous kinds of stone. It appears to arise from the water with which the body is soaked being extruded by the expansion due to cold when near its freezing-point, and becoming solidified as it passes the surface of the substance. It is, as it were, spun out of the pores of the rotten wood or porous stone. This explanation accounts for the fact, noticed by his Grace, that this form of crystal is not found upon those parts of a decayed branch upon which the bark is unbroken.

Harlton, Cambridge, January 23 O. FISHER

WHILE residing upon the South Downs I observed, during hard frosts, that prisms of ice exuded from small pieces of chalk, and having their sections identical with the piece of chalk. It is clear that the prism was formed by the moisture passing through the chalk by capillary attraction. May not this explain the formation of the filaments described by the Duke of Argyll? H. KING

The Kangaroo

I NOTICE in NATURE, vol. xx. p. 511, in a lecture on "Tails," the following remarks in reference to kangaroos:—

"These creatures make use of their tails not only sometimes to carry grass, and to a certain extent in their jumps," &c. Permit me to state that the former statement is perfectly erroneous and the latter one is correct only in a very modified degree. Kangaroos *cannot* use their tails to carry grass, and never attempt it, and the use of their tails in jumping is confined to balancing the body, and whatever leverage may be exerted in the swaying of it when in motion. The tail *never* touches the ground in going. Twenty years' observation in three colonies is my authority for saying so. ALFRED MORRIS

Sydney, N.S.W., December 30, 1879

Chinese Geese

IT may interest some who read Mr. Darwin's note on this variety, to know that there are—or were only a few months ago—a rather large number of hybrids, of apparently all grades, at the Bristol Zoological Gardens. When I was there in September there was quite a respectable flock, pure Chinese being among them.

I have not unfrequently found both the pure variety and hybrids in the country, and have usually found that the people regarded them merely as a variety. The differences mentioned by Mr. Darwin seem scarcely so great as those presented by the Polish fowl—which also, by the way, seems almost to have been regarded as a species by some naturalists of good repute. LEWIS WRIGHT

The Molecular Velocity of Heat

IN NATURE, vol. xxi. p. 201, which reached me only recently, I find a letter of your correspondent "K", to whom I am much obliged for having pointed out to me an error into which I had fallen, in common with many others. I may quote, *e.g.*, the exhaustive work of Rühlmann,[1] where, in the chapter on the history of the molecular theory, Joule is only alluded to, and immediately afterwards the theory of Krönig is given *in extenso*, without any hint that it is practically identical with that given by Joule in 1848. Having read "K's" letter, I immediately procured the original article of Joule, and I am now ready to admit that Joule's article contains all that is essential to Krönig's method of computing the velocity of gas molecules. It is true, the formula itself as an algebraical expression is not found there, but the calculations given are to all purposes equivalent to the formula.

It is scarcely necessary to add that this makes no difference at all in reference to the contents of my letter in NATURE, vol. xxi. p. 176, referring, as it does, only to the historical footnote. L. HAJNIS

Prague, Spálená ulice, 2 nové, January 20

Suicide of the Scorpion

SINCE writing mine of the 12th inst. I have, I believe, discovered in Byron's "Giaour" the scientific (?) flight of fancy upon which Dr. R. F. Hutchinson based his *central glowing*

[1] "Handbuch der mechanischen Wärmetheorie."

inference in his last letter (NATURE, vol. xxi. p. 226). Here you have it:—

> "The Mind, that broods o'er guilty woes,
> Is like the scorpion girt by fire;
> In circle narrowing as it glows,
> The flames around their captive close,
> Till inly search'd by thousand throes,
> And maddening in her ire,
> One sad and sole relief she knows:
> The sting she nourish'd for her foes,
> Whose venom never yet was vain,
> Gives but one pang, and cures all pain,
> And darts into her desperate brain."

I hope to tax your patience no further on scorpion *felo de se.*

Prov. de Jaeo, Linares, Spain, January 17 F. GILLMAN

Meteor

A MAGNIFICENT meteor was seen here last Monday evening (19th inst.) at 6.8 P.M. The meteor when first observed had an elevation of about 30° above the horizon and was travelling due west. It appeared to me to be at least four times the size of Jupiter and much more brilliant, the colour being bright blue. It seemed to be moving comparatively slowly and was in sight for some two or three seconds. When still about 15° above the horizon it burst, sending forth a number of different coloured sparks, in fact strikingly reminding one of the bursting of a sky-rocket. No report could be heard after the explosion. I may add that the night was very fine and the moon bright, and that a number of small meteors were seen at the same time.

West Calder, N.B., January 21 J. S. THOMSON

ON HALLEY'S MOUNT

"Hoc primum ab homine Anglo inventum fuisse non inficiabitur æqua posteritas."

IN Mrs. Gill's account of her voyage to Ascension,[1] she relates how her husband (since appointed astronomer at Cape Town) visited Halley's Mount, a prominent spur on the northern declivity from Diana's Peak, the central culminating point of the Island of St. Helena. Here, on a small plate u, the sight of a few roughly-squared blocks of tufa cannot fail to inspire the beholder with deep interest, for these stones, now overgrown with wild-pepper and blackberry brambles, are all that remain to mark the site of a celebrated astronomical station.

The neglected state of these ruinous foundations,

> "In which there was obscurity and fame,
> The glory and the nothing of a name,"

contrasts in a marked manner with the "exquisite neatness" (as Mrs. Gill terms it) which distinguishes the cœnotaph of Napoleon[2] in the so-called "Vale of the Tomb" several hundred feet beneath.

Here it was that Edmund Halley 200 years ago established his observatory, and first constructed his "Catalogus Stellarum Australium;" here he observed the transit of Mercury, and wrote his method of obtaining the sun's parallax by the forthcoming transits of Venus, and here made the first[3] magnetical observations in the southern hemisphere.

On the eve of Mr. Gill's astronomical experiment at Ascension, then a matter of uncertain expectancy, now happily a successful *fait accompli*, no wonder is it that a sincere sympathy with the aspirations of his predecessor determined him to some day find the means and opportunity to raise a memorial on the spot.

[1] See NATURE, vol. xix. p. 240. "Six Months in Ascension. An Unscientific Account of a Scientific Expedition." By Mrs. Gill. (Murray, 1878.)

[2] Darwin says: "After the volumes of eloquence which have poured forth on this subject, it is dangerous even to mention the tomb. A modern traveller, in twelve lines, burdens the poor little island with the following titles: it is a grave, tomb, pyramid, cemetery, sepulchre, catacomb, sarcophagus, minaret, and mausoleum!" ("A Naturalist's Voyage," p. 486.) Darwin's lodgings at Hutt's Gate were within a stone's throw of Halley's observatory, of which fact he appears to have been unaware; and, similarly, neither Napoleon nor any of his staff appear to have remarked the scientific associations of Halley's Mount during the six years they were resident at Longwood; a circumstance the more curious, as Napoleon always patronised science, perhaps less for its own sake than from motives of policy.

[3] In 1667 Halley found the variation of the compass to be 40′ E., it is now 24° W.

To astronomical students the apotheosis of the great Halley is immortally celebrated by the comet which bears his name; but to the "*profanum vulgus*" the mention of Dr. Halley conveys no conception of his genius nor of the practical scientific benefits he bequeathed to the English nation. It was Delambre who, speaking of Halley's "Synopsis Astronomicæ Cometæ," said (*Ast. Siècle*, xviii. p. 310): "Voilà bien, depuis Kepler, ce qui on a fait de plus grand, de plus beau, de plus neuf en astronomie."

It is a fact hardly yet appreciated either in England or America, that Dr. Edmund Halley is second only to Isaac Newton, whose friend and contemporary he was (Newton's "Principia" was first printed in 1686-7 at Halley's expense), and that it is to this close contemporaneity alone that the bright light of Halley's star has suffered diminution of lustre from the brilliant rays of his world-renowned neighbouring luminary.

No biographer has yet appeared to write the life of this great man, nor does any public monument yet adequately represent the national estimation which is so richly deserved by the second most illustrious of Anglo-Saxon philosophers. The first of these two reproaches is, we believe, on the eve of being wiped away; for we learn that Prof. Pritchard[1] of the Oxford University, to whom (as holding the Chair of Astronomy denied to Halley by Stillingfleet) pertains the honour of compiling so valuable a biography, is preparing for the press a full account of the long life-work of the venerable astronomer.

It is to remove the second of these wants that we now would advocate, through the columns of NATURE, the erection of a fitting memorial to our illustrious countryman on the spot which is indissolubly connected with his name, as the scene of his famous achievement.

The onerous duties of the astronomer at Capetown have prevented his doing more than suggesting the idea of a monument to Halley and the most appropriate site; it now remains for us with more leisure at home to forward the idea, and do our utmost to carry out his well-intentioned scheme; nor need we fear that it will be lost sight of and fall to the ground, now that it has been brought forward to the notice of our scientific societies. This recognition of the claim of Halley to his proper place on the roll of English scientific worthies, although somewhat tardy, need not therefore be the less hearty and thorough now that it takes place. It is now some seven or eight years since the Tuscans expended nearly forty thousand pounds in a memorial to their "Divinus Galilæus," at Florence;[2] and in 1874 the preparations for observing the transit of Venus recalled to our minds the hitherto obscure memory of the long-forgotten Jeremiah Horrocks. Surely we need not wait for the advent of the next transit in 1882 to remind the present generation what they owe to the St. Helena observer of 1677. Have we not therefore established the fact that it is desirable to erect a memorial to Halley on the ancient site of his observatory in St. Helena?

Receiving in anticipation an affirmative reply from our readers in answer to the question above, we may now approach the next stage of our subject by inquiry as to the form which such a memorial should take; and the fact is that it matters very little in reality whether tablet or bust; whether column, pyramid, or statue be chosen, so long as it is not too ornate.[3] The simplest and most

[1] See *Monthly Notices*, Royal Astronomical Society, December, 1875, p. 54. Large materials for a life of Dr. Halley were found among the papers of the late Prof. Rigaud, which will be edited by Prof. Charles Pritchard, M.A.

[2] "Tuscan Memorial to Galileo," by G. F. Rodwell (NATURE, vol. viii. p. 328, August, 1873)

[3] The sketch of one design has been shown us, consisting of a pyramid whose four sides are inclined at an angle of 70° with the base standing on a podium, which is dodecagonal surrounded with seats. The faces of the pyramid face the cardinal points. On the north face is Ursa Major, and on

severe design alone will suit the locality, which we will presently describe, and may safely be left to the discretion of a committee of taste by a general meeting of the subscribers to the memorial as only a small sum of money need be expended on this object; but we would ask if this alone will appease the manes of Edmund Halley? We must give further explanations.

Within sight of Halley's Mount are *two* disestablished observatories. One, the most important, is that on Ladder Hill, with this inscription over the doorway: "HÆC SPECULA ASTRONOMICA Condita fuit A.D. MDCCCVII." This was Johnson's observatory, broken up when the Imperial Government took the island from the East India Company in 1834. It is now used as a mess-room for the officers, R.A. and R.E., at Ladder Hill.[1] The other is at Longwood, and was established in 1840 by Sabine as a magnetic and meteorological observatory; this station was broken up in 1845. In front of it on Deadwood Plain is the base-line measured by Lefroy, 2,986·3 yards in length.

The re-establishment of these valuable observing stations would indeed be a lasting memorial such as Halley would approve. Of the fitness of the first-named station as an astronomical observatory, we need only judge from the actual work accomplished there by Johnson and by Gill's appreciation of its position and capabilities. Of the second it will be manifest to all meteorologists, what an advantage such an establishment in the heart of the south-east trades would be to science; whilst Halley's magnetical researches could be renewed in an island where the atmospherical electricity is so seldom disturbed that lightning conductors are never fitted to the powder magazines, and where distant thunder is heard seldom more than once in a generation.[2]

A few more words may not be out of place to describe Halley's Mount. Nearly in the centre of the island it commands from its elevation of 2,400 feet, the whole of the northern portion of St. Helena. Four miles looking due north is the northern extremity of the island called Sugar-loaf, and four miles to the right is Dry-gut Bay and Stone-top, whilst the same distance to the left or west, is Bennett's Point. Throughout the whole of this northern semicircle, the view is bounded only by the sea horizon. Behind us the crateral ridge just under 3,000 feet hides the southern coast, which is distant only three miles in Sandy Bay. But although this ridge hides the view, it forms a fine background and shelter against the southern winds. Above Halley's Mount the mountain-tops are covered with indigenous vegetation, shrubby Campanulaceæ, Scævoleæ, mosses, lycopods, and arborescent Dicksonias, and the peculiar composite trees with cauliflower-like blossoms, much the same as when Halley was here two centuries ago; but beneath us, how changed. As Sir Joseph Hooker observed in a lecture on "Insular Floras," at the Nottingham meeting of the British Association in 1866, in reference to St. Helena:—"When discovered about 360 years ago, it was entirely covered with forests, the trees drooping over the tremendous precipices that overhang the sea. Now all is changed, fully five-sixths of the island are utterly barren, and by far the greater part of the vegetation which exists, whether herbs, shrubs, or trees, consists of introduced European, American, African, and Australian plants." On Halley's Mount the indigenous and exotic plants meet on equal terms, a fit vegetation to surround a cosmopolitan relic.

the south Crux. On the east the inferior planets, and on the west the comet. On the twelve seats are the signs of the Zodiac (has any one remarked that the conventional signs of the Zodiac have become a recognised ornamental pattern on the jewellery made by the natives on the west coast of Africa?) and the names of astronomical workers in the southern hemisphere

[1] See "Six Months at Ascension," p. 26. David Gill's feelings at viewing this degraded observatory, remind us of Halley's disappointment on reaching Greenwich, on his appointment as King's Astronomer, 1720, and finding that the executors of Flamsteed had removed all the instruments See Whewell's "Inductive Science," vol. ii. Compare also the desolation of Uraniburg.

[2] We have not been able to ascertain in which observatory Capt. Foster's pendulum experiments were carried on between 1828-1831, but we presume in Johnson's observatory; nor are we sure where Maskelyne's station was.

In the present day the most conspicuous features in the landscape of St. Helena, as viewed from the highlands, are the sombre plantations of pinaster (only introduced in 1787), which contrast strongly with the willow-leaved acacias of New South Wales; whilst on all sides are ever wider extending acres of *Phormium tenax*, grown for the sake of its economical fibre, and whose seeds afford capital fare to the numerous Chinese pheasants which inhabit the covers on the sides of Halley's Mount.

THE U.S. WEATHER MAPS

WE are again enabled, through the courtesy of Gen. Myer, of Washington, to present our readers with two Weather Maps of the War Department of the United States, which graphically present the mean pressure and temperature for the whole of the Northern Hemisphere of the earth for April, 1878, and the tracks of the centres of storms for the same month. As these maps are constructed from the observations of all the stations reporting to the Army Signal Service, they must be held as very accurately representing the meteorology of the period, and they may serve to show the extraordinary energy with which this well-directed meteorological system is conducted and turned to account in the interests of the public and of science.

The outstanding characteristic of the weather of 1878 was its extraordinarily high temperature to the east of the Rocky Mountains, chiefly in the upper valleys of the Missouri and Mississippi, and the Lakes region, rising in the latter to nearly 11°·0 above the mean of the month. April is one of the months in which the western prairies receive their annual maximum of rain, but during April, 1878, this maximum rose greatly above its normal amount, the rainfall of the basins of the Mississippi and its affluents, with the exception of Ohio, being generously large. In Minnesota the fall was nearly four inches in excess of the average. The region of absolutely heaviest rainfall covered a broad track extending from St. Louis, Mo., to Florida.

These characteristics of the distribution of the temperature and rainfall were impressively felt in the singular distribution of atmospheric pressure, which everywhere was under the average of April, but most pronouncedly so to the west and north-west of the regions of the extreme excess of temperature and rainfall. The deficiency at Omaha amounted to fully two-tenths of an inch, an unusual deficiency for that region and season.

Turning now to the map of the tracks of the centres of the storms of April, 1878, we observe that most of them group together and lingered longest in this very region of low pressure, and that immediately to the *east and south-east* lay those regions where temperatures ranged so unusually high, rain fell so copiously, and thunderstorms played so strikingly brilliant a *rôle* among the weather phenomena of the month.

These tracks of the different storm centres admirably illustrate some of the more prominent types of the States' storms. Storm No. I. is seen to branch into two shortly after it began its advance on the States, the one passing northwards and dying out after one day's course, near the Cumberland River, whilst the other pursued a north-easterly course toward Newfoundland. No. II. originated to the east of Pike's Peak, and after a two days' course to north-north-east, was lost sight of in Canada for want of the observations necessary to trace its course over that part of the Dominion. Whilst this storm had its centre over Minnesota, a deep barometric trough ran southward into the Gulf of Mexico—a feature of American storms of no unfrequent occurrence—and the rain area extended eastward over the lakes, the middle, and South Atlantic States, with frequent heavy thunderstorms, accompanied with hail. Storms IV. and V. illustrate the coalescence

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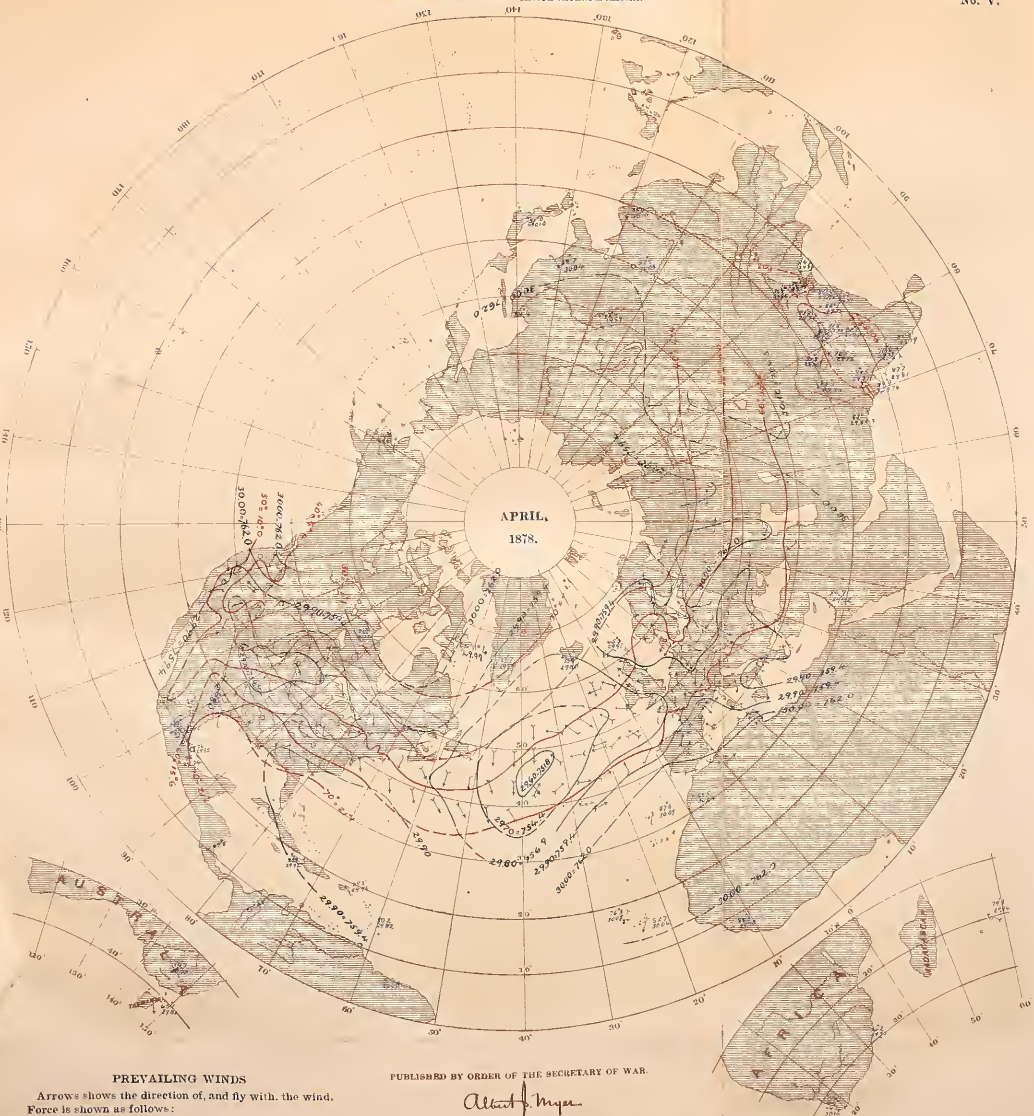
INTERNATIONAL MONTHLY CHART.

Showing mean pressure, mean temperature, mean force and prevailing direction of winds at 7:35 A. M., Washington mean time, for the month of April, 1878, based on the daily charts of the International Bulletin.

No. V.



PREVAILING WINDS

Arrows shows the direction of, and fly with. the wind. Force is shown as follows:

Symbols.	Force.	Velocity.	
		Miles per hour.	Metres per second.
	1, 2	0 to 9	0 to 4.0
	3, 4	9.1 to 22.5	4.1 to 10.1
	5, 6	22.6 to 40.5	10.1 to 18.1
	7, 8	40.6 to 67.5	18.1 to 30.2
	9, 10	67.6 up	30.2 & over.

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

Albert J. Myer

BRIG. GEN. (BVT ASSG'D) CHIEF SIGNAL OFFICER. U. S. A.

ISOBARS AND ISOTHERMS.

Isobars in *blue*; detached barometer means in English inches.

Isotherms in *red*; detached temperature means in degrees Fahrenheit.

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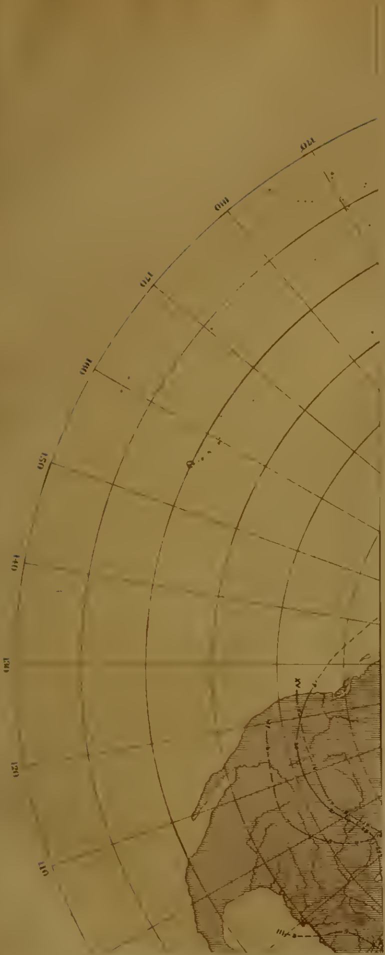

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INTERNATIONAL CHART.
Showing Tracks of Centres of Low Barometer for
April, 1878

No. VI

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

Albert J. Myer

BRIG. GEN. (BVT. ASSG'D) CHIEF SIGNAL OFFICER, U. S. A.

Storm-tracks in *Black*. The Arabic numerals show location of the centres of Low Barometer, at 7:35 A. M., Washington mean time, of that date.
Broken or dotted lines, are doubtful.

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of two storms; storms V. and VI. advanced from the Pacific, crossed California and the Rocky Mountains, and thence swept eastward over the States; and storm VIII. began its course near Chicago, ran out south-eastward to near Cape Hatteras, and then recurved in the direction of Niagara, where it died out after having traced a course nearly elliptical. It is to an exhaustive treatment of a tolerably large number of instances of these different types of storms, that we must look for the key of the mystery of the genesis, progress, and termination of the cyclone which comprehends within itself by far the major portion of all weather changes. Towards this great and perhaps not far distant result, nowhere is any meteorological system making contributions so large and so effective as is Gen. Myer through the munificent liberality of the United States Government.

DIFFUSION OF COPPER IN THE ANIMAL KINGDOM

THE fact of the normal presence of minute quantities of copper in various members of the animal kingdom has been noticed by several chemists within the past twenty-five years. Kingzett states that he has invariably found it to be a constituent of the human brain, while Odling and Dupré, and Bergeron and Hôté have determined analytically the average amount of copper present in the liver and kidneys of human beings and domestic animals. In the latter case the average percentage of copper found was about 35 millionths. Some two years since Cloez examined the blood of a deer, and found it to contain 6 millionths of copper. The most interesting instance of the occurrence of copper in the animal creation is, however, that communicated by Prof. Church to the Royal Society in 1869. At this time he was engaged in the investigation of a peculiar, soluble, red colouring matter present in the wings of the Turaco, a bird from the West Coast of Africa. A thorough study of this pigment showed it to contain 5·8 per cent. of copper, and Prof. Church established for it the formula $C_{50}H_{56}O_{19}NCu$. Led to seek the source of this strange factor in the animal economy of the Turaco, he succeeded in detecting copper in the fruit of the *Musa sapientum*, which forms the chief article of the bird's diet.

To these few isolated cases of the normal assimilation of copper in the animal kingdom, Dr. M. Giunti, in the last fascicule of the *Gazetta Chimica Italiana* (vol. ix. p.541), adds a number of interesting and diversified instances.

His attention was first directed to the subject accidentally by finding over one-third of 1 per cent. of copper in the guano deposits from bats occurring in certain Italian caves. This led to an analytical examination of the bat, the results of which showed that about four ten-thousandths of the weight of the ashes of this animal consist of cupric oxide. Still bent upon finding a more ultimate source for the metal, Giunti has subjected to analysis quantities of the insects which form the food of the bat, and in all cases he has found copper present in greater or less amount. The quantity would seem to vary in the different orders, families, and species. Aquatic insects contain less than those found on land, and the Coleoptera appear to yield the highest percentage. Thus the ashes of *Anomola vitis* contain 0·1 per cent. of cupric oxide, and those of *Blatta orientalis* 0·826 per cent. High as this percentage seems, the amount of copper in an individual insect is infinitesimal, being, in the case of *Anomala vitis*, less than four-millionths of a gramme. Copper was also detected amongst other Coleoptera (such as *Cetonie, Cerambix, Ateucus sacer, Leurus striatus*, and notably the lava of *Srillotalpa*); amongst Diptera (*Mosca domestica*), Lepidoptera (*Vanessa cardui, Piaris sinapis, Limenites camilla*, &c.), and Hymenoptera (*Æschena maculatissima, Libellula depressa, Calabroni*, &c.).

Giunti has next sought to ascertain whether other insectivorous animals besides the bat are wont to assimilate the copper present in their insect prey. This was found to be the case with all members of this class subjected to examination, such as snakes, lizards, urchins, &c. The ashes of the latter contain from one to two ten-thousandths of copper, while the ashes of lizards contain over fifteen thousandths. In their case most of the copper is to be found in the skin of the animal.

Giunti's experiments have likewise been extended amongst the invertebrates. Various varieties of spiders; of myriapods, such as *Julus terrestris*; of isopods, such as *Armaditlidium vulgare*; and of snails, have all given affirmative responses to his tests. Amongst these, *Julus terrestris* contains the largest amount of copper, its ashes showing a percentage of 0·18.

The investigations of the Italian chemist in this novel branch of physiological chemistry are still being continued, and it is to be hoped that more extended observations will inform us of the exact nature of the *rôle* played by cupric compounds in the animal economy.

T. H. NORTON

NOTES

NEXT week we publish an extra number entirely devoted to an account of the life and work of M. Dumas, the eminent French chemist, and one of the greatest of living Scientific Worthies. Dr. Hofmann, of Berlin, has been good enough to devote a great deal of time and research to this paper, and has treated the important subject in such detail that, owing to the pressure on our space at present, it is impossible for us to find room for this long article in the ordinary way, and we are therefore compelled to devote to it an extra number. We are sure our subscribers will give us their willing approval and support in an emergency so very special, and all will doubtless be glad to have this sketch of an eminent French chemist by so eminent a German *confrère*.

A PAPER has been circulated by the Perpetual Secretary of the Paris Academy giving notice that M. Maindron has been officially commissioned to collect under their authority the archives of the Academy, in a locality belonging to the Institute. Persons possessing documents available for that purpose are requested in the name of science kindly to send them. A fair example has been recently given by M. Bornet, whose liberality has been publicly acknowledged. M. Etienne Charavay, the expert in autographs, has recovered on behalf of the Institute a number of documents which had belonged to the Academy.

THE Society for the Promotion of Hellenic Studies, which was inaugurated in June last, held its second general meeting on Thursday, January 22, at 7, Adelphi Terrace, Mr. C. T. Newton in the chair, when the rules drawn up by the Committee were adopted, the Bishop of Durham elected President, and other officers settled as follows:—Vice-Presidents: Lord Morley, Mr. Justice Bowen, the Dean of St. Paul's, M. Gannadius, Mr. Newton, Mr. E. Maunde Thompson, the Master of Trinity College, Cambridge, Prof. Colvin, Rev. H. F. Tozer. Prof. Sayce, Prof. Jebb, and Prof. T. K. Ingram. Council: The Bishop of Lincoln, the Dean of Westminster, the Dean of Christchurch, the Rector of Lincoln College, Oxford, Sir John Lubbock (Treasurer), Sir Charles Dilke, Professors Bryce, Hort, Kennedy, Mahaffy, B. Price, H. J. S. Smith, Tyrrell, Messrs. A. J. Balfour, M.P., Oscar Browning, J. Bywater, W. W. Capes, H. O. Coxe, T. Chenery, E. A. Freeman, Percy Gardner, George Macmillan (Hon. Sec.), Ernest Myers, D. B. Monro, J. Cotter Morison, H. F. Pelham, F. C. Penrose, Walter Perry, J. A. Symonds, and Oscar Wilde. The objects of the Society, as stated in the outset of the Rules, are:—1. To advance the study of Greek language, literature, and art, and to illustrate the history of the Greek race in the ancient, Byzantine, and Neo-Hellenic periods, by the publication of memoirs and unedited documents or monuments in a journal to be issued periodically. 2. To collect drawings, fac-similes, transcripts, plans, and photographs of Greek inscriptions, MSS., works of art, ancient sites and remains, and with this view to invite travellers to communicate to the Society notes or sketches of archæological and topographical interest. 3. To organise means by which members of the Society may have increased facilities for visiting ancient sites and pursuing archæological researches in countries which, at any time, have been the sites of Hellenic civilisation.

AMONGST the prizes offered by the Istituto Reale Veneto di Scienze e Lettere at Venice we mention the following:—(1) 1,500 lire (about 58*l.*) "for a detailed description of the determinations hitherto made of the mechanical equivalent of the heat unit, investigation of causes, &c. ; (2) 3,000 lire (116*l.*) "for a representation of the advantages which the application of physics has brought to medical science, and to clinical medicine in particular;" (3) 3,000 lire "for a summary of the recent investigations in theoretical hydrodynamics, followed by a representation of the true and essential progress made in this part of scientific mechanics;" (4) 3,000 lire "for a description of the most recent hypotheses in physical science concerning the phenomena of light, heat, electricity, and magnetism, followed by an indication of the changes which scientific language would have to undergo in order to be in accordance with the best founded theories, this indication to be illustrated by some examples describing some of the principal phenomena." The competition for the first and fourth of these prize-themes ends on March 31 next, that for the second and third on March 31, 1881. For further details we must refer our readers to the Institution itself.

ON his passage through Rome, Dr. Gerhard Rohlfs was received in special audience by the King of Italy, who personally decorated the great traveller with the Commander Cross of the Italian Order of the Crown.

THE Royal Academy of Sciences at Turin has awarded the Bressa prize for the four years 1875 to 1878, to Mr. Charles Darwin.

WE had occasion some time ago to call attention to the excellent scientific work which is being carried on at the Carlsberg Laboratory, Copenhagen. This laboratory of research, it will be remembered, was founded and endowed by Mr. J. C. Jacobsen with the intention of aiding, as far as possible, in placing upon a secure scientific basis the technical processes of brewing and malting. We have now before us a Report of the work carried out during the past year. This is published under the title of "Meddelelser fra Carlsberg Laboratoriet" by the committee of management appointed by the Royal Danish Academy of Sciences. The original report is in Danish and is accompanied by a very full *résumé* in French. We append the titles of the principal papers embodied in the Report:—"Contributions à la Connaissance des Organismes qui peuvent se trouver dans la Bière et le Moût de Bière et y vivre," par E. Chr. Hansen. "Sur l'Influence que l'Introduction de l'Air atmosphérique dans le Moût qui fermente exerce sur la Fermentation," par E. Chr. Hansen. "Recherches sur les Ferments producteurs de Sucre," par J. Kjeldahl. (1) Recherches sur la Diastase; (2) Recherches sur la Ptyaline (Diastase de la Salive).

WITH regard to distinguishing artificial from natural butter, M. Donny remarks, in a recent note to the Belgian Academy, that the two behave very differently when heated between 150 and 160 degrees in a capsule or test-tube. At this temperature artificial butter produces very little froth, but the mass undergoes a sort of irregular boiling, accompanied by violent jerks which tend to project some of the butter out of the vessel. The mass grows brown, but this is by reason of the caseous matter separating out in clots on the walls; the fatty portion of the sample sensibly retains its natural colour. Natural butter, on the other hand, heated to 150° or 160° produces abundant froth, the jerks are much less pronounced, and the mass grows brown but in a different way. A good part of the brown colouring matter remains in suspension in the butter, so that the whole mass has a characteristic brown aspect similar to that of the sauce called *au beurre noir*. All natural butters behave thus, and it is strange, M. Donny says, that this simple method of distinguishing natural from artificial butter has not been indicated before.

A BODY of Russian *savans* is expected to go next spring into the Slavonic Balkan provinces to study their geology and ethnographically examine the palæographic architectural remains. The expenses of this expedition are to be defrayed by the Russian Geographical Society and a Slavonic committee.

THE death is announced at New Braunfels, in Texas, of Ferdinand Lindheimer, a German botanist, long settled in Texas, for the botany of which he did much by the valuable collections he made.

SEVERAL shocks of earthquake were felt at Havana on the night of January 22. On Sunday last two slight shocks were felt at Carlsruhe.

A MUNICH correspondent describes an interesting anatomical model recently constructed by Prof. Rüdinger of that city. The model represents a whole human body, life-size, which can be taken to pieces in eight different ways. The sixteen section planes thus obtained show most minutely all anatomical details. The model was executed, under the learned professor's direction, by Messrs. Zeiller.

THE *Gazette de Lausanne* of January 20 publishes a very interesting letter by Dr. Forel, on the probability of the Lake of Geneva being frozen during this winter. After having made several measurements on January 15, Dr. Forel proved that the temperature of water throughout the lake (at a certain distance from the shores) was on that day equal to 5°·2 Celsius. Now comparing this figure with the temperature of water measured at various depths on October 23, 1879, he concludes that the water of the lake has lost during eighty-five days no less than thirty calorific units for each square centimetre of its surface, and that it must lose twenty-four units more to reach the temperature of maximum density (4° Celsius), when a superficial freezing might become possible. The laws of freezing are but imperfectly known; but applying to the Lake of Geneva the results of measurements he has made during December last on the frozen Lake Morat, Dr. Forel concludes that the waters of the former lake must lose eight calorific units more to lower the temperature of the water at the surface to the freezing-point. Thus the waters of Lake Leman must lose altogether thirty-two calorific units per square centimetre of surface before any freezing would become possible. The lake having lost but thirty units from October 23 to January 15, we ought to experience a period of cold of the same intensity as that which was experienced during the last three months, for the freezing of the lake. But, according to the computations of Prof. Plantamour, it would be highly improbable that the cold December of 1879 should be followed by a January as cold as that of 1830. Thus, it is highly improbable that the Lake of Geneva will freeze during this year, but it is possible that the "Little Lake" (*i.e.*, its south-western part) might freeze in January. January, however, is near an end, and we have not yet heard of the lake being frozen.

THE ice on the Loire continues to occupy the French engineers. The works are proceeding actively but not very favourably; more frosty weather having prevailed the water freezes behind the boats of the men trying to open a channel in the ice-barrier. Immense disasters are anticipated from the thaw if some means are not found to work more effectually. It is stated that the block was formed principally in consequence of the situation of the bridge of Saumur, which some competent engineers proposed to demolish many years ago as creating a danger on the occasion of inundations. The proposal was renewed during the present crisis without having met with any success.

THE Canal Saint Martin, which is used so largely for provisions of Paris, has also been entirely frozen, and the blocks of ice not having melted, as in the Seine, the Director of the City Works is busy in disencumbering it as much as possible. The difficulty is not so much in cutting the ice as in sending it into the Seine by the flood gates. Although having a length of only a few kilometres, the Canal St. Martin has so many locks, that the problem of freeing it is one of the most difficult than can be imagined.

THIS week the Commission of the Municipal Council of Paris will deliberate upon the desirability of continuing the experiments on electric lighting in the Avenue de l'Opéra. Since the article by M. de Fonvielle was written, the Siemens brothers have exhibited their lamps on one of the largest confectionery shops on the Boulevard Montmartre. It works very well, and creates some sensation in Paris.

AT the last meeting of the St. Petersburg Gardening Society, Prof. Beketoff made an interesting communication on the discovery in the government of Ekaterinoslav, in a wild state, of vine-plants and of the Hungarian oak (*Quercus cervis*). Both are probably degraded plants, affording remarkable specimens of natural transformism.

AMONG the numerous bibliographical indexes which have lately appeared in Russia, we notice the "Bibliography of works in Finance, Industry, and Trade in Russia, from 1714 to 1870," by M. Karataeff, which contains a complete systematic list of more than 6,000 books, papers, and newspaper notices on these subjects. The work has just appeared at St. Petersburg.

WE notice in the last number of the *Journal* of the Russian Chemical and Physical Society, the sixth part of the memoir by Prof. Menshutkin, on the influence of isomerism of acids on the formation of compound ethers. As seen from numerous measurements published by the author, the isomerism of acids is of great influence on the absolute and relative rate of etherisation, the primary acids being etherised in from 72 to 120 hours, whilst no less than 336 hours are necessary for the complete etherisation of several tertiary acids. Besides the rate of etherisation decreases also with the increase of the molecular weight. The same journal contains a paper by MM. Beilstein, and Courbatoff on chloranilines and chlornitranilines, and the minutes of the meetings of the Society.

THE new French cable for America has been placed at the disposal of the public for correspondence. It goes direct from Brest to St. Pierre, and from St. Pierre to Massachusetts, where it is connected with the American Telegraphic Union. A new cable will be laid from Brest to Penzance by the *Faraday* steamer, in the beginning of February, and afterwards from Penzance to St. Pierre. This second cable will be used for English telegrams.

IT is stated that a valuable bed of anthracite has been prospected at Ching-mên-chow, near Ichang on the Upper Yangtszi-kiang, and that it is already being worked. The coal district is said to extend for seventy-five square miles, and to contain ten beds of coal, one of which, at Wo-tsze-kow, is estimated to contain 1,200,000 tons, and lying only 100 feet below the surface.

THE Cracow newspaper *Wiek* states that the Cracow Academy proposes to convoke a general congress of historians.

THE Forty-sixth Annual Report of the York School Natural History Society is on the whole favourable; good work has been done in the geological section especially.

THE annual meeting of the Yorkshire Naturalists' Union was held at Huddersfield on Saturday week, Dr. H. C. Sorby, the president, occupying the chair. There are now twenty-six societies in the Union; Prof. Williamson, of Manchester, was chosen as Dr. Sorby's successor in the presidency. The latter gave his annual address in the evening on "The Structure and Origin of Limestones."

WE have received a report of a very successful scientific exhibition which has been opened for a few days by the enterprising Dundee Naturalists' Society. We notice from the programme of the Society, that besides lectures by eminent men of science, a number of papers of a thoroughly scientific character, will be read by members of the society during the present session.

A BANK, commonly called Hafner, in the Lake of Zurich, and situated at a distance of a few thousand feet from the Mansion House Promenade, is now being minutely investigated by order of the town authorities. It appears that remains of a prehistoric pile dwelling are coming to light at this spot, consisting of a quantity of coarse and fine clay vessels, coals, a few bronze implements, &c. The piles upon which the old colony rested are particularly numerous.

THE additions to the Zoological Society's Gardens during the past week include a Chinese Rhesus Monkey (*Macacus lasiotus*) from Shanghai, presented by Messrs. John Morris and A. H. Brown; two Blue-eyed Cockatoos (*Cacatua opthalmica*) from the Duke of York's Island, presented by the Rev. Geo. Brown, C.M.Z.S.; two Martinican Doves (*Zenaida martinicana*) from Grenada, W.I., presented by Capt. H. King; a Kittiwake Gull (*Rissa tridactyla*), European, presented by Mr. W. H. Cope, F.Z.S.; a Common Barn Owl (*Strix flammea*), European, presented by Mr. G. D. Edwards; a Jaguar (*Felis onça*) from South America, four Common Peafowls (*Pavo cristata*) from India, two Knots (*Tringa canutus*), four Widgeon (*Mareca penelope*), a Wild Duck (*Anas boschas*), two Scaup Ducks (*Fuligula marila*), European, purchased.

OUR ASTRONOMICAL COLUMN

PERIODICAL VARIATION IN THE BRIGHTNESS OF NEBULÆ.—In 1877, in a communication to the Royal Astronomical Society, Prof. Winnecke drew attention to the nebula H. II. 278, remarking that it appeared to exhibit not only a variability in its light, but, which he considered much more remarkable and difficult of explanation, that *periodical* fluctuations of brightness seemed to take place. A short time since he briefly pointed out a second case of similar character, in the nebula H. I. 20; in the last number of the *Astronomische Nachrichten* he returns to the subject, and collecting the descriptions of the latter nebula, presents very strong evidence of the variability of its light and indications that it may prove periodical.

H. I. 20 is No. 882 *h*, and No. 2405 of the General Catalogue: its position for 1880 is in R.A. 11h. 18m. 13s., N.P.D. 77° 59'·6, or it precedes B.A.C. 3882 by 34·5s., and is 5' south of the star. A star 12m. follows at 2·8s., 2'·1 to the north. Sir W. Herschel described it as "very bright" on March 15, 1785. Forty-five years afterwards his son found it "extremely faint;" and remarked at the time: "This nebula must have changed greatly, if it ever belonged really to the 1st class." On April 4, 1831, he again found it faint. The next record of its appearance was made by Boguslawski, during his preparation of Hour XI. of the Star-charts of the Berlin Academy, when it appears to have been bright enough to be well seen in the comparatively small telescope used in the formation of the chart (aperture 3·8 inches); this would be at the epoch 1840 ±. On March 7, 1856, Winnecke found it pretty bright with the Berlin refractor. D'Arrest, on February 19, 1863, noted a considerable diminution of brightness: "Hodie aperte non supra tertiam classem," and he adds: "Locum hæc nebula non mutat, an lucem?" On April 10, 1878, it had again brightened, Winnecke recording: "Bei hellem Mond, deutlich gesehen, gewiss I. Classe." On March 21, 1879, he considered it "wohl nicht I., aber gut II. Classe." This nebula is of the elongated class, the direction of elongation not very far from the parallel; the longest diameter about $1\frac{1}{2}'$. It is evidently well deserving of continuous observation.

Prof. Julius Schmidt directed attention in 1862 to another very suspicious case in the same quarter of the heavens. The object to which he refers in his communication to the *Astronomische Nachrichten* appears to be H. IV. 4, though he does not mention the identity. Sir W. Herschel, observing on February 22, 1874, describes it as "extremely faint, small, like a star with a very faint brush s.p.; 240 shows the star." It will be remembered that Sir W. Herschel's fourth class included "stars with burs, with milky chevelure, with short rays, remarkable shapes, &c." Sir John Herschel's description on April 13, 1828, does not differ from his father's; he calls it a "star 13·14 m., with a faint, small, nebulous brush." In the General Catalogue, where it is No. 2403, it is noted "very faint, small: attached to a star 13 m." Prof. Schmidt commences his note upon the probable variability of this object by remarking that it is found upon Chart No. 6 of the Bonn Durchmusterung, and must have been seen in the zone-telescope, a Fraunhofer comet-seeker of three inches aperture and two feet focus; it is No. 2436 at p. 24 in vol. iii. of the Bonn Observations. At the date of his communication (1862, March 29) he says: "This nebula is at the limit of visibility for the Athens refractor." He determined the position of the nebula and of two small neighbouring stars by reference to Weisse No. 315, with the following results for 1855·0:—

	R.A. h. m. s.		Decl. ° ′ ″	
Nebula	11 16 22·6	... Decl.	−0 18 36	Light of nucleus = 13 m.
x	11 16 28·1	,,	−0 21 59	12·13
y	11 16 42·5	,,	−0 20 34	11·12

The Bonn position reduced to the same epoch gives R.A. 11h. 16m. 28·8s., Decl. −0° 21′·8, agreeing almost precisely with Schmidt's small star x. There may be a suspicion, therefore, that the place of greatest condensation of the nebulosity changes, as would appear to be the case with the first variable nebula in Taurus, discovered by Mr. Hind in 1852, according to M. Otto Struve's observations at Pulkowa. These objects require, and certainly merit, very close observation with adequate instruments.

Total Solar Eclipses in the next Decade.—The report of the observation of an intra-Mercurial planet, during the total eclipse of the sun on the 11th inst., from one of the higher mountains in California (which, however, at the time we write, has not received the confirmation that might have been expected), naturally directs attention to the similar opportunities for observation of such a body that are approaching, and we may briefly particularise the circumstances under which the total eclipses of the sun, within the next ten years, will take place. The first is the eclipse of 1882, May 17, where the central line passes over Egypt, not far from Luxor, near Teheran, and so across Asia to Shanghai; the greatest duration of totality is 1m. 48s., but at the most accessible stations will not exceed 1m. 15s.; maps exhibiting the general features of this eclipse are already published in the *Nautical Almanac* and the *American Ephemeris*. Then follows the eclipse of 1883, May 6, in which the course of the central line is wholly on the Pacific Ocean, avoiding apparently, with the exception of the Marquesas, the inhabited islands. From the Admiralty chart of this group, it seems that the total phase may be observable at Chanel Island, where it will commence about 0h. 42m. local time, continuing 2m. 52s. The eclipse of 1885, September 9, may be well observed in New Zealand, where the sun will have risen to an altitude of fifteen or sixteen degrees, the duration of totality on the central line in the longitude of Wellington being 1m. 54s. Next follows the great eclipse of 1886, August 29, a recurrence of that of 1868, August 17, which was observed in India. Unfortunately in this case we have again an ocean track for the belt of totality, except near the beginning and ending of its course; at the southern extremity of the Island of Grenada the sun will be hidden for 3m. 15s., while at an altitude of about 20°; but in about 14° 13′ west of Greenwich, and latitude 2° 58′ N., where the sun is centrally eclipsed on the meridian, totality will continue for nearly 6m. 30s., and it may be expected that efforts will be made to secure in this part of the Atlantic, at least such observations as bear upon the existence of an intra-Mercurial planet or planets; when the central line reaches the African coast the duration of total phase will have diminished to about 4m. 45s., in 12° S. latitude. The next eclipse is that of 1887, August 19, which it was supposed for a long time would be total in this country, the central line, however, does not reach England; commencing in Central Germany, or in 11° 39′ east of Greenwich, and 51° 38′ N., it passes by Berlin and Moscow, to a point in 102° 15′ E., and 53° 46′ N., where the sun will be totally eclipsed on the meridian, and thence to 173° 47′ E. and 24° 32′ N., where the central phase passes off the earth; at Berlin, where the sun will only just be clear of the eastern horizon, totality continues 1m. 41s., and in the longitude of Moscow, to the north of the city, 2m. 30s., with the sun at an altitude of 17°; on the shores of Lake Baikal, where he will be near the meridian, the duration of totality is increased to 3m. 38s. The last total eclipse of the decade to which this note applies will take place on December 22, 1889; it may be observed at Bridgetown, Barbadoes, where the sun at an altitude of about 6° will be hidden for 1m. 48s.; at a point on the Angola coast in about 10° S, totality will continue 3m. 34s., the central eclipse passes off the earth in 60° 55′ E. and 6° 53′ N.

BIOLOGICAL NOTES

Bees Eating Entrapped Moths.—Mr. Packard, jun., writing in the January number of the *American Naturalist*, says that a flowering stalk of an asclepiad (*Physianthus* [*Aranja*] *albens*) was brought to him last September, with the bodies of several moths (*Plusia precationis*) hanging dead from the flowers, being caught by their tongues or maxillæ. "These moths had, in endeavouring to reach the pollen-pockets of the flowers, been caught as if in a vice by one of the opposing edges of the five sets of hard, horny contrivances covering the pollinia." A very short time afterwards the Rev. L. Thompson, of North Woburn, Mass., a careful observer, sent Mr. Packard the following details of the behaviour of bees (*Apis mellifica*) also frequenting the flowers of the same asclepiad:—"My attention was attracted by two or three bees buzzing immediately around as many entrapped moths that were alive and struggling to get away. Every moment or two a bee suddenly and furiously darted upon a prisoner and seemed to me to sting it, despite its desperate efforts to escape. This onset was generally instantaneous, but was repeated again and again; and after a moth became still and apparently lifeless the bee settled upon and, if my eyes did not greatly deceive me, began to devour it." Mr. Thompson previously noticed tongues of the same species of moth caught in the flowers, the bodies to which they belonged having disappeared. At the time he fancied these were probably eaten by birds, but on further examination he came to the conclusion that the bees had really feasted on animal food as well as upon the nectar of the surrounding flowers. Specimens of these bees being captured, the species was determined by Mr. Packard. On this fact being communicated to Mr. Darwin, he wrote that he "never heard of bees being in any way carnivorous, and the fact is to me incredible. Is it possible that the bees opened the bodies of the Plusia to suck the nectar contained in their stomachs? Such a degree of reason would require confirmation, and would be very wonderful." Hermann Müller wrote "that his brother Fritz in South Brazil has observed that honey-bees (species doubtful) licked eagerly the juice dropping from pieces of meat which had been suspended in the open air to dry; but he thinks nothing has been published on the carnivorous habits of bees." The well-known apiarian, Prof. A. J. Cook, however, reminds Mr. Packard "that honey-bee workers within the hive, on killing off the drones, tear them in pieces with their mandibles rather than sting them, and that he has seen them thus kill a humble-bee that had entered the hive." Huber, if we mistake not, also tells us that under certain circumstances the common hive-bee will devour the eggs laid by the queen bee.

New Mosasauroid Reptiles.—The Mosasauroid Reptiles are so rare in Europe that the famous type specimen described by Cuvier still remains the most perfect yet discovered there. This was the specimen said to have been given up to the French army on the capture of Maestricht, and which is now in the Paris Museum. So much was thought about it that the story goes that the French gunners had orders not to point their artillery to that portion of the town where it was known to be. In America Prof. O. C. Marsh tells us, the group attained a marvellous development, and was represented by very many genera and species belonging to even diverse families. In a paper in the current number (January) of the *American Journal of Science* he gives some new characters of the group, based on the examination of an enormous collection in the museum of Yale College, which is calculated to contain the remains of not less than 1,400 distinct individuals. In not a few of these the skeleton is nearly if not quite complete, so that every part of its structure can be determined with almost absolute certainty. Already from this immense storehouse has Prof. Marsh made out various important details of the anatomy of the group. In the present paper he communicates several others which had escaped other observers. Several specimens, one of which is figured, prove the presence of a sternum which is of the true lacertilian type. The entire pectoral arch and paddles in several genera are described; the general structure of the paddles is Cetacean in type; hyoid bones have been found. In some genera the orbit was protected by a ring of osseous plates, composed of but a single row of plates overlapping; the transverse bone of Cuvier (ecteopterygoid, Owen) is present in several of the genera. The accuracy of Cuvier's determination of the pterygoid bones can no longer be called in question; Cope errs in calling them palatines. All these newly-discovered characters and facts indicate a true lacertilian alliance, and a new sub-order of lizards should be formed, to be called Mosasauria.

New England Isopods.—In the *Proceedings* of the United States National Museum (November 5, 1879) Oscar Harger briefly describes the marine isopods collected by the United States Commission of Fish and Fisheries. Fuller descriptions with figures of most of the species are promised later. As new species are described *Janira spinosa*, from Banquerean, and *Leptochelia rapax*, from Aunisquam. There are forty-three species enumerated, of which eleven are to be found on the coasts of Europe.

The Fossil Horses of Constantine.—Veterinary Surgeon P. H. Thomas has quite recently published an interesting account of the remains of some fossil horses found in the neighbourhood of Constantine, in Algeria. It will be remembered that the environs of Constantine are traversed by large and deep valleys, on the flanks of which, as far as an elevation seldom exceeding 600 metres, the stripes of a fluvial-lacustrine pliocene formation lie stratified. These, at their base, are characterised by the presence of a chalky marl, and towards their summits by gritty conglomerates, pudding-stones, and sand; the fluvial lacustrine deposits contain a somewhat transition fauna-composed of some of the larger vertebrates, amongst which two species of horse have been found, one an Hipparion and one very near to, if not identical with, the *Equus stenonis* (Gaudry), of the pliocene of Europe. In the bottom of these valleys, at the base of the steep banks of the larger rivers, turfy deposits are found, appertaining in all probability to a recent quaternary period in which a fauna appears—which, though showing some affinities to the previously-mentioned fauna, is more clearly connected with that actually existing. Here are to be found remains of a horse (*Equus caballus*) differing by only a few secondary characters from the actually living African horse; an ass of small dimensions, presenting in its dentition some characters calling to mind the genus Hipparion, which genus had, however, disappeared since the preceding geological period. In the grey marl which immediately lie over the alluvial turf, and which appear to be very recent, there will be found in the lowest strata the remains of horses, horned cattle, and molluscs, differing in no way from those of the present day. In a middle stratum remains of flint weapons have been found (at about 2·50 m. from the surface of the soil), while at about 1 metre below this surface, vestiges of the Roman occupation will be met with.

PHYSICAL NOTES

Measurements of the movements of glaciers have hitherto been directed either to approximate determination of the yearly or daily mean velocity, or to showing that the motion of glaciers resembles that of liquids. Some new measurements by Herr Koch and Fr. Klocke (*Wied. Ann.*, No. 12) have been limited to ascertaining the motion of a point of the surface in a vertical plane parallel to the direction of length of the glacier, with a view to finding the real nature of the glacier's progress, whether continuous and in the same direction or not. Two scales were placed, one vertical, the other horizontal, being attached to a post, fixed half a metre deep in the ice, and having a cone of ice and *débris* formed round it. This was on the west side of the Morteratsch glacier, about 1½ km. from its principal extremity. The observations were made in August and September, the scales being watched by day only, through a fixed telescope with cross-wires. The number of scale parts passing the cross gave the direct and horizontal components of the motion. Another similar post with scales was set up near, and in the field of vision. The observations proved that the motion of the glacier is by no means uniform, for one and the same point may move now upwards, now downwards, towards the mountain, or towards the valley. Further, two points of the surface, about 50 to 60 metres separate from each other, may, at the same time, move in different, and even in opposite directions.

The behaviour of membranes in sounding columns of air has been recently investigated by Herr Kohlrausch (*Wied. Ann.*, No. 12), and with the following results (which sufficiently indicate the line of research):—1. Open membranes (freely in contact with the air on both sides) vibrate in the ventral segments of stationary waves, and come to rest in the nodes; covered membranes (shut off from the external air on one side) vibrate in the nodes and come to rest in the ventral segments. 2. A fine open membrane stretched over a ring is a *very sensitive* means of determining the position of the nodes in stationary waves. 3. If a solid body be brought between two nodes of the stationary vibrations of a pipe, the half-wave between these two nodes contracts, while the others are lengthened, and the pipe gives a tone corresponding to the longer half-waves, consequently a deeper one.

From a comparison of the temperature co-efficients of fluidity and galvanic conductivity for a number of substances (*Wied. Ann.*, No. 12), Herr Grotrian finds that with increasing concentration of a solution, both coefficients vary in the same sense. In solutions of NH_4Cl. KCl, KBr, and KI, the galvanic conductivity increases nearly in proportion to the percentage proportion. The fluidity, on the other hand, varies but little with the concentration.

A slight improvement has been introduced into the Bunsen grease-spot photometer by Herr Toepler (*Wied. Ann.*, No. 12), rendering the observations much less dependent on the position of the observer (the angle between his line of sight and the paper screen). The grease spot is done away with, and the thickness of paper is reduced instead, to give a spot. Between two very thin moderately transparent sheets of parchment paper, having a small circular aperture, is placed a sheet of ordinary strong paper.

Dr. Baumgartner has recently made, in Prof. Pfaundler's laboratory (*Wied. Ann.*, No. 12), a series of determinations of the specific heat of water by a method of mixtures, in which *boiling* water was poured directly into the cold water of the calorimeter. The specific heat at 100° (that at 0° = 1) was found 1·0307 (as against 1·0130 by Regnault; 1·0220 Regnault, according to Bosscha's calculations, 1·0302 v. Münchhausen and Wüllner, 1·0720 Heinrichsen, 1·1220 Jamin and Amaury, 1·1255 Marie Stamo).

The telephone has been found by Herr Niemöller (*Wied. Ann.*) capable of determining very quickly and accurately the resistance of liquids. It is substituted for the galvanometer in a galvanic bridge, and an induction current is used; then, if the resistances compared are a large liquid resistance on the one hand, and a Siemens's resistance-box on the other, so that the electro-dynamic constants of the branches are very small; if, further, a German-silver or platinum wire be used as measuring wire, it is found that in the position where the galvanometer shows no deflection, the tone in the telephone has a well-marked minimum of intensity. Supposing the liquid resistance has 2,000 units, a variation of it, even four units, reveals itself in a displacement of the minimum position.

For study of liquid waves Signor Bazzi lately used (N. Cim. (3) 6, p. 98) a trough 6 m. long, 10 ctm. deep, and 5 ctm. wide. In one end of it dipped a wooden parallelepiped, which could be moved up or down in guides, and served to produce waves. A movable apparatus indicated on a cylinder the movements of the surface at any point; the moment of immersion was also indicated. The following results were arrived at:—1. If the body be drawn out and a wave of depression produced, a whole series of other waves follows this, which are of gradually decreasing height. 2. Both the primary and the secondary waves are, from a certain distance from the origin onwards, propagated with uniform velocity, which, for the same depth, is independent of the mode of the immersion. The first primary wave has the greatest velocity; it coincides with that resulting from Lagrange's calculations. The velocity of the others decreases from wave to wave, so that their length increases proportionally to the distance from the origin. 3. The depth of the first wave is proportional to the volume brought out of the position of equilibrium; and it decreases inversely as the square root of the distance from the origin (this corresponds to Boussinesq's development). 4. The profile of each secondary wave is a sinusoid, but that of the primary is much more complicated. These results are in contradiction to nearly all analytical results on wave motion. The author is prosecuting his inquiry further.

In an interesting memoir presented to the Belgian Academy, on the influence of the form of masses on their attraction, M. Lagrange arrives at the following theorem, which he considers as fundamental for the mechanical theory of crystallisation: A mass of any form, at a distance from its centre of inertia, acts with maximum, mean, and minimum energies in three rectangular directions, and these directions coincide respectively with the three axes of maximum, mean, and minimum inertia of the mass; the attraction diminishing the more rapidly the less the mass in question. M. Lagrange offers some preliminary considerations on the structure of bodies, and one curious consequence of his formulæ is that the molecules of a body are not always distributed symmetrically with regard to the three rectangular directions, owing to the influence of certain secondary axes of attraction, which is combined with that of the principal axes of inertia. The principal modes of crystallisation of bodies seem to M. van der Mensbrugghe (who reports on the memoir), in perfect harmony with the classification of molecular groups, (1) according to their principal axes of inertia, (2) according to their secondary axes of attraction. M. Lagrange promises, in an early work, a complete solution of the problems of crystallisation of bodies.

M. Thollon has recently observed, by the aid of his spectroscope of high dispersive power, a solar protuberance whose height equalled one-sixteenth of the diameter of the sun, or about 55,000 miles.

Herr Edelmann describes, in Carl's *Repertorium*, a novel quadrant electrometer in which the needle, instead of being a flat plate, consists of two quadrants cut vertically from a cylinder. This swings concentrically within another cylinder slit into four quadrants, which replace the usual pairs of flat quadrantal plates. The needle and its attached mirror are supported by a bifilar suspension, and the charge is given to the needle by connecting the cup of concentrated sulphuric acid, into which it dips, with the pole of a Zamboni pile. This latter arrangement is simpler than the usual replenisher and gauge of the well-known Thomson electrometers, but cannot be anything like as reliable.

Herr Böttger describes a process for steeling copper plates by electrolysis. 100 parts of ferrous-ammonia sulphate, together with 50 parts of sal-ammoniac, are dissolved in 500 parts of pure water, a few drops of sulphuric acid being added to acidulate the solution. The copper plate connected to the negative pole of a battery of two or three Bunsen elements, an iron plate of equal size being employed as an anode. The solution is maintained at from 60° to 80°. The deposit of iron is of a hard steel-like quality, and is very rapidly formed.

An acoustico-electrical kaleidoscope, the invention of M. Michelangiolo Monti, is mentioned in *Les Mondes*. It consists of a microphone used in conjunction with an induc ion-coil and a Geissler tube, and is like Edmunds's phonoscope, which it resembles, intended for the optical study of sounds. A complete description of the instrument is not, however, given.

Prof. Graham Bell communicated a notice of "Some Experiments relating to Binaural Audition" to the recent meeting of the American Association for the Adva cement of Science. The paper, which contains some extremely valuable observations, will be published *in extenso* in the *American Journal of Otology*.

GEOGRAPHICAL NOTES

In opening the proceedings of the Geographical Society on Monday evening, Lord Houghton read a letter from Sir Bartle Frere, in which he spoke in the highest terms of Dr. Emil Holub as the most competent traveller he had met for a long time, and in which he also expressed the opinion that, with the exception of a very small portion, the Valley of the Zambesi was well suited for Europeans in regard to climatic conditions. After an amusing sketch of his early experiences in South Africa, and a brief account of his two preparatory journeys, Dr. Holub delivered an address, describing vividly and in considerable detail his main journey, which occupied twenty-one months, from the Diamond Fields to the upper waters of the Zambesi. Among other matters, he thus explained how the River Zooga flows at one time to the east and at another to the west. When the Shallow Lake Ngami is filled up by the streams falling into it from the west, its waters pass through the Zooga to the salt lakes on the east, but when these streams do not pour in such an amount of water, the level of the lake becomes very low, and the Zooga, often largely increased in volume from the overflowing salt lakes, sends its waters into Lake Ngami. This solution of a curious phenomenon agrees, we believe, with the conclusion arrived at by Major Serpa Pinto. Dr. Holub dwelt for some time on the Marutse Empire, which he considered to be some 400 miles long and 450 broad, and the languages and customs of which he had ample opportunities for studying from his prolonged stay at Shesheke. When examining the country to the north of this place, Dr. Holub was unfortunately prostrated by severe illness, which compelled him to give up all further explorations in this interesting region. He made his return journey through the western Makalaka region of the Matabele country, about which he gave many particulars. Dr. Holub exhibited a very carefully drawn chart which he had made of part of the course of the Zambesi, and gave some information respecting his various collections. These include ethnographical objects, a large number of skins of birds and animals, fishes, insects, reptiles, &c., besides numerous botanical specimens. Dr. Holub hopes that before long he may have an opportunity of exhibiting his collections in London.

We have received the first number of the new *Zeitschrift für wissenschaftliche Geographie*, edited by Herr J. I. Kettler, of Lahr, in Baden, assisted by an imposing staff of German geographers. We expected great things from this new journal, judging from the prospectus to which we referred some weeks ago; but we confess this first number disappoints us. Fifteen pages are devoted to a discussion of the first landing-point of Columbus, by Dr. R. Pietschmann, surely a great waste of space in a journal that professes to devote itself to scientific geography. The editor takes up seven pages with an article on the position of Brunswick; the old story of Severstoff's Ferghona expedition is related, and Dr. O. Krummel reproduces his discussion of the mean depths of the ocean, which has gone the round of the journals long ago. Behm's *Jahrbuch* for 1879, now out of date almost, is reviewed, and some old letters of Humboldt's are given, interesting only on the writer's account. An elaborate series of small charts are the only maps given, illustrating the paper on Columbus's landing-point. We trust the succeeding numbers will be both more scientific and more novel, else the new journal can scarcely justify its existence.

Last week the French expedition commissioned to explore the Sahara in connection with the proposed railway left Paris for Marseilles, whence it will sail for Algeria. The expedition will devote its attention mainly to the country south of Wargla, which is too imperfectly known at present to enable a decision to be come to as to the precise route which the railway ought to take. The expedition is under the command of Lieut.-Col. Flatters, who is accompanied by an efficient scientific staff of engineers and others. They will be accompanied by an escort of trustworthy frontier Arabs. At the last meeting of the Paris Society of Commercial Geography, M. Masqueray, the Saharan explorer, gave some interesting information concerning the land of Adrar, in the Western Sahara. This he derived from three pilgrims on their way to Mecca, who had been plundered in the desert, and supplied with funds by the French Government in Algiers to continue their pilgrimage. On their return they have promised to conduct the French explorer to their country. Adrar, or Aderer, presents two or three of the chief aspects of the Sahara, which is by no means the universal desert at one time supposed. In the south-west are long bands of sand, not exceeding eight days' march in width. Adrar-Temar, the country of the travellers, is placed like a long and narrow island between two of these bands of sand. It is an almost level region, slightly elevated above the sands, which tend to encroach upon its borders. Intermittent streams are found in the country, and there are numerous towns or large villages, containing a considerable population. The three pilgrims represent their country as covered with gum-acacias, and ostriches greatly abound. The most important commercial fact in connection with Adrar is the existence at Ijil of an immense deposit of rock salt, which, as we advance towards the country of the negroes, becomes the most valuable article of trade. Tichu (? Tishit), some days' journey to the south-east of Ijil, is the principal market for the trade in salt, for which slaves are the principal exchange.

Herr Clemens Denhardt, who has just returned to Germany from an exploring tour in Eastern Central Africa, has received a grant of 500 marks (20*l.*) from the Gesellschaft für Erdkunde, at Berlin, to defray the cost of publishing his notes of travel.

M. Grandidier, the explorer of Madagascar, has been appointed president of the governing body (Section Centrale) of the Paris Geographical Society for 1879. Admiral La Roncière Le Nourry has been continued president of the Society. The Geographical Society of Paris is preparing to hold a reception when Prof. Nordenskjöld arrives in France; but the first step will be taken by the Society of Marseilles, the city at which Nordenskjöld will land from Naples, according to all probability.

We learn from the last number of the *Isvestia* of the Russian Geographical Society that the expedition of M. Pyevtsoff to Mongolia was very successful. M. Pyevtsoff, after having stayed seven days at Koukou-khoto, started for Kalgan (in the south-east part of the Gobi steppe) where he remained for two months, studying the trade of China with Mongolia. Thence the expedition went to Urga, and from Urga to Ulassoutai, following thus a route which never was before explored. From Ulassoutai M. Pyevtsoff turned west to the Chuyra river, which was reached at Kosh-agach; this route was quite unknown until now. On the whole thousand miles' distance between Urga and Kosh-agach the expedition made a survey, and M. Pyevtsoff determined the latitudes and longitudes of twelve points. On the whole the expedition has made, on its way from Khobdo to Kalgan and thence to Kosh-agach, no less than 2,700 miles of surveys, and determined astronomically the position of twenty-six points, all longitudes being determined as well by chronometers as by the occultations of stars. Barometrical measurements were made during the whole journey, and very rich zoological, botanical, and mineralogical collections were obtained.

The St. Petersburg Geographical Society has received news from Col. Prjvalsky, *viâ* Pekin. The intrepid traveller has safely arrived at Zaidam, on the Tibetian frontier, after having crossed the hitherto unknown country from Hami *viâ* Shatsheu to Zaidam. From the latter place he will proceed to the interior of Tibet. News has also been received from the chief of the so-called Samara Expedition, referring to the readiness of the Chiwinz tribe to restore the old course of the Amu Darya by destroying the dykes on the lower part of the river. The expedition sent out by the Russian Government Office for Communications, under Col. Gluchowski, and charged with the investigation of the lower course of the Amu Darya, with a view to rendering it navigable in future, also begins to show signs of activity.

The "Karl Stangen'sche Reisebureau," at Berlin, will publish a description of its first journey round the world (1878-79) early in March, this description to serve as a guide for future journeys and intending tourists.

THE EFFECTS OF UNINTERRUPTED SUNLIGHT ON PLANTS

Prof. Schübeler of Christiania, who for nearly thirty years has been engaged in observing the influence exerted by differences of climate on vegetation, has published the result of his observations in recent numbers of our Norwegian namesake, *Naturen*. The first of the series of his observations, which he has given in detail, refer to winter-wheat, and were undertaken with the special view of noting what effect the almost unbroken sunlight of the short Scandinavian summers had on plants raised from foreign seed. The experiments were made with samples of grain from Bessarabia and Ohio, and in both cases it was found that the original colour of the grain gradually acquired each year a richer and darker colour—the difference being perceptible even in the first year's crop—until it finally assumed the yellow-brown tint of other home-grown Norwegian winter-wheats. Similar results were obtained with maize, different kinds of garden and field peas and beans, and certain other garden plants, as celery, parsley, &c. In no case has Dr. Schübeler found that an imported plant, capable of being cultivated in Norway, loses in intensity of colour after continued cultivation; while in regard to many of the common garden flowers of Central Europe, he believes it may be asserted with certainty, that after their acclimatisation in Norway, they acquire an increase of size, as well as an augmentation of colour. These altered conditions are more forcibly manifested the further north we go, within the limits of capacity of vegetation for different plants. Thus it has been observed by Prof. Wahlberg of Stockholm, that *Epilobium angustifolium*, *Lychnis sylvestris*, *Geranium sylvaticum*, and many other plants common to Lapmark and the more southern districts of Sweden, attain in the former a size and brilliancy of tint unknown in the latter. The change in the case of *Veronica serpyllifolia* and *Trientalis europæa* is remarkable; the former changing as it goes further north from a pale to a dark blue, and the latter from white to rose-pink. It is noteworthy that a tinge of red is a common characteristic of the vegetation of the Scandinavian Fjælds; this being observable alike in blue, yellow, green, and white colours.

Colour is not, however, the only property affected by the unbroken continuance of daylight in the summers of Scandinavia, for according to Dr. Schübeler, the aroma of all wild and cultivated fruits, capable of cultivation in the northern lands, is much greater than that of the same fruits when grown in more southern countries. This is especially observable in regard to strawberries, cherries, and the various kinds of wild marsh and wood berries. In corroboration of this, Prof. Flückiger of Strassburg has found that the Norwegian juniper yields a much larger amount of essential oil than can be obtained from the shrub when grown in Central Europe. This excess of aroma in northern plants and fruits co-exists with an inferior degree of sweetness; thus the common golden-drop plum, and the greengage of Christiania, or Throndhjem, although large, well-coloured, and rich in aroma, are so deficient in sweetness as to seem unripe to those who have eaten these fruits in France, or Southern Germany.

Dr. Edmond Göze, who has long been resident at Coimbra, informs Dr. Schübeler, that his observations on the fruits of Portugal enable him to corroborate that observer's opinion in regard to the different conditions on which aroma and sweetness respectively depend. The strawberries grown in large numbers near Coimbra are, he says, of great size, extremely sweet, but almost wholly deficient in aroma and flavour. The same remark refers to the Portuguese wines, when compared with the highly flavoured yields of the Rhenish and other northern vineyards; and a consideration of these varying conditions leads him to accept as an established fact, that light bears the same relation to aroma, as heat does to sweetness.

This increase of aroma, or intensification of flavour, due to the uninterrupted action of the sun's light, has the effect of making some of our most savoury garden plants almost uneatable in Scandinavia. Thus Dr. Schübeler has found that common white stick-celery, which had been grown near Christiania with careful attention to the methods followed in England, and which in outward appearance could not be distinguished from plants brought direct from Covent Garden Market, had a sharp unpleasant taste, when compared with the milder and more agreeably flavoured English plants. The same result was observed in garlick, shalots, and onions, and although it must be admitted that as the expressions of mere individual taste, the writer's conclusions in regard to this point are open to doubt, it should at the same time be borne in mind that they are based on practical observations and experiments, continued for nearly thirty years, and confirmed by the concurrent testimony of several of his colleagues, who, like himself, were desirous of deducing practical results from the acclimatisation of plants in Norway. From this point of view, some of Dr. Schübeler's observations are especially interesting, and in the present low condition of Norwegian industrial development, their practical application would be highly important. Thus, he shows that while linseed oil is obtained in Holland, Germany and Middle Russia in the proportion of about 3 or 4 p. c. of the weight of the plants from which it is extracted, the yield from uncultivated plants in Norway varies from 4 to 5, or 5 to 8 per cent. Again his experiments of the yield of the essential oil of lavender, have convinced him, that plants grown in Christiania or Throndhjem, when compared to those grown near Merton, which have hitherto been regarded as the first in the world, greatly excel the latter in aroma, and he considers that the cultivation of this plant could be carried on with undoubted success on the coast-lands of Norway.

While Dr. Schübeler has no hesitation in maintaining that light engenders aroma, as heat engenders sweetness, he has not been able to determine to what extent the vegetable alkaloids are affected by either. In connection with his own observations, he reports some curious particulars in regard to the action of continuous light in the polar regions, which he has obtained from intelligent residents, who had undertaken to conduct certain experiments under his direction. Thus it was found both at Alten in West Finmark, and at Stamsund in the Lafodens, that plants of *Acacia lophantha* never contracted their leaves during the two months, or longer, that the sun remained above the horizon. An experiment was made at Alten to shade one half of the crown of an acacia during the night, and the result was that in about twenty minutes' time, the protected leaves began to contract, and remained closed until the plant was again wholly exposed to the midnight-sun, when after a time the leaves began slowly to unfold. At Stamsund it was observed that whenever the acacias were placed on the north side of a house, which was partially screened by a neighbouring Fjæld, the leaflets turned upwards, without however wholly closing, and the same thing was noticed in rainy weather. The leaves of *Mimosa pudica* contracted in the lightest and clearest nights, and remained folded back for some hours.

Withou entering further into the details of Dr. Schübeler's numerous experiments, we may summarise their results as follows:—

1. The grain of wheat, that has been grown in low lying lands, may be propagated with success on the high Fjælds, and will reach maturity earlier at such elevations, even although at a lower mean temperature. Such grain, after having been raised for several years at the highest elevation which admits of its cultivation, is found when transferred to its original locality to ripen earlier than the other crops which had not been moved. The same result is noticeable in grain that has been transported from a southern to a more northern locality, and *vice versâ*.

2. Seeds imported from a southern locality, when sown within the limits compatible with their cultivation, increase in size and weight, and these same seeds, when removed from a more northern locality to their original southern home, gradually diminish to their former dimensions. A similar change is observable in the leaves and blossoms of various kinds of trees and other plants. Further, it is found that plants raised from seed, ripened in a northern locality, are hardier, as well as larger than those grown in the south, and are better able to resist excessive cold.

3. The further north we go—within certain fixed limits—the more energetic is the development of the pigment in flowers, leaves and seeds. Similarly, the aroma, or flavour of various plants or fruits, is augmented in intensity the further north they are carried within the limits of their capacity for cultivation, conversely, the quantity of saccharine matter diminishes in proportion as the plant is carried further northward.

MYTHOLOGIC PHILOSOPHY[1]

I. *THE GENESIS OF PHILOSOPHY.*—The wonders of the course of nature have ever challenged attention. In savagery, in barbarism, and in civilisation alike, the mind of man has sought the explanation of things. The movements of the heavenly bodies, the change of seasons, the succession of night and day, the powers of the air, majestic mountains, ever-flowing rivers, perennial springs, the flight of birds, the gliding of serpents, the growth of trees, the blooming of flowers, the forms of storm-carved rocks, the mysteries of life and death, the institutions of society—many are the things to be explained.

The yearning to know is universal. *How* and *why* are everlasting interrogatories profoundly instinct in humanity. In the evolution of the human mind the instinct of cosmic interrogation follows hard upon the instinct of self-preservation.

In all the operations of nature man's weal and woe is involved. A cold wave sweeps from the north, rivers and lakes are frozen, forests are buried under snows, and the fierce winds almost congeal the life fluids of man himself, and man's sources of supply under the rocks of water. At another time the heavens are as brass, and the clouds come and go with mockery of unfulfilled promises of rain, the fierce midsummer sun pours its beams upon the sands, and scorching blasts heated in the furnace of the desert sear the vegetation, and the fruits, which in more congenial seasons are subsistence and luxury, shrivel before the eyes of famishing men. A river rages and destroys the adjacent valley with its flood. A mountain bursts forth with its rivers of hell, the land is buried, and the people are swept away. Lightning shivers a tree and rends a skull.

The silent, unseen powers of nature, too, are at work bringing pain or joy, health or sickness, life or death to mankind. In like manner, man's welfare is involved in all the institutions of society.

How and *why* are the questions asked about all these things—questions springing from the deepest instinct of self-preservation.

In all stages of savage, barbaric, and civilised inquiry, every question has found an answer, every *how* has had its *thus*, every *why* its *because*. The sum of the answers to the questions raised by any people constitute its philosophy; hence all people have had philosophies consisting of their accepted explanation of things. Such a philosophy must necessarily result from the primary instincts developed in man in the early progress of his differentiation from the beast. This I postulate; if demonstration is necessary, demonstration is at hand.

Not only has every people a philosophy, but every stage of culture is characterised by its stage of philosophy. Philosophy has been unfolded with the evolution of the human understanding. The history of philosophy is the history of human opinions from the earlier to the later days—from the lower to the higher culture. In the production of a philosophy phenomena must be discerned, phenomena must be discriminated, phenomena must be classified. Discernment, discrimination, and classification are the processes by which a philosophy is developed. In studying the philosphy of a people at any stage of culture, to understand what such a people entertain as the sum of their knowledge, it is necessary that we should understand what phenomena they saw, heard, felt—discerned; what discriminations they made, and what resemblances they seized upon as a basis for the classification on which their explanations rested. A philosophy will be higher in the scale, nearer the truth, as the discernment is wider, the discriminations nicer, and the classification better.

The sense of the savage is dull compared with the sense of the civilised man. There is a myth current in civilisation to the effect that the barbarian has highly-developed perceptive faculties. It has no more foundation than the myth of the wisdom of the owl. A savage sees but few sights, hears but few sounds, tastes but few flavours, smells but few odours, his whole sensuous life is narrow and blunt, and his facts, that are made up of the combination of sensuous impressions, are few.

In comparison the civilised man has his vision extended away toward the infinitesimal and away toward the infinite; his perception of sound is multiplied to the comprehension of rapturous symphonies; his perception of taste is increased to the enjoyment of delicious viands; his perception of smell is developed to the appreciation of most exquisite perfumes; and the facts that are made up of his combination of sensuous impressions are multiplied beyond enumeration. The stages of discernment, from the lowest savage to the highest civilised man, constitute a series, the end of which is far from the beginning.

If the discernment of the savage is little, his discrimination is less. All his sensuous perceptions are confused, but the confusion of confusion is that universal habit of savagery—the confusion of the objective with the subjective, so that the savage sees, hears, tastes, smells, feels the imaginings of his own mind. Subjectively determined sensuous processes are diseases in civilisation, but normal functional methods in savagery.

The savage philosopher classifies by obvious resemblances—analogic characters. The civilised philosopher classifies by essential affinities—homologic characteristics; and the progress of philosophy is marked by changes from analogic categories to homologic categories.

[1] From Vice-Presidential Address of Prof. J. W. Powell, of Washington, Vice-President Section B, American Association for the Advancement of Science, Saratoga Meeting, August, 1879.

2. *Two Grand Stages of Philosophy.*—There are two grand stages of philosophy—the mythologic and the scientific. In the first, all phenomena are explained by analogies derived from subjective human experiences; in the latter, phenomena are explained as orderly successions of events.

In sublime egotism man first interprets the cosmos as an extension of himself; he classifies the phenomena of the outer world by their analogies with subjective phenomena; his measure of distance is his own pace, his measure of time his own sleep, for he says, "It is a thousand paces to the great rock," or, "It is a thousand sleeps to the great feast." Noises are voices, powers are hands, movements are made afoot. By subjective examination discovering in himself will and design, and by inductive reason discovering will and design in his fellow-men and in animals, he extends the induction to all the cosmos, and there discovers in all things will and design. All phenomena are supposed to be the acts of some one, and that some one having will and purpose.

In mythologic philosophy, the phenomena of the outer physical world are supposed to be the acts of living, willing, designing personages. The simple are compared with and explained by the complex. In scientific philosophy, phenomena are supposed to be children of antecedent phenomena, and so far as science goes with its explanation, they are thus interpreted. Man with the subjective phenomena gathered about him is studied from an objective point of view, and the phenomena of subjective life are relegated to the categories established in the classification of the phenomena of the outer world; thus the complex is studied by resolving it into its simple constituents. Some examples of the philosophic methods belonging to widely separated grades of culture may serve to make my statements clearer.

Wind.—The Ute philosopher discerns that men and animals breathe. He recognises vaguely the phenomena of the wind and discovers its resemblance to breath, and explains the winds by relegating them to the class of breathings.

He declares that there is a monster beast in the north that breathes the winter winds, and another in the south, and another in the east, and another in the west. The facts relating to winds are but partially discerned; the philosopher has not yet discovered that there is an earth surrounding atmosphere. He fails also in making the proper discriminations.

His relegation of the winds to the class of breathings is analogic, but not homologic. The basis of his philosophy is personality, and hence he has four wind gods.

The philosopher of the ancient Northland discovered that he could cool his brow with a fan, or kindle a flame, or sweep away the dust with the wafted air. The winds also cooled his brow, the winds also swept away the dust, and kindled the fire into a great conflagration, and when the wind blew he said, "Somebody is fanning the waters of the fiord," or "Somebody is fanning the evergreen forests," and he relegated the winds to the class of fannings, and he said, "The god Hraesvelger, clothed with eagle plumes, is spreading his wings for flight, and the wind rise from under them."

The early Greek philosopher discovered that air may be imprisoned in vessels or move in the ventilation of caves, and he recognised wind as something more than breath, something more than fanning, something that can be gathered up and scattered abroad, and so when the winds blew he said, "The sacks have been untied," or, "The caves have been opened."

The philosopher of civilisation has discovered that breath, the fan wafted breeze, the air confined in vessels, the air moving in ventilation, that these are all parts of the great body of air which surrounds the earth, all in motion, swung by the revolving earth, heated at the tropic, cooled at the poles, and thus turned into counter currents and again deflected by a thousand geographic features, so that the winds sweep across valleys, eddy among mountain crags, or waft the spray from the crested billows of the sea, all in obedience to cosmic laws.

The facts discerned are many, the discriminations made are nice, and the classifications based on true homologies, and we have the science of meteorology, which exhibits an orderly succession of events even in the fickle winds.

Sun and Moon.—The Ute philosopher declares the sun to be a living personage, and explains his passage across the heavens along an appointed way by giving an account of a fierce personal conflict between Ta-vi, the sun-god, and Ta-wats, one of the supreme gods of his mythology.

In that long ago, the time to which all mythology refers, the sun roamed the earth at will. When he came too near with his fierce heat the people were scorched, and when he hid away in his cave for a long time, too idle to come forth, the night was long and the earth cold. Once upon a time Ta-wats, the hare-god, was sitting with his family by the camp fire in the solemn woods anxiously waiting for the return of Ta vi, the wayward sun-god. Wearied with long watching the hare-god fell asleep, and the sun-god came so near that he scorched the naked shoulder of Ta-wats. Foreseeing the vengeance which would be thus provoked, he fled back to his cave beneath the earth. Ta-wats awoke in great anger, and speedily determined to go and fight the sun-god.

After a long journey of many adventures the hare-god came to the brink of the earth, and there watched long and patiently, till at last the sun-god coming out, he shot an arrow at his face, but the fierce heat consumed the arrow ere it had finished its intended course; then another arrow was sped, but that also was consumed, and another, and still another, till only one remained in his quiver, but this was the magical arrow that had never failed its mark. Ta-wats, holding it in his hand, lifted the barb to his eye, and baptised it in a divine tear; then the arrow was sped and struck the sun-god full in the face, and the sun was shivered into a thousand fragments, which fell to the earth, causing a general conflagration.

Then Ta-wats, the hare god, fled before the destruction he had wrought, and as he fled, the burning earth consumed his feet, consumed his legs, consumed his body, consumed his hands and his arms; all were consumed but the head alone, which bowled across valleys and over mountains, fleeing destruction from the burning earth, until at last, swollen with heat, the eyes of the god burst and the tears gushed forth in a flood, which spread over the earth and extinguished the fire.

The sun-god was now conquered, and he appeared before a council of the gods to await sentence. In that long council was established the days and the nights, the seasons and the years, with the length thereof, and the sun was condemned to travel across the firmament by the same trail day after day till the end of time.

In the same philosophy we learn that in that ancient time a council of the gods was held to consider the propriety of making a moon, and at last the task was given to Whip-poor-will, a god of the night, and a frog yielded himself a willing sacrifice for this purpose, and the Whip-poor-will, by incantations and other magical means, transformed the frog into the new moon.

The truth of this origin of the moon is made evident to our very senses, for do we not see the frog riding the moon at night? And the moon is cold, because the frog from which it was made was cold.

The philosopher of Oraibi tells us that, when the people ascended by means of the magical tree which constituted the ladder from the lower world to this, they found the firmament—the ceiling of this world low down upon the earth—the floor of this world. Machito, one of their gods, raised the firmament on his shoulders to where it is now seen. Still the world was dark, as there was no sun, no moon, and no stars. So the people murmured because of the darkness and the cold. Machito said, "Bring me seven maidens," and they brought him seven maidens; and he said, "Bring me seven baskets of cotton bolls," and they brought him seven baskets of cotton bolls; and he taught the seven maidens to weave a magical fabric from the cotton, and when they had finished it he held it aloft, and the breeze carried it away toward the firmament, and in the twinkling of an eye it was transformed into a beautiful full-orbed moon, and the same breeze caught the remnants of flocculent cotton which the maidens had scattered during their work, and carried them aloft, and they were transformed into bright stars. But still it was cold, and the people murmured again, and Machito said, "Bring me seven buffalo robes," and they brought him seven buffalo robes, and from the densely matted hair of the robes he wove another wonderful fabric, which the storm carried away into the sky, and it was transformed into the full-orbed sun.

Then Machito appointed times and seasons and ways for the heavenly bodies, and the gods of the firmament have obeyed the injunctions of Machito from the day of their creation to the present.

The Norse philosopher tells us that Night and Day each has a horse and a car, and they drive successively one after the other around the world in twenty-four hours. Night rides first with her steed, named Dew-hair, and every morning as he ends his course he bedews the earth with foam from his bit. Ti[illegible] driven by Day is Shining-hair. All the sky and earth glisten with the light of his name. Jarnved, the great iron-wood forest lying to the east of Midgard, is the abode of a race of witches. One monster witch is the mother of many sons in the form of wolves, two of which are Skol and Hate. Skol is the wolf that would devour the maiden, Sun, and she daily flies from the maw of the terrible beast, and the moon-man flies from the wolf Hate.

The philosopher of Samos tells us that the earth is surrounded by hollow crystalline spheres set one within another, and all revolving at different rates from east to west about the earth, and that the sun is set in one of these spheres, and the moon in another.

The philosopher of civilisation tells us that the sun is an incandescent globe, one of the millions afloat in space. About this globe the planets revolve, and the sun and planets and moons were formed from nebulous matter by the gradual segregation of their particles, controlled by the laws of gravity, motion, and affinity. The sun, travelling by an appointed way across the heavens, with the never-ending succession of day and night, and the ever-recurring train of seasons, is one of the subjects of every philosophy. Among all peoples, in all times, there is an explanation of these phenomena, but in the lowest stage, away down in savagery, how few the facts discerned, how vague the discriminations made, how superficial the resemblances by which the phenomena are classified!

In this stage of culture, all the daily and monthly and yearly phenomena, which come as the direct result of the movements of the heavenly bodies, are interpreted as the doings of some one, some good acts. In civilisation, the philosopher presents us the science of astronomy, with all its accumulated facts of magnitude, and weights, and orbits, and distances, and velocities, with all the nice discriminations of absolute, relative, and apparent motions, and all these facts he is endeavouring to classify in homologic categories, and the evolutions and revolutions of the heavenly bodies are explained as an orderly succession of events.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Exactly 102 names are in the Cambridge Mathematical Tripos list this year (including three Ægrotant honours). The signification of this is not quite apparent, but lower in the list will be found two whose degree is allowed, but who are not to count it as an honour's degree. These men did well enough in the part of the examination they took to deserve a "poll," and not an honour's degree. Trinity has passed more than a score, St. John's 14, several colleges eight; but Jesus, Sidney, and Magdalene, as usual, have few mathematicians. Christ's has picked up well, having no fewer than ten in mathematical honours; Trinity Hall gets in only two, and Downing has one representative.

Prof. Humphry announces that his lectures on Anatomy and Physiology (the Muscular and Circulatory Systems) will be resumed on February 3, while his classes for the second M.B. and for the Natural Sciences Tripos recommence on Friday, February 6. Mr. Wherry (recently elected surgeon to Addenbrooke's Hospital) began a class in osteology on January 21, continuing on Mondays, Wednesdays, and Fridays at 1 P.M. Dr. Paget's lectures on the Principles and Practice of Physic begin on Monday, February 2.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science, January.—H. M. Ward, on the embryo-sac and development of *Gymnadenia conopsea*, pl. 1-3.—Fred. Elfving, studies on the pollen bodies of the angiosperms, pl. 4.—F. O. Bower, on the development of the conceptacle in the Fucaceæ, pl. 5.—Dr. Cunningham, on certain effects of starvation on vegetable and animal tissues.—J. E. Blomfield, on the development of spermatozoa; part 1, Lumbricus, pl. 6, 7.—F. M. Balfour, on the spinal nerves of Amphioxus.—G. A. Hansen, the bacillus of leprosy, pl. 8.—Notes and Memoranda.—*Proceedings* of Dublin Microscopical Club, April, 1879, to October, 1879.

THE *American Naturalist*, vol. xiii. No. 12., December. 1879.—George H. Perkins, archæology of the Champlain Valley.—G. de Mortillet, the origin of the domestic animals.—F. Brendel, historical sketch of the science of botany in North America from 1635 to 1840.—E. D. Cope, on the extinct American rhinoceroses and their allies.—Recent Literature; General Notes; Scientific News.

Vol. 14, No. 1, January.—Henry J. Rice, observations on the habits, structure, and development of *Amphioxus lanceolatus*.—Elliot Coues, sketch of North American ornithology in 1879.—F. Brendel, historical sketch of the science of botany in North America from 1840 to 1858.—The Editor, notes on the present position of affairs in the Philadelphia Academy.—Recent Literature; General Notes; Scientific News.

Proceedings of the Academy of Natural Sciences, Philadelphia, 1879. Part 2, April to October.—Thos. Meehan, on hybrid fuchsias; on special fecundity in plants; do snakes swallow their young? on *Lonas inodora*; on sex in *Castanea americana*; Variations in *Thuja* and *Retinospora*.—Rev. H. C. M'Cook, the adoption of an ant-queen; mode of depositing ant-eggs; on the marriage flights of *Lasius flavus* and *Myrmica lobricornis*; pairing of *Linyphia marginata*; on mound-making ants; notes on *Tetramorium cæspitum*; on *Myrmecocystus mexicanus*.—John A. Ryder: on a new Pauropod and its larva (*Eurypauropus spinosus*); on a new Chirocephalus, *C. holmani*; on honey glands on Catalpa leaves; description of *Streptocephalus sealii*, sp. nov.—Dr. Chapman, on Amphiuma; placenta of *Macacus cynomolgus*.—Dr. Dercum: the lateral sensory apparatus of fishes.—Dr. Leidy: on rhizopods in Sphagnum; fossil foot-tracks of the anthracite coal-measures; explosion of a diamond; on *Orgya*; on some coast animals of New Jersey; on *Cristatella idæ*; on *Amœba blattæ*.—E. Potts: on the supposed sensitive characters of the glands of the Asclepiadaceæ.—E. Goldsmith, on amber containing fossil insects.—Angelo Heilprin, on some new eocene fossils from the Claiborne marine formation of Alabama, plate 13.

Revue des Sciences Naturelles, 2nd ser., tome 1, No. 3, December 15, 1879.—L. Tillier, contributions to a memoir on the geographical distribution of marine fish (conclusion).—A. de Saint-Simon, anatomical notes on some species of Pomatias.—Ph. Thomas, note on some species of horses found fossil in the neighbourhood of Constantine.—M. Leymerie, a sketch of the Pyrenees of the department of Aude.—Scientific Review, containing notices of French works on zoology, botany, and geology, published in 1879.—Bulletin.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 27, 1879.—"On certain Definite Integrals," No. 6. By W. H. L. Russell, F.R.S.

January 6.—"On certain Definite Integrals," No. 7. By W. H. L. Russell, F.R.S.

"On a Possible Mode of Detecting a Motion of the Solar System through the Luminiferous Ether." By the late Prof. J. Clerk Maxwell. In a letter to Mr. D. P. Todd, Director of the *Nautical Almanac* Office, Washington, U.S. Communicated by Prof. Stokes, Sec. R.S.

Mr. Todd has been so good as to communicate to me a copy of the subjoined letter, and has kindly permitted me to make any use of it.

As the notice referred to by Maxwell in the *Encyclopædia Britannica* is very brief, being confined to a single sentence, and as the subject is one of great interest, I have thought it best to communicate the letter to the Royal Society.

From the researches of Mr. Huggins on the radial component of the relative velocity of our sun and certain stars, the coefficient of the inequality which we might expect as not unlikely, would be only something comparable with half a second of time. This, no doubt, would be a very delicate matter to determine. Still, for anything we know *à priori* to the contrary, the motion might be very much greater than what would correspond to this; and the idea has a value of its own, irrespective of the possibility of actually making the determination.

In his letter to me Mr. Todd remarks, "I regard the communication as one of extraordinary importance, although (as you will notice if you have access to the reply which I made) it is likely to be a long time before we shall have tables of the satellites of Jupiter sufficiently accurate to put the matter to a practical test."

I have not thought it expedient to delay the publication of the letter on the chance that something bearing on the subject might be found among Maxwell's papers.

(Copy.)

Cavendish Laboratory,
Cambridge,
19th March, 1879

SIR,

I have received with much pleasure the tables of the satellites of Jupiter which you have been so kind as to send me, and I am encouraged by your interest in the Jovial system to ask you if you have made any special study of the apparent retardation of the eclipses as affected by the geocentric position of Jupiter.

I am told that observations of this kind have been somewhat put out of fashion by other methods of determining quantities related to the velocity of light, but they afford the *only* method, so far as I know, of getting any estimate of the direction and magnitude of the velocity of the sun with respect to the luminiferous medium. Even if we were sure of the theory of aberration, we can only get differences of position of stars, and in the terrestrial methods of determining the velocity of light, the light comes back along the same path again, so that the velocity of the earth with respect to the ether would alter the time of the double passage by a quantity depending on the square of the ratio of the earth's velocity to that of light, and this is quite too small to be observed.

But if J E is the distance of Jupiter from the earth, and l the geocentric longitude, and if l' is the longitude and λ the latitude of the direction in which the sun is moving through ether with velocity v, and if V is the velocity of light and t the time of transit from J to E,

$$J\,E = [V - v \cos \lambda \cos (l - l')]\, t.$$

By a comparison of the values of t when Jupiter is in different signs of the zodiac, it would be possible to determine l' and $v \cos \lambda$.

I do not see how to determine λ, unless we had a planet with an orbit very much inclined to the ecliptic. It may be noticed that whereas the determination of V, the velocity of light, by this method depends on the differences of J E, that is, on the diameter of the earth's orbit, the determination of $v \cos \lambda$ depends on J E itself, a much larger quantity.

But no method can be made available without good tables of the motion of the satellites, and as I am not an astronomer, I do not know whether, in comparing the observations with the tables of Damoiseau, any attempt has been made to consider the term in $v \cos \lambda$.

I have, therefore, taken the liberty of writing to you, as the matter is beyond the reach of any one who has not made a special study of the satellites.

In the article E [ether] in the ninth edition of the "Encyclopædia Britannica," I have collected all the facts I know about the relative motion of the ether and the bodies which move in it, and have shown that nothing can be inferred about this relative motion from any phenomena hitherto observed, except the eclipses, &c., of the satellites of a planet, the more distant the better.

If you know of any work done in this direction, either by yourself or others, I should esteem it a favour to be told of it.

Believe me,
Yours faithfully,
(Signed) J. CLERK MAXWELL

D. P. Todd, Esq.

Linnean Society, January 15.—Prof. Allman, president, in the chair.—Mr. A. J. Hewett exhibited and made remarks on a common web on community of cocoons, and of the moths (genus *Anaphe?*) escaped therefrom, said to have been got at Old Calabar.—Mr. Baker brought under notice a monstrous form of Thistle (*Carduus crispus*) obtained by the Rev. J. A. Preston in Wiltshire. In this specimen the capitula were abnormally numerous, and aggregated in secondary heads as in *Echinops*.—A Moa's tibia and tarsus (*Dinornis maximus*) dug up four feet from the surface at Omaru, N.Z., were shown on behalf of Mr. Jas. Forsyth.—A paper was read on the birds and mammals introduced into New Zealand, by Mr. H. M. Brewer. The author refers to Dr. Buller's Avifauna of New Zealand as not written too soon, for the rapid disappearance of many highly interesting forms is to be deplored. Finches and other small birds introduced are preyed on by the New Zealand Owl, but nevertheless quite a long list of British songsters, game birds, and others have been successfully established. Pheasants in some districts abound; and it is observed that when the tremor of an earthquake occurs the cock pheasants set up a continuous crow, either of defiance or fear (?). Partridges thrive best on the south island. Red deer are now seen in herds on the hills near Nelson. Hares have increased too rapidly, and the female in New Zealand has become more prolific, giving birth to six or seven yonng at a time. Kangaroos and varions other mammals have likewise been imported, but unfortunately facts mentioned point out that the acclimatisation of some of them is not altogether an unmitigated blessing to the farmer colonist.—Then followed a memoir by Mr. J. G. Baker "Synopsis of the Aloineæ and Yuccoideæ." To these two tribes belong all the shrubby arborescent tribes of the capsular Liliaceæ. Aloes belong entirely to the Old World; out of a total of 200 species 170 being concentrated at the Cape of Good Hope, the remainder in the highlands of Tropical Africa. Of the Yuccoideæ there are about fifty species altogether, and nearly all are natives of Mexico and the Southern United States. The yuccas fruit rarely under cultivation, the large white pendulous flowers being in the wild plant fertilised by a moth of the genus *Pronuba*. *Herreria*, belonging to temperate South America, is a shrubby climber with the habit of *Smilax* and *Dioscorea*.—Messrs. J. Poland, J. Darell Stephens, and Prof. Allen Thomson were elected Fellows, and T. Jeffery Parker, an Associate of the Society.

Zoological Society, January 6.—Prof. Flower, F.R.S., president, in the chair.—Prof. Newton, F.R.S., V.P., exhibited, on behalf of Mr. G. B. Corbin, a specimen of *Acanthyllis* sive *Chætura caudacuta*—the Needle-tailed Swift—shot near Ringwood, in Hampshire, in July, 1879, remarking that it was the second example of this Siberian species which had been obtained in England.—Mr. John Henry Steel, F.Z.S., read a series of preliminary notes on the individual variations observed in the osteological and myological structure of the Domestic Ass (*Equus asinus*).—A communication was read from Mr. E. W. White, C.M.Z.S., containing notes on the distribution and habits of *Chlamyphorus truncatus*, from observations made by the author during a recent excursion into the western provinces of the Argentine Republic, undertaken for the purpose of obtaining a better knowledge of this animal.—Dr. John Mulvany, R.N., read a paper on a case which seemed to him to indicate the moulting of the horny beak in a Penguin of the genus *Eudyptes*.—Mr. O. Thomas, F.Z.S., read the description of a new species of *Mus*, obtained from the Island of Ovalau, Fiji, by Baron A. von Hügel, and proposed to be called *Mus huegeli*, after its discoverer.—A communication was read from Mr. R. G. Wardlaw Ramsay, F.Z.S., containing a report on a collection of birds made by Mr. Bock, a naturalist employed by the late Lord Tweeddale, in the neighbourhood of Padang. Three species were described as new, and proposed to be called *Dicrurus sumatranus*, *Turdinus marmoratus*, and *Myiophoneus castaneus*.—Dr. Günther, F.R.S., read a description of two new species of Antelopes, of the genus *Neotragus*, *N. kirki*, from Eastern Africa, and *N. molaris*, from Damara-land.

GENEVA

Society of Physics and Natural History, May 1, 1879.—M. Charles Soret details his experiments for investigating the mode of distribution of salts in solutions, the constituents of which are subjected to different temperatures. The attempts made upon azotate of potash and chloride of sodium led him to the discovery that there is a greater concentration in the cold part than in the warm.

June 5.—Prof. Schiff discusses the comparative properties of the nerves of sense and those of motion. He demonstrates on a curarised frog, the persistence of sensibility after the animal has lost all capacity for movement under the action of the poison. He observes, at the same time, that the persistence is only relative, and that the sensibility presently disappears, after an interval varying in duration according to the temperature. If that temperature is low (3° or 4° C., for example) the frog may live for eighteen days.—MM. L. Soret and E. Sarasin have determined the principal elements of the magnesium spectrum, by measuring the refraction indices of qnartz for its principal lines, and by the existence of numerous photographs.—M. G. Lunel describes a new species of Trygonide belonging to the genus Pteroplatea, brought from Rio Janeiro.—M. R. Pictet reports his investigations to solve the problem—What form must be given to a definite surface that it may maintain its equilibrium in the air with the minimum of mechanical work? His experiments were made with kites having a dynamometer of great sensibility attached to their strings. His conclusion was that, with reference to the work done, a given surface would the more easily support a fixed weight in proportion as the surface presented its shorter dimension in the direction of the wind, and its longer dimension perpendicularly to that direction.—M. A. De Candolle announces the publication of the last part of the fourth volume of M. Boissier's "Flora Orientalis," completing the description of Dicotyledons.

July 8.—MM. Micheli gives an abstract of his monographic investigations of the families Alismaceæ, Buromaceæ, and Juncagineæ.—M. E. Ador has studied with MM. Friedel and Crafts the action of chloride of methyl on benzine, in presence of chloride of aluminium.—M. Forel has detected in the oscillations of the surface of Lake Geneva a movement which he terms "seiches dicrotes," consisting in a redoubling of the oscillation in two series of oscillations which mutually interfere, being of unequal duration.—Prof. Colladon observed an upward current of air round the Pissevache Waterfall, which is surrounded by a layer from 30 to 40 cm. in thickness, filled with very small drops of water. This phenomenon, due to the air-suction of the fall, might serve to explain the atmospheric currents accompanying the formation of hail.

August 7.—Prof. Schiff relates his researches on the action exercised upon hysterical subjects by the contact of metals and electric currents.—M. R. Pictet saw on Mount Jura, during a storm that broke forth on the 5th, a bluish light produced over a forest, resembling St. Elmo's fire. It disappeared and reappeared three times, under the influence of successive violent thunder-claps.

September 4.—M. Soret believes the "seiches dicrotes" observed by M. Forel can be explained by the superposition of two oscillations, one "uninodal," lasting seventy-two minutes, the other "binodal," lasting a little less than half that time.

October 2.—Dr. Marcet shows his instruments for collecting and analysing the air emitted from the lungs.—M. C. de Candolle has ascertained the prolonged action of low temperatures on the germinative power of various kinds of grain.

November 6.—MM. L. Soret and Rilliet have investigated the absorption of the ultra-violet rays of the spectrum by certain organic substances—the azotates of ethyl, isobutyle, and amyl, ammonia, &c.—M. R. Pictet presents a barometer intended to measure vapour tensions. It is composed of a vertical glass tube, wide at the top and very narrow towards the bottom, which bends at a right angle to be prolonged into a long horizontal tube. The lower level of the mercury is therefore constant, and as its volume does not vary, the variations of the higher level in the large tube are reproduced on a much enlarged scale in the narrow horizontal tube from which the readings are taken.—From a comparison of a series of eighty years' meteorological observations made at Geneva, Prof. Wartman has observed that the odds are remarkable in favour of August 15 being a stormy day.—Prof. Brun shows a fragment of fulgurite found on Mount Jura in chalky soil, a circumstance of very rare occurrence. Its surface is covered with small vitrefied globules which can only be explained by the fusion of the chalky matter under the influence of the lightning.

Paris

Academy of Sciences, January 19.—M. Edm. Becquerel in the chair.—M. Daubrée presented the fifth volume of his "Traité de Méchanique."—The following papers were read:—On some applications of elliptic functions, by M. Hermite.—On the heat of formation of hydrate of chloral, by M. Berthelot. He offers experimental proof that gaseous chloral and water-vapour combine together with liberation of heat, and without change of state. The two are introduced from the boiling liquids into a small glass globe (with thermometer and drawing-off tube), one through a strait ht, the other (chloral vapour) through a spiral tube, and these parts are inclosed in a stoppered piece of glass tube, through which a steam current from the same source as the other circulates, and which also holds a thermometer. Throughout the experiment, after the vapours met, the thermometer in the globe showed a higher temperature than that of the inclosure, and the temperature was about 1° above that of boiling water, during twenty-five minutes. Negative results may be got, if the relative proportions be not regulated.—Note on hydrate of chloral, by M. Wurtz. With similar conditions of experiment, and the chloral previously boiled to expel hydrochloric acid, he had not found the least rise of temperature.—Note on the utility of concentric curved plates to alternately charge siphons by means of an oscillating liquid column, by M. De Caligny.—Simplification of American audiphone apparatus for the deaf and dumb, by M Colladon. A simple disk of a particular kind of pasteboard, which is compact, homogeneous, elastic, and tenacious, is substituted for the hardened caoutchouc, no cords being required to fix the tension. The part applied to the teeth is coated with a substance to resist moisture. Musical sounds, and words uttered near, were understood by deaf mutes who tried the instrument.—The General Inspector of Navigation communicated figures regarding the daily height of the Seine in 1879, at the Pont Royal and the Pont de la Tournelle. The highest water at the former was 6·21 m. on January 9, the lowest 1·67 m. on October 10, 15, and 17; the mean, 2·72 m.—A letter was read, suggesting to saw into pieces the bank of ice on the Loire, near Saumur. Admiral Paris gave details of an attempt made in Russia in 1855 to liberate ships from ice by means of saws. He thought the method very useful where there is a current to carry off the ice; the ice being sawn in long strips across the current, which break up *en rou e*.—On a class of linear differential equations, by M. Picard.—Experimental and clinical researches on anæsthesia produced by lesions of the cerebral convolutions, by M. Tripier. Sensibility may be more or less diminished by lesions of the fronto-parietal region, which has been thought only a motor zone.—On the plants which serve as base for various curares, by M. Planchon. Four distinct regions are centres of preparation for curare, and for each a principal plant can be indicated. (The regions are English and Upper French Guiana, that of the Upper Amazon, and that of the Rio Negro.)—On the linear and lacunar confluents of the connective tissue of the cornea, by M. Renaut.—On the parturition of the common porpoise (*Phocæna communis*), by M. Jourdain.—Influence of climates on the maturation of corn, by M. Balland. This relates to observations at Orleansville, in Algeria. The mean monthly temperatures in 1877–78–79 are given; they range from 7°·8 to 32°·6. It is calculated that wheat, to reach its full evolution, must have received 2498° of heat in 1877-78, and 2432° in 1878-79, which is near the number (2365°) obtained by M. Hervé Mangon for Normandy; but the time required at Orlean ville was 180 days, as against 266 in the other case.—Remarks on the use of Smithson's pile for detection of mercury, especially in mineral waters, by M. Lefort. Arsenic may, with it, be confounded with mercury. The easy reduction of oxygenated acids of arsenic by metals, under influence of the weakest electric current, is made evident.—Light, cover, and humus, studied in their influence on the vegetation of trees in forests, by M. Gurnaud.

CONTENTS

THURSDAY, FEBRUARY 5, 1880

CLERK-MAXWELL'S SCIENTIFIC WORK

AT the instance of Sir W. Thomson, Mr. Lockyer, and others I proceed to give an account of Clerk-Maxwell's work, necessarily brief, but I hope sufficient to let even the non-mathematical reader see how very great were his contributions to modern science. I have the less hesitation in undertaking this work that I have been intimately acquainted with him since we were schoolboys together.

If the title of mathematician be restricted (as it too commonly is) to those who possess peculiarly ready mastery over symbols, whether they try to understand the significance of each step or no, Clerk-Maxwell was not, and certainly never attempted to be, in the foremost rank of mathematicians. He was slow in "writing out," and avoided as far as he could the intricacies of analysis. He preferred always to have before him a geometrical or physical representation of the problem in which he was engaged, and to take all his steps with the aid of this: afterwards, when necessary, translating them into symbols. In the comparative paucity of symbols in many of his great papers, and in the way in which, when wanted, they seem to grow full-blown from pages of ordinary text, his writings resemble much those of Sir William Thomson, which in early life he had with great wisdom chosen as a model.

There can be no doubt that in this habit, of constructing a mental representation of every problem, lay one of the chief secrets of his wonderful success as an investigator. To this were added an extraordinary power of penetration, and an altogether unusual amount of patient determination. The clearness of his mental vision was quite on a par with that of Faraday; and in this (the true) sense of the word he was a mathematician of the highest order.

But the rapidity of his thinking, which he could not control, was such as to destroy, except for the very highest class of students, the value of his lectures. His books and his written addresses (always gone over twice in MS.) are models of clear and precise exposition; but his *extempore* lectures exhibited in a manner most aggravating to the listener the extraordinary fertility of his imagination.

His original work was commenced at a very early age. His first printed paper, "*On the Description of Oval Curves, and those having a Plurality of Foci*," was communicated for him by Prof. Forbes to the Royal Society of Edinburgh, and inserted in the "*Proceedings*" for 1846, before he reached his fifteenth year. He had then been taught only a book or two of Euclid, and the merest elements of Algebra. Closely connected with this are three unprinted papers, of which I have copies (taken in the same year), on "*Descartes' Ovals*," "*The Meloid and Apioid*," and "*Trifocal Curves*." All of these, which are drawn up in strict geometrical form and divided into consecutive propositions, are devoted to the properties of plane curves whose equations are of the form

$$mr + nr' + pr'' + \ldots = \text{constant},$$

r, r', r'', &c., being the distances of a point on the curve from given fixed points, and m, n, p, &c., mere numbers. Maxwell gives a perfectly general method of tracing all such curves by means of a flexible and inextensible cord. When there are but two terms, if m and n have the same sign we have the ordinary Descartes' Ovals, if their signs be different we have what Maxwell called the Meloid and the Apioid. In each case a simple geometrical method is given for drawing a tangent at any point, and some of the other properties of the curves are elegantly treated.

Clerk-Maxwell spent the years 1847-50 at the University of Edinburgh, without keeping the regular course for a degree. He was allowed to work during this period, without assistance or supervision, in the Laboratories of Natural Philosophy and of Chemistry: and he thus experimentally taught himself much which other men have to learn with great difficulty from lectures or books. His reading was very extensive. The records of the University Library show that he carried home for study, during these years, such books as Fourier's *Théorie de la Chaleur*, Monge's *Géometrie Descriptive*, Newton's *Optics*, Willis' *Principles of Mechanism*, Cauchy's *Calcul Différentiel*, Taylor's *Scientific Memoirs*, and others of a very high order. These were *read through*, not merely consulted. Unfortunately no list is kept of the books consulted in the Library. One result of this period of steady work consists in two elaborate papers, printed in the *Transactions of the Royal Society of Edinburgh*. The first (dated 1849) "*On the Theory of Rolling Curves*," is a purely mathematical treatise, supplied with an immense collection of very elegant particular examples. The second (1850) is "*On the Equilibrium of Elastic Solids*." Considering the age of the writer at the time, this is one of the most remarkable of his investigations. Maxwell reproduces in it, by means of a special set of assumptions, the equations already given by Stokes. He applies them to a number of very interesting cases, such as the torsion of a cylinder, the formation of the large mirror of a reflecting telescope by means of a partial vacuum at the back of a glass plate, and the theory of Örsted's apparatus for the compression of water. But he also applies his equations to the calculation of the strains produced in a transparent plate by applying couples to cylinders which pass through it at right angles, and the study (by polarised light) of the doubly-refracting structure thus produced. He expresses himself as unable to explain the permanence of this structure when once produced in isinglass, gutta percha, and other bodies. He recurred to the subject twenty years later, and in 1873 communicated to the Royal Society his very beautiful discovery of the *temporary* double refraction produced by shearing in viscous liquids.

During his undergraduateship in Cambridge he developed the germs of his future great work on "Electricity and Magnetism" (1873) in the form of a paper "On Faraday's Lines of Force," which was ultimately printed in 1856 in the "Trans. of the Cam. Phil. Soc." He showed me the MS. of the greater part of it in 1853. It is a paper of great interest in itself, but extremely important as indicating the first steps to such a splendid result. His idea of a fluid, incompressible and without mass, but subject to a species of friction in space, was confessedly adopted from the analogy pointed out by

Thomson in 1843 between the steady flow of heat and the phenomena of statical electricity.

Other five papers on the same subject were communicated by him to the *Philosophical Magazine* in 1861–2, under the title *Physical Lines of Force*. Then in 1864 appeared his great paper "*On a Dynamical Theory of the Electromagnetic Field*." This was inserted in the *Philosophical Transactions*, and may be looked upon as the first complete statement of the theory developed in the treatise on *Electricity and Magnetism*.

In recent years he came to the conclusion that such analogies as the conduction of heat, or the motion of the mass-less but incompressible fluid, depending as they do on Laplace's equation, were best symbolised by the quaternion notation with Hamilton's ∇ operator; and in consequence, in his work on electricity, he gives the expressions for all the more important physical quantities in their quaternion form, though without employing the calculus itself in their establishment. I have discussed in another place (NATURE, vol. vii. p. 478) the various important discoveries in this remarkable work, which of itself is sufficient to secure for its author a foremost place among natural philosophers. I may here state that the main object of the work is to do away with "action at a distance," so far at least as electrical and magnetic forces are concerned, and to explain these by means of stresses and motions of the medium which is required to account for the phenomena of light. Maxwell has shown that, on this hypothesis, the velocity of light is the ratio of the electro-magnetic and electro-static units. Since this ratio, and the actual velocity of light, can be determined by absolutely independent experiments, the theory can be put at once to an exceedingly severe preliminary test. Neither quantity is yet fairly known within about 2 or 3 per cent., and the most probable values of each certainly agree more closely than do the separate determinations of either. There can now be little doubt that Maxwell's theory of electrical phenomena rests upon foundations as secure as those of the undulatory theory of light. But the life-long work of its creator has left it still in its infancy, and it will probably require for its proper development the services of whole generations of mathematicians.

This was not the only work of importance to which he devoted the greater part of his time while an undergraduate at Cambridge. For he had barely obtained his degree before he read to the Cambridge Philosophical Society a remarkable paper *On the Transformation of Surfaces by Bending*, which appears in their *Transactions* with the date March 1854. The subject is one which had been elaborately treated by Gauss and other great mathematicians, but their methods left much to be desired from the point of view of simplicity. This Clerk-Maxwell certainly supplied; and to such an extent that it is difficult to conceive that any subsequent investigator will be able to simplify the new mode of presentation as much as Maxwell simplified the old one. Many of his results, also, were real additions to the theory; especially his treatment of the *Lines of Bending*. But the whole matter is one which, except in its almost obvious elements, it is vain to attempt to popularise.

The next in point of date of Maxwell's greatest works is his "Essay on the Stability of the Motion of Saturn's Rings," which obtained the Adams' Prize in the University of Cambridge in 1857. This admirable investigation was published as a pamphlet in 1859. Laplace had shown in the *Mécanique Céleste* that a uniform solid ring cannot revolve permanently about a planet; for, even if its density were so adjusted as to prevent its splitting, a slight disturbance would inevitably cause it to fall in. Maxwell begins by finding what amount of *want* of uniformity would make a solid ring stable. He finds that this could be effected by a satellite rigidly attached to the ring, and of about $4\frac{1}{2}$ times its mass:—but that such an arrangement, while not agreeing with observation, would require extreme artificiality of adjustment of a kind not elsewhere observed. Not only so, but the materials, in order to prevent its behaving almost like a liquid under the great forces to which it is exposed, must have an amount of rigidity far exceeding that of any known substance.

He therefore dismisses the hypothesis of solid rings, and (commencing with that of a ring of equal and equidistant satellites) shows that a continuous liquid ring cannot be stable, but may become so when broken up into satellites. He traces in a masterly way the effects of the free and forced waves which must traverse the ring, under various assumptions as to its constitution; and he shows that the only system of rings which can dynamically exist must be composed of a very great number of separate masses, revolving round the planet with velocities depending on their distances from it. But even in this case the system of Saturn cannot be permanent, because of the mutual actions of the various rings. These mutual actions must lead to the gradual spreading out of the whole system, both inwards and outwards:—but if, as is probable, the outer ring is much denser than the inner ones, a very small increase of its external diameter would balance a large change in the inner rings. This is consistent with the progressive changes which have been observed since the discovery of the rings. An ingenious and simple mechanism is described, by which the motions of a ring composed of equal satellites can be easily demonstrated.

Another subject which he treated with great success, as well from the experimental as from the theoretical point of view, was the Perception of Colour, the Primary Colour Sensations, and the Nature of Colour Blindness. His earliest paper on these subjects bears date 1855, and the seventh has the date 1872. He received the Rumford Medal from the Royal Society in 1860, "For his Researches on the Composition of Colours and other optical papers." Though a triplicity about colour had long been known or suspected, which Young had (most probably correctly) attributed to the existence of three sensations, and Brewster had erroneously[1] supposed to be objective, Maxwell was the first to make colour-sensation the subject of actual measurement. He proved experimentally that any colour C (given in intensity of illumination as well as in character) may be expressed in terms of three arbitrarily chosen standard colours, X, Y, Z, by the formula

$$C = aX + bY + cZ.$$

Here a, b, c are numerical coefficients, which may be

[1] All we can positively say to be erroneous is some of the principal arguments by which Brewster's view was maintained, for the subjective character of the triplicity has not been absolutely *demonstrated*.

positive or negative; the sign = means "matches," + means "superposed," and − directs the term to be taken to the other side of the equation.

These researches of Maxwell's are now so well known, in consequence especially of the amount of attention which has been called to the subject by Helmholtz' great work on Physiological Optics, that we need not farther discuss them here.

The last of his greatest investigations is the splendid Series on the Kinetic Theory of Gases, with the closely connected question of the sizes, and laws of mutual action, of the separate particles of bodies. The Kinetic Theory seems to have originated with D. Bernoulli; but his successors gradually reverted to statical theories of molecular attraction and repulsion, such as those of Boscovich. Herapath (in 1847) seems to have been the first to recall attention to the Kinetic Theory of gaseous pressure. Joule in 1848 calculated the average velocity of the particles of hydrogen and other gases. Krönig in 1856 (*Pogg. Ann.*) took up the question, but he does not seem to have advanced it farther than Joule had gone; except by the startling result that the weight of a mass of gas is only half that of its particles when at rest.

Shortly afterwards (in 1859) Clausius took a great step in advance, explaining, by means of the kinetic theory, the relations between the volume, temperature and pressure of a gas, its cooling by expansion, and the slowness of diffusion and conduction of heat in gases. He also investigated the relation between the length of the mean free path of a particle, the number of particles in a given space, and their least distance when in collision. The special merit of Clausius' work lies in his introduction of the processes of the theory of probabilities into the treatment of this question.

Then came Clerk-Maxwell. His first papers are entitled "Illustrations of the Dynamical Theory of Gases," and appeared in the *Phil. Mag.* in 1860. By very simple processes he treats the collisions of a number of perfectly elastic spheres, first when all are of the same mass, secondly when there is a mixture of groups of different masses. He thus verifies Gay-Lussac's law, that the number of particles per unit volume is the same in all gases at the same pressure and temperature. He explains gaseous friction by the transference to and fro of particles between contiguous strata of gas sliding over one another, and shows that the coefficient of viscosity is independent of the density of the gas. From Stokes' calculation of that coefficient he gave the first deduced approximate value of the mean length of the free path; which could not, for want of data, be obtained from the relation given by Clausius. He obtained a closely accordant value of the same quantity by comparing his results for the kinetic theory of diffusion with those of one of Graham's experiments. He also gives an estimate of the conducting power of air for heat; and he shows that the assumption of non-spherical particles, which during collision change part of their energy of translation into energy of rotation, is inconsistent with the known ratio of the two specific heats of air.

A few years later he made a series of valuable experimental determinations of the viscosity of air and other gases at different temperatures. These are described in *Phil. Trans.* 1866; and they led to his publishing (in the next volume) a modified theory, in which the gaseous particles are no longer regarded as perfectly elastic, but as repelling one another according to the law of the inverse fifth power of the distance. This paper contains some very powerful analysis, which enabled him to simplify the mathematical theory for many of its most important applications. Three specially important results are given in conclusion, and they are shown to be independent of the particular mode in which gaseous particles are supposed to act on one another. These are:—

1. In a mixture of particles of two kinds differing in amounts of mass, the average energy of translation of a particle must be the same for either kind. This is Gay Lussac's Law already referred to.

2. In a vertical column of mixed gases, the density of each gas at any point is ultimately the same as if no other gas were present. This law was laid down by Dalton.

3. Throughout a vertical column of gas gravity has no effect in making one part hotter or colder than another; whence (by the dynamical theory of heat) the same must be true for all substances.

Maxwell has published in later years several additional papers on the Kinetic Theory, generally of a more abstruse character than the majority of those just described. His two latest papers (in the *Phil. Trans.* and *Camb. Phil. Trans.* of last year) are on this subject:—one is an extension and simplification of some of Boltzmann's valuable additions to the Kinetic Theory. The other is devoted to the explanation of the motion of the radiometer by means of this theory. Several years ago (NATURE, vol. xii. p. 217), Prof. Dewar and the writer pointed out, and demonstrated experimentally, that the action of Mr. Crookes' very beautiful instrument was to be explained by taking account of the increased length of the mean free path in rarefied gases, while the then received opinions ascribed it either to evaporation or to a quasi-corpuscular theory of radiation. Stokes extended the explanation to the behaviour of disks with concave and convex surfaces, but the subject was not at all fully investigated from the theoretical point of view till Maxwell took it up. During the last ten years of his life he had no rival to claim concurrence with him in the whole wide domain of molecular forces, and but two or three in the still more recondite subject of electricity.

"Every one must have observed that when a slip of "paper falls through the air, its motion, though un-"decided and wavering at first, sometimes becomes "regular. Its general path is not in the vertical direc-"tion, but inclined to it at an angle which remains nearly "constant, and its fluttering appearance will be found to "be due to a rapid rotation round a horizontal axis. The "direction of deviation from the vertical depends on the "direction of rotation. . . . These effects are commonly "attributed to some accidental peculiarity in the form of "the paper. . . ." So writes Maxwell in the *Cam. and Dub. Math. Jour.* (May, 1854), and proceeds to give an exceedingly simple and beautiful explanation of the phenomenon. The explanation is, of course, of a very general character, for the complete working out of such a problem appears to be, even yet, hopeless; but it is thoroughly characteristic of the man, that his mind could never bear to pass by any phenomenon without satisfying itself of at least its general nature and causes.

In the same volume of the *Math. Journal* there is an exceedingly elegant "problem" due to Maxwell, with his solution of it. In a note we are told that it was "suggested by the contemplation of the structure of the crystalline lens in fish." It is as follows:—

A transparent medium is such that the path of a ray of light within it is a given circle, the index of refraction being a function of the distance from a given point in the plane of the circle. Find the form of this function, and show that for light of the same refrangibility—

1. The path of *every ray within the medium* is a circle.

2. All the rays proceeding from any point in the medium will meet accurately in another point.

3. If rays diverge from a point without the medium and enter it through a spherical surface having that point for its centre, they will be made to converge accurately to a point within the medium.

Analytical treatment of this and connected questions, by a novel method, will be found in a paper by the present writer (*Trans. R.S.E.* 1865).

Optics was one of Clerk-Maxwell's favourite subjects, but of his many papers on various branches of it, or subjects directly connected with it, we need mention only the following:—

"On the General Laws of Optical Instruments" (*Quart. Math. Jour.* 1858).

"On the Cyclide" (*Quart. Math. Journal*, 1868).

"On the best Arrangement for Producing a Pure Spectrum on a Screen" (*Proc. R.S.E.* 1868).

"On the Focal Lines of a Refracted Pencil" (*Math. Soc. Proc.* 1873).

A remarkable paper, for which he obtained the Keith Prize of the *Royal Society of Edinburgh*, is entitled "On Reciprocal Figures, Frames, and Diagrams of Forces." It is published in the *Transactions* of the Society for 1870. Portions of it had previously appeared in the *Phil. Mag.* (1864).

The triangle and the polygon of forces, as well as the funicular polygon, had long been known; and also some corresponding elementary theorems connected with hydrostatic pressure on the faces of a polyhedron: but it is to Rankine that we owe the full principle of diagrams, and reciprocal diagrams, of frames and of forces. Maxwell has greatly simplified and extended Rankine's ideas: on the one hand facilitating their application to practical problems of construction, and on the other hand extending the principle to the general subject of stress in bodies. The paper concludes with a valuable extension to three dimensions of Sir George Airy's "Function of Stress."

His contributions to the *Proceedings of the London Mathematical Society* were numerous and valuable. I select as a typical specimen his paper on the forms of the stream-lines when a circular cylinder is moved in a straight line, perpendicular to its axis, through an infinitely extended, frictionless, incompressible fluid (vol. iii. p. 224). He gives the complete solution of the problem; and, with his usual graphical skill, so prominent in his great work on Electricity, gives diagrams of the stream-lines, and of the paths of individual particles of the fluid. The results are both interesting and instructive in the highest degree.

In addition to those we have mentioned we cannot recall many pieces of *experimental* work on Maxwell's part:—with two grand exceptions. The first was connected with the determination of the British Association Unit of Electric Resistance, and the closely associated measurement of the ratio of the electrokinetic to the electrostatic unit. In this he was associated with Professors Balfour Stewart and Jenkin. The Reports of that Committee are among the most valuable physical papers of the age; and are now obtainable in a book-form, separately published. The second was the experimental verification of Ohm's law to an exceedingly close approximation, which was made by him at the Cavendish Laboratory with the assistance of Prof. Chrystal.

In his undergraduate days he made an experiment which, though to a certain extent physiological, was closely connected with physics. Its object was to determine why a cat always lights on its feet, however it may be let fall. He satisfied himself, by pitching a cat gently on a mattress stretched on the floor, giving it different initial amounts of rotation, that it instinctively made use of the conservation of Moment of Momentum, by stretching out its body if it were rotating so fast as otherwise to fall head foremost, and by drawing itself together if it were rotating too slowly.

I have given in this journal (vol. xvi. p. 119) a detailed account of his remarkable elementary treatise on "Matter and Motion," a work full of most valuable materials, and worthy of most attentive perusal not merely by students but by the foremost of scientific men.

His "Theory of Heat," which has already gone through several editions, is professedly elementary, but in many places is probably, in spite of its admirable definiteness, more difficult to follow than any other of his writings. In intrinsic importance it is of the same high order as his "Electricity," but as a whole it is *not* an elementary book. One of the few knowable things which Clerk-Maxwell did not know, was the distinction which most men readily perceive between what is easy and what is hard. What *he called* hard, others would be inclined to call altogether unintelligible. In the little book we are discussing there is matter enough to fill two or three large volumes without undue dilution (perhaps we should rather say, *with the necessary dilution*) of its varied contents. There is nothing flabby, so to speak, about anything Maxwell ever wrote: there is splendid muscle throughout, and an adequate bony structure to support it. "Strong meat for grown men" was one of his favourite expressions of commendation; and no man ever more happily exposed the true nature of the so-called "popular science" of modern times than he did when he wrote of "the forcible language "and striking illustrations by which those who are past hope "of being even beginners [in science] are prevented from "becoming conscious of intellectual exhaustion before "the hour has elapsed."

To the long list of works attached to Maxwell's name in the Royal Society's Catalogue of Scientific Papers may now be added his numerous contributions to the latest edition of the "Encyclopædia Britannica"—Atom, Attraction, Capillarity, &c. Also the laborious task of preparing for the press, with copious and very valuable original notes, the "Electrical Researches of the Hon. Henry Cavendish." This work has appeared only within a month or two, and contains many singular and most unexpected revelations as to the early progress of the science of electricity. We hope shortly to give an account of it.

The works which we have mentioned would of themselves indicate extraordinary activity on the part of their author, but they form only a fragment of what he has published; and when we add to this the further statement, that Maxwell was always ready to assist those who sought advice or instruction from him, and that he has read over the proof-sheets of many works by his more intimate friends (enriching them by notes, always valuable and often of the quaintest character), we may well wonder how he found time to do so much.

Many of our readers must remember with pleasure the occasional appearance in our columns of remarkably pointed and epigrammatic verses, usually dealing with scientific subjects, and signed $\frac{dp}{dt}$.[1] The lines on Cayley's portrait, where determinants, roots of -1, space of n dimensions, the 27 lines on a cubic surface, &c., fall quite naturally into rhythmical English verse;—the admirable synopsis of Dr. Ball's Treatise on Screws;—the telegraphic love-letter with its strangely well-fitting *volts* and *ohms;* and specially the "Lecture to a Lady on Thomson's Reflecting Galvanometer," cannot fail to be remembered. No living man has shown a greater power of condensing the whole marrow of a question into a few clear and compact sentences than Maxwell shows in these verses. Always having a definite object, they often veiled the keenest satire under an air of charming innocence and *naïve* admiration. Here are a couple of stanzas from unpublished pieces of a similar kind:—first, some ghastly thoughts by an excited evolutionist—

> To follow my thoughts as they go on,
> Electrodes I'd place in my brain;
> Nay, I'd swallow a live entozöon,
> New feelings of life to obtain——

next on the non-objectivity of Force—

> Both Action and Reaction now are gone;
> Just ere they vanished
> Stress joined their hands in peace, and made them one,
> Then they were banished.

It is to be hoped that these scattered gems may be collected and published, for they are of the very highest interest, as the work during leisure hours of one of the most piercing intellects of modern times. Every one of them contains evidence of close and accurate thought, and many are in the happiest form of epigram.

I cannot adequately express in words the extent of the loss which his early death has inflicted not merely on his personal friends, on the University of Cambridge, on the whole scientific world, but also, and most especially, on the cause of common sense, of true science, and of religion itself, in these days of much vain-babbling, pseudo-science, and materialism. But men of his stamp never live in vain; and in one sense at least they cannot die. The spirit of Clerk-Maxwell still lives with us in his imperishable writings, and will speak to the next generation by the lips of those who have caught inspiration from his teachings and example.

P. G. TAIT

[1] This *nom de plume* was suggested to him by me from the occurrence of his initials in the well-known expression of the second Law of Thermodynamics (for whose establishment on thoroughly valid grounds he did so much) $\frac{dp}{dt} = $ J. C. M.

CENTRAL AMERICAN BIOLOGY

Biologia Centrali-Americana; or, Contributions to the Knowledge of the Fauna and Flora of Mexico and Central America. Edited by F. Duncane Godman and Osbert Salvin. 4to. Zoology, Parts 1 and 2, 1879. Botany, Parts 1 and 2, 1879. (London, 1879, published for the Editors by R. H. Porter, 10, Chandos Street, Cavendish Square, W.)

TWENTY years ago the Natural History of Central America was almost unknown to us. With the exception of a few stray papers in periodicals—most of them of ancient date—the student had no means of becoming acquainted with the many rich and rare forms of life which are found in that part of the Neotropical Region. Mexican and Central American specimens were scarcely found in our museums, and were looked upon as the greatest rarities. Within recent years all this has been changed. Naturalists and collectors have ransacked every part of the Central-American Isthmus, from the frontiers of the United States down to the Panama Railway, and though, no doubt, much remains to be done, the fauna and flora of this district are perhaps, on the whole, better explored than those of any other part of th region to which they belong.

It is to one of the authors of the work now before us, more than to any other person, we believe, that this great change in our knowledge of the fauna and flora of Central America is due. Mr. Osbert Salvin first became interested in the plants and animals of Guatemala more than twenty years ago, when he was induced by the example of the late Mr. George Ure Skinner—a name well known to collectors of orchids and humming-birds, to visit this district and to explore the verdant forests of Vera Paz. Since that period Mr. Salvin has made three other journeys to Central America—accompanied on one of these occasions by his friend and fellow-labourer, Mr. Godman. Besides that, the joint collection of Central American birds and butterflies amassed by these two gentlemen, has been largely increased by the aid of native collectors employed in various parts of the Panamanic sub-region, while mammals and reptiles from the same sources have been furnished to the British Museum, and series of plants to the Royal Herbarium at Kew. Numerous papers contributed by Messrs. Salvin and Godman themselves, or by fellow-workers upon materials furnished by them to the *Ibis*, the *Proceedings* of the Zoological Society, the *Annals* of Natural History, and other periodicals, testify to the success that has rewarded their efforts, not only as regards the discovery of new forms, but also as to the better knowledge of many which were previously but little known.

After twenty-two years' labour on the particulars our authors have wisely determined that the time is come when they may safely undertake a general work upon this extensive subject. Under the title of "Biologia Centrali-Americana" they accordingly propose to publish a series of quarto volumes, of which the first four numbers are now before us. These volumes will contain a series of essays upon the Fauna and Flora of Mexico and Central America, from the valleys of Rio Grande and Rio Gila, on the north, down to the Isthmus of Darien on the south—being the area embraced in what Mr. Sclater, we believe, has called the Panamanic or Transpanamanic division of his Neotropical Region. For the better perfecting of this great undertaking, the editors have wisely confined their own labours to the birds and butterflies, to which they have given their principal attention. In other groups they have obtained the assistance of their brother naturalists, and have, we must say, shown great qualifications for the editorial portion of their work, by making a very judicious selection of contributors.

Mr. E. R. Alston, well known as a most efficient contributor to the *Zoological Record*, has undertaken the mammals. For the part devoted to the reptiles, amphibians, and fishes, the valuable services of Dr. Günther have been secured; while for the land and fresh-water molluscs, our editors have gone as far as Berlin, whence Dr. E. von Martens has promised to give them his most efficient assistance. The crustaceans, or at least a small but particularly interesting division of them, have found a friend nearer home, in the person of Prof. Huxley, with whom we all know the Malacostraca are one of his pet subjects. The Arachnida have been assigned to the Rev. O. Pickard-Cambridge; whilst the various groups of insects have been undertaken by different experts, amongst whom we notice the names of Mr. Bates, Mr. McLachlan, and Mr. Wood-Mason. The botanical portion has been placed in the hands of Mr. W. B. Hemsley, late of the Royal Herbarium of Kew.

So much for the plan of the present work, which, when complete, will form, it is estimated, as many as twelve or thirteen volumes of 500 pages, although the authors, being still in constant receipt of additional collections, do not bind themselves to restrict their labours even to this liberal allowance. Let us now turn over the parts already issued, and see in what style they have commenced their somewhat ambitious undertaking.

The two zoological parts contain the commencement of the essays on the mammals by Mr. Alston; on the Birds, by Messrs. Salvin and Godman; on the Butterflies, by the same gentleman; and on the Longicorn Coleoptera, by Mr. Bates. All these groups, if we understand it rightly, are proposed to be treated of in nearly the same manner. Taking Mr. Alston's contribution for an example, we find the commencement of a complete account of the mammals hitherto ascertained to occur within the limits of the Transpanamanic Sub-region. After a short general introduction on the monkey-life of Central America and a review of the previous authorities on the subject, Mr. Alston takes the species individually and gives us an excellent account of each of them, including its history, habits, and distribution. Out of the ten known genera of American monkeys, six are represented by one or more species in Central America, and one of these (*Ateles vellerosus*) ranges as far north as the upper basin of the Tampico River, in the State of San Luis Potosi, about 23° N. L. This is the highest point north at which Quadrumana are known to occur in the New World; but in the Old World they certainly extend further north, as, besides the Rock of Gibraltar, a well-known locality of the Barbary Ape—the Japanese Island of Niphon is inhabited by a peculiar species of Macaque which probably extends northwards of the 35th parallel.

In working up his next order, the Chiroptera, Mr. Alston has largely availed himself of the labours of Dr. Peters and Mr. Dobson, both well-known authorities on this difficult group, of which the Central American species are numerous, and of great interest. We are presented with an excellent figure of *Chiroderma salvini*, a discovery of Mr. Salvin's in Costa Rica, recently described by Mr. Dobson. The Insectivora, which follow next in order, are but feebly represented in the Neotropical Region, where their place seems to be occupied by the small marsupials of the family Didelphyidæ. Four species of shrews of the genera *Sorex* and *Blarina* are the only true insectivora yet known to occur within the limits of the present work.

The "Aves" of the present work are undertaken by the two editors themselves, and are worked out in a somewhat more elaborate manner than are the mammals. Latin diagnoses of all the species are given, and besides the ordinary particulars as to their history and affinities many details as to their habits in their native wilds are extracted from well-stored note-books of the authors. The plates accompanying this division of the work, by Mr. Keulemans, are well executed and well-coloured.

The "Rhopalocera," also prepared by the editor, though in this case Mr. Godman's name is placed first, as taking, we suppose, the greater share of the labour in this section upon himself, are likewise fully treated of and illustrated by some very beautiful plates. There is not, however, so much scope in this group for the records of personal observation as in the case of the birds.

Besides the Mammals, Birds, and Butterflies we have in part ii. of the "Zoology" the beginning of Mr. Bates's essay upon the Longicorn Coleoptera of Central America. Of this it need only be said that neither Mr. Bates's ability to treat of any portion of one of his favourite groups of insects, nor the mode in which he has executed his present task are likely to be questioned. The thorough character of all Mr. Bates's work is well known, and in this case its value is increased by the beautiful coloured plates by which some of the greater rarities are illustrated. Our editors may well be congratulated on having pressed such a first-class recruit into their service.

Besides the two zoological parts above mentioned the botanical parts of the "Biologia Centrali-Americana" by Mr. Hemsley have also been issued. These contain an enumeration of the Phanerogamous Plants of Central America as far as the Meliaceæ, according to Bentham and Hooker's arrangement, with the localities added, and the characters in the case of the novelties recently described. Six or seven plates by Fitch are attached to each part, some of which are coloured from original sketches made by Mrs. Salvin in Guatemala. What the exact extent of the botanical portion will be we do not find stated, but we presume that it will when complete embrace a list of all the known Phanerogams of Central

America, and we believe the Filices are also to be included.

We are pleased to see that at the conclusion of the work it is announced that an introductory volume will be given containing an account of the physical features of the country and a series of maps. No specially faunistic work should be issued in these days without a map, and in that map moreover all the localities mentioned in the letterpress should be inserted. Furthermore care should be taken that the names of the places should be spelt alike in the letter-press and in the map—a point which in several instances that have come before us, has not been sufficiently attended to.

We are, however, fully aware that in the present case our authors are well acquainted with the value of geography—one of the two "*faces Zoologiæ*," as the late Prince Bonaparte called it, and we do not fear that they will even spell their names of places incorrectly. And on the whole it may be fairly said that the "Biologia Centrali-Americana," if carried, and we doubt not it will be carried, to its promised extent, favoured as it is by the co-operation of some of the most accomplished naturalists of the day, will not only remain a lasting testimony to the learning and munificence of its editors, but will also equal in completeness and finish any geographical work on natural history ever published.

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.*]

Visualised Numerals

It may interest those who have read my memoir in NATURE, vol. xxi. p. 252, on visualised numerals, to learn some of the principal results obtained thus far through its publication. I have received several new diagrams more or less similar to those already published, so that I have now about thirty of them in all. My new contributors are of the same classes as before. There is only one high mathematician among them; the remainder are pursuers of science, authors of various degrees of reputation, persons engaged in tuition, students at Oxford and Cambridge, some other adults, and one schoolboy. If my collection becomes still further increased, I have grounds for belief that I shall be able to classify the cases, and to extract more meaning out of them than has hitherto been feasible.

It has been a satisfaction to me to receive emphatic acknowledgment of its correctness from the author of the curious shaded diagram (Fig. 5) in the memoir. The sketch sent to me was drawn with evident painstaking, but it was rubbed and faint; the engraver, however, succeeded in justly interpreting it, and supplying its defects of tone. Fig. 4 is unfortunate, and I am to blame. I stated in the accompanying text that I had compiled it from a large diagram, much as a map-maker would compile a small map from an elaborate itinerary. However, my map proves to be a failure, so I withdraw it. The other diagrams were almost exact reductions of plain drawings; their truth has been acknowledged in one group of cases, and I have no grounds for doubt as to the remainder. FRANCIS GALTON

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A Psychological Aspect of the Vortex-Atom Theory

It is a very generally accepted fact that the phenomena of thought are at least *connected* with a physical basis, however difficult it may be at present to trace the connection. The dependence, however, of mental attributes and sensations upon brain-structure, is too notorious a fact to admit of doubt by competent judges. This view is illustrated well by a remark of Prof. Huxley's in his essay "On the Physical Basis of Life," viz.: "And if so, it must be true in the same sense and to the same extent that the thoughts to which I am now giving utterance and your thoughts regarding them are the expression of molecular changes in that matter of life which is the source of our other vital phenomena" (*Fortnightly Review*, 1868).

It becomes evident in view of this that the phenomena of thought would be enormously influenced by the changes or permutations of which the molecules of matter were capable. Under the old theory of *perfectly rigid* molecules, it would seem difficult to conceive permutations enough to act as an accompanying physical basis to the phenomena of thought, for according to this theory, the mere motion or change of place of the molecules among each other would be the sole permutations of which they could be capable. But the modern theory of vortex-molecules shows molecules to be *elastic* bodies, which are consequently "capable of *infinite* changes of form"[1]—as the late Prof. Clerk Maxwell remarks [*Encyc. Brit.* 1875, Article "Atom"]. It would therefore follow that according to the modern theory, the permutations of the physical accompaniment of thought would be absolutely *infinite*, in analogy with the infinite variety and range of thought itself. Possibly this may be a point of interest, if indeed it has not already been reflected on by others.

London S. TOLVER PRESTON

A Speculation Regarding the Senses

On examining the modes of action of the senses we find a series of advances in refinement. Beginning with *touch*, we find it has primarily to do with *solids* which come into *direct* contact with the organ. In *taste* a *liquid* medium is necessary. In *smell* we have minute particles carried by a *gas*. In *hearing* we have *vibrations* (longitudinal) in a gas. In *sight*, finally, we find transverse vibrations transmitted by a finer medium, the *ether*.

Now, whatever views may be taken of the doctrine of evolution, there can be no doubt of the progress of the human race in what we may generally here term *power*. And it is interesting to look into the future and inquire whether future developments of the relations between the *ego* and the *non-ego* may not, in time, take such forms as will be equivalent to the acquisition of new senses.

Guided by the gradation above referred to, I would throw out the suggestion that the molecular vibrations in the brain accompanying thought, may affect a surrounding medium, and through that, other brains at a distance, awaking in these corresponding vibrations and thoughts. The medium might be supposed, perhaps, one of different nature from that in which light-vibrations occur, or (not to multiply ethers) the same as the so-called luminiferous ether; and in the latter case we might suppose the vibrations such as not to be appreciated through any of the present senses of ordinary persons.

A person of high refinement and delicate organisation has a wonderfully exalted power (as compared, say, with a country bumpkin) of interpreting the *tout ensemble* of external appearance and bodily motions of another person in his presence, thereby perceiving at a glance much of the thought of that other, as it arises. But the kind of action I have referred to is of a still more delicate kind, and may be supposed to obtain when the eyes, and perhaps other avenues of sense, are closed. It might be termed a kind of *induction of thought*.

This speculation is not, I think, without some encouragement in actual fact. It is a familiar experience that two persons who are together will discover themselves to have been thinking of the same thing at the same moment; and this without any apparent cause in what one *sees* in the other, or in association of ideas in conversation. The ascertained facts of *clairvoyance* and *mesmerism*, however, are what I have more specially in view, and the light in which I would place them is that of a natural development of human faculty, at present appearing only sporadically and in few persons, but destined, perhaps,

[1] The molecules of matter, according to this theory, though indestructible (like the molecules of the ancients), are nevertheless *elastic*, or capable of distortion or changes of form (much in analogy with larger scale elastic solids), the molecule always tending to recover its natural symmetrical shape when released from constraint. These changes of form may of course be conceived infinite in variety, without the total amount of distortion itself being at any time great. This *elasticity* possessed by molecules is sufficiently proved by the vibrations of varied periods which the spectroscope shows them to be capable of executing.

by-and-by to become a universal possession in more or less degree.

It may require some peculiar state of mental calm or abstraction for this reading of the thoughts of another (apart from external expressions appreciated by the other senses) to become practicable, just as, in order to perceive distinctly the over-tones of a musical sound, it may be necessary to quench the fundamental tone.

As to the modification in the human body, supposing the sense in question to become general, this might be of a very minute character, constituting, not in the ordinary view, yet in a quite correct one, a distinct *organ*.

With regard to the influence of distance on the supposed sense, little, of course, can be said; but it is perhaps noteworthy that corresponding to the gradation referred to at the outset there is a general gradation in the distance at which the sense-exciting cause is capable of operating; from the direct contact of touch, to the action of light at the distance of a remote fixed star.

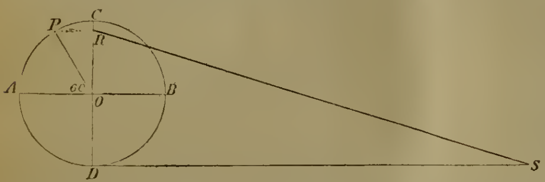
M.

The Circumference of the Circle

To some readers of NATURE the following construction will perhaps be of interest:—

Take $A\ O\ B$, $D\ C$ two diameters of a circle at right angles to one another.

Make the length of the tangent $D\ S$ equal to three diameters of the circle $A\ D\ B\ C$, then make the angle $A\ O\ P = 60°$, and



draw $P\ R$ at a right angle to $D\ C$. Connecting the points S and R you will find the length $R\ S$ very nearly equal to the circumference of the circle.

This will be clear from the following proof:—

From the triangle $D\ R\ S$ we have—

$$RS = \sqrt{DR^2 + DS^2}.$$

But taking the diameter $D\ C = 1$ the length $D\ S$ is $= 3$, whereas $DR = OD + OP \cos 30° = \frac{1}{2} + \frac{1}{2} \cos 30 = 0{\cdot}9330127$. Therefore—

$$\begin{aligned} DR^2 &= 0{\cdot}9330127^2 = 0{\cdot}8705127 \text{ and} \\ DS^2 &= \quad 3^2 \quad = 9{\cdot}0000000 \\ \hline DR^2 + DS^2 &= 9{\cdot}8705127 \\ RS = \sqrt{DR^2 + DS^2} &= 3{\cdot}141738, \text{ whereas the exact} \end{aligned}$$

value of π is 3·141592,

giving a difference of 0·000146, or 0·0046 per cent.

This approximation is, of course, more than sufficient for practical purposes. Although this method has been found by me quite independently, yet I shall not be surprised to hear of its having been proposed before by others, for it is almost too simple not to have occurred to somebody else as well as to me.

Prague, Spálená ulice, 2 nové, January 11 L. HAJNIŠ

Sun-Spots, &c.

I READ with interest the letter of Mr. Bedford's in NATURE, vol. xxi. p. 276, on "Sun-Spots." Perhaps the following may interest Mr. Bedford, and as I have not seen this noticed before by students of the solar orb, it may interest others besides Mr. Bedford.

Prof. Sayce, in his Lectures, says: "The Accadians had anticipated our almanack-makers in discovering a connection between the weather and the changes of the moon; indeed all kinds of astronomical phenomena were supposed to have an influence upon the clouds; and in anticipation, as it were, of Dr. Hunter, the same weather was expected to recur after a cycle of twelve solar years." . . . Even the appearance of the sun was not allowed to go unnoticed, and in one place we are told that on the 1st of Nisan it was "bright yellow," and in another that it was "spotted." Who, says the professor, "would have thought of looking for a notice of sun-spots in the clay tablets of ancient Babylonia?" Lectures, pp. 53–54. See also the "Astronomy and Astrology of the Babylonians," by the same, in the *Transactions* of the Society of Biblical Archæology, vol. iii. pp. 145, 339.

EDWARD PARFITT

Devon and Exeter Institution, Exeter, January 27

Intellect in Brutes

IT might prove interesting to some of your readers to put the following incidents on record relative to intellect in brutes:— Some time ago I kept in town a bitch and three of its puppies; the former had a strong pair of lungs and a weakness for letting the passers-by know it; when the latter became of age they exhibited all the hereditary peculiarities of the mother, and when the four animals joined in chorus, which was their favourite amusement at night, the result was anything but agreeable. Some of my friends hinted to me that if that state of things continued I should probably be indicted for causing a nuisance, and I therefore determined to explain to my four animals that they really mustn't bark. One night I remained late in town, and having provided myself with a stick, I waited till I heard one of them bark, and I immediately afterwards went out and chastised him, or rather the one I thought had made the noise. I was, however, soon met by a difficulty; although I could recognise the bark of the old one, I could not discriminate well between those of the puppies; and whilst the old one was silenced after a few chastisements, the puppies were not; probably in mistake I had thrashed the wrong puppy. I therefore hit upon the plan of making the whole four responsible for each other, and as soon as I heard any one of them bark I applied my stick freely to the whole four, the one after the other. When this had been done two or three times I heard one of the puppies bark, and the next moment it gave a pitiful squeal; the mother had it by the neck. I went out and patted her, thus explaining that she had done well. She wagged her tail, as much as to say she understood me perfectly, and the dogs never barked again except upon the most provoking occasions.

Some other instances which I observed lately might be mentioned as tending to show that animals of a much lower class exhibit reasoning faculties. I had occasion lately to keep some leeches and water-beetles; they were put into round open glass vessels, about six inches high and about two-thirds full of water. A medical leech which was put into one of these vessels got out, and within an hour afterwards it was found on the table and replaced in the water. Now although the vessel was left uncovered as before, this leech never again tried to get out. A horse-leech and two water-beetles, treated in the same way did the same thing once, and once only; each preferred the water to the dry table, and on being replaced they never tried to get out again; *ergo*, they had been taught by experience. Is this not a high order of intelligence? How many examples have we of the genus *homo* where so much intelligence is not exhibited?

Manchester, January 17 W. THOMSON

SEEING a letter in NATURE, vol. xxi. p. 276, with the heading of a "clever spider," puts me in mind of a circumstance that came under my own observation near Tremadoc, in North Wales, many years ago. I sat down on a bank about four o'clock in the afternoon after a long day, when I presently saw I was close to one of the common garden spiders of rather large size, with its pretty spreading net-like web about a yard from the ground; so, for want of something to do, I alarmed the spider to discover where his *den* was, when off he trotted about the distance of a foot to a couple of leaves nicely tied together, where he stayed perhaps ten minutes; I then saw a beetle of rather large size walking at my feet—one of those slow moving dull black ones—I am not coleopterist enough to know its name; I picked it up and put it in the web at a place I thought sufficiently strong to hold it, when out rushed the spider in his boldest manner. But when he saw who his visitor was, what an alteration in his manner! He drew back, and rapidly separated the cords, when down dropped the beetle on a single line, rather quickly, to within about 4 inches of the ground, so that he was suspended on a line about $2\frac{1}{2}$ feet long. The spider then trotted back to his den. The beetle was now struggling in its slow, awkward-looking fashion. I must have stayed and watched them for about twenty minutes, when out came the spider and descended the single line to the beetle, on which he boldly rushed; after a few seconds the beetle's struggles got weaker and weaker, when the spider returned to its den; in a few seconds more the struggles of the beetle ceased. Now, did the spider intend the beetle for its food when he cut away his web to save it from destruction from the beetle's struggles, or was that an after-thought, or why should he know it was a "creature comfort"? and was the fact of the line being so near the ground an accident, or was it premeditated? If you put a small pebble or small piece of wood in a web, a spider will let it drop altogether; if you put a grasshopper in it he rapidly turns it round till the creature looks like a mummy; but I suppose circumstances alter cases even with spiders.

JAMES R. GREGORY

THE following fact may be of interest to those of your readers who are connected with the correspondence in your columns regarding the possession of intellect by brutes.

Having been much worried by the depredations of bandicoots (*Mus giganteus*) I laid three pieces of bread for them smeared with Roth and Ringeisen's phosphor paste. Next morning the pieces of bread were found near the door where they had been placed but turned *upside down*. The bandicoot evidently was suspicious of the poison, had turned over the bread and nibbled away all the sound portion. On the next night I smeared the poison on very thin slices of bread, leaving hardly any of it free from the paste. On this occasion the caution of the bandicoot seems to have deserted it, for the bread was eaten, and the dead animal was found next day in the garden.

Bangalore, India, January 8 ELPHINSTONE BEGBIE

Suicide of the Scorpion

Apropos of the discussion on this point that has lately taken place in NATURE, will you allow me to say that I tried the experiment referred to therein a score of times at least during my long residence in India, and that I never saw the phenomenon so graphically delineated by Byron. My experiments were conducted in cholera and other camps, in the open air, often in the presence of others, and always under circumstances which could admit of no doubt. The conclusion I came to in the matter was that "the scorpion girt by fire" is too stupid or too cowardly a creature to "cure its pain by darting its sting," or anything else, "into its desperate brain." It either rushed blindly into the flames at once, and was then and there destroyed, or it wandered meaninglessly about the margin of "the circle," recoiling nervously from the actual contact, or retiring as far as it could from the heat, to resume, after a short respite, its old manœuvres. I believe as the result of these inquiries that the impression or belief created by the fine imagery of the great poet is a myth and nothing more. WM. CURRAN

Warrington

WILL Mr. Gillman or some other tell us *how* scorpions achieve suicide? The animal stings, as I know to my cost, by a backward lash out and straightening of the tail, and the force which drives the somewhat blunt point into the enemy goes on accumulating as the reversal becomes more complete, and reaches its maximum on or near the horizontal plane and at the furthest point of extension. But when the tail is drawn back above the animal's head, the point is turned upwards, and therefore away from the head, and even if it could be turned towards the head, there is no possible force to drive it through the tough or hard carapace.

Can a man pummel his own back? Can a horse kick its own belly? But the feat attributed to the scorpion, apart from its moral obliquity, is physically even more triumphant. B.

Stags' Horns

OBSERVING in a late number of NATURE a communication concerning the disappearance of stags' horns after being cast off, and a request for information upon the subject from whatever source it might be had, I venture to send the following:—

A few winters ago I spent some weeks in the woods of Georgia, where most of my time was devoted to deer-hunting. In roaming over the woody *hummocks* of that country I several times stumbled upon the cast-off antlers of bucks. Being, like your correspondent, impressed with the popular belief that these were always buried or in some way destroyed by the animals, I inquired of old hunters if it was of common occurrence to meet with them, and was told that they were not rarely found just as we had seen them upon the occasion in question. I suppose that the popular belief in their burial or destruction arose out of the fact that about the time for shedding their horns the bucks retire to the most secluded spots accessible so as to avoid disturbance by other bucks or any enemy during the first few days of the tender, velvety stage of the new horns, and into such retired places man does not commonly venture.

This brings to mind the similar habit which prevails among most crustaceans. The edible crab of this region, for example, waits for a very high tide, and goes with it far inland, where, in shelter of some dark nook, and quite away from its common enemies, it slips off the old shell and spends a few hours on land awaiting the hardening process of the new one before entering again into the struggles of life. The fishermen have learned, however, that the most favourable times for catching *soft crabs* is connected with certain phases of the moon, to which they attribute some mysterious influence upon the crabs directly; of course the dependence of tides and moon solves this little mystery.

BOLLING W. BARTON

Baltimore, Maryland, U.S.A., January 22

MOUNTAIN BUILDING[1]

FEW problems in physical geology are more fascinating than that which deals with the origin of mountains. At the same time few present greater difficulties. In the first place it is absolutely necessary to ascertain the facts of mountain structure before proceeding to frame any theory to account for them. Yet to do this involves an amount of mere physical toil which of itself raises a formidable impediment to progress. For the mountains cannot be understood from a distance. One may not intuitively interpret them by merely looking at them from below. They must be climbed and scrutinised in detail from crest to crest and valley to valley. But to be able to understand what one sees in these elevated regions, one must have an eye that has been well trained in the observation of geological structure, and which, while losing sight of no essential detail, can yet detect the dominant lines amid the apparent disarray of crag and scar, slope and pinnacle. In the next place, having elicited the fundamental facts, it is needful to find for them some explanation which, while connecting them harmoniously and luminously, shall be in strict accordance with the laws of physics, and from the point of view of geological dynamics may be regarded as not only possible but probable.

Thus two obvious paths lead to the consideration of the subject. By the one we are conducted into the region of geological observation in the field. By the other we are drawn to the laboratory and the workshop, where the processes of nature can in some measure be repeated and watched. But these two roadways lie near each other, and the traveller along either of them, if he would keep himself from profitless divergence, should never lose sight of the other. Unfortunately this caution has not always been followed. Hence theories of mountain growth have been proposed, some of them wholly regardless of the real facts of mountain structure, others as defiant of physical possibilities.

Within the last few years the most detailed studies of the actual structure of mountains yet attempted have been carried out among the Alps. Chief among these are the admirable monograph of Dr. Baltzer upon the Glärnisch, and the still more remarkable and beautifully illustrated work of Prof. Heim, on the mechanism of mountain-making. These two writers deserve the thanks of all who take interest in the many questions which the forms of the mountains never cease to raise in the mind. They

[1] "Der Mechanismus der Gebirgsbildung." Dr. F. Pfaff. (Heidelberg, 1879.)

have done much to supply what has all along been a fundamental defect in the conditions for the discussion of the problem—the want of detailed and carefully observed facts. But geologists will never be able satisfactorily to work out the problem until they construct large detailed sections on a true scale, vertical and horizontal, and insert upon them the thicknesses and angles of inclination of the rocks in their exact relations. It would be a task well worthy of the time and energy which any enthusiastic student of the science could bestow to run such a section across the Alps, or at least across some typical portion of the chain. The true outlines and related structure as thus determined, would make most of the existing diagrams of alpine structure appear as ludicrous exaggerations.

Among those who have essayed to follow in the wake of Sir James Hall, the founder of experimental geology, and to seek a solution of some of the problems of mountain building by well-devised experiments, Daubrée and Favre have in recent years been specially successful. Another experimenter has just appeared in the person of the accomplished Dr. Pfaff, of Erlangen. His previous works have shown him to possess no ordinary powers of scientific exposition, and in particular his "Allgemeine Geologie als exacte Wissenschaft" deserves the attention of geologists as a remarkably incisive criticism of their science in its present aspects. He is essentially an experimenter, who would reduce every geological problem if possible to the test of actual measurement and experiment. Some of his own practical work in this department is full of ingenuity and suggestiveness. He has now come forward as a disputant in the vexed question of the formation of mountains. His critical faculty, however, here shows itself rather destructive than constructive. He institutes numerous experiments to prove the inadequacy of previous theories, but he leaves us with very little that is satisfactory to put in their place.

As we read Dr. Pfaff's essay and note how he gravely argues as to the capabilities of rocks under pressure and the processes of mountain building, from what he has been able to do with a few square inches of limestone, a steel punch, and other appliances, we are reminded of the censure pronounced by Hutton on the temerity of those who "judge of the great operations of the mineral kingdom from having kindled a fire and looked into the bottom of a little crucible." He forgets that while much may be learnt from experiment, it must always be first of all determined how far the conditions of experiment resemble those of nature. Thus he takes a solid cylinder of Solenhofen limestone 4 mm. in diameter, tightly fitting into a hollow steel cylinder with a small aperture on one side, and subjects it to a pressure of 9,970 atmospheres for seven weeks. He then finds that the stone has not in the least degree been forced into the empty aperture prepared for it, and that its microscopic structure shows no sign of internal alteration or rearrangement. Accordingly he concludes that even with so high a pressure rock acquires no plasticity. With this conclusion no fault can be found until it is applied to the solution of problems in mountain structure. Surely Dr. Pfaff does not mean to affirm that there is any analogy between his solid cone of homogeneous limestone tightly fitting into a steel cylinder and the alternations of various sediments differing so much in texture, structure, density, and inclosed water which constitute most of the visible part of the earth's crust. He does not seem to be aware of the fact that rocks have been experimentally proved to be plastic under much less pressure than he applied. We would recommend him to read the classical memoir of Sir James Hall and the researches of Daubrée and Tresca on the flow of solids. He will find also some convincing proofs in Mr. Miall's paper on the contortion of rocks, that even on the surface, under every-day conditions, not inconsiderable curvatures of solid stone take place merely through gravitation. If he will visit this country we shall be happy to conduct him to some graveyards where the centres of vertically-placed slabs of Italian marble have, under the influence of weathering, been started out from their backing, so that they "belly" out like partially-filled sails.

Dr. Pfaff does not, of course, deny that rocks have been violently compressed and contorted, and he is no doubt well aware that their inclosed fossils have often undergone extraordinary deformation. He contends, however, that these are mere superficial phenomena, and endeavours to support and explain his contention by sections of the earth's crust, about which we venture to predict that Prof. Heim and his Swiss colleagues will have something to say before long. Dr. Pfaff has a theory of his own to explain curvature and deformation. He regards these as the results of the co-operation of water with gravity! Though hitherto no Neptunist, he now distinctly avows himself as a believer in the paramount power of water in the elevation of mountains. It is a pity that after more than a hundred pages devoted to the demolition of all our views as to the effects of terrestrial contraction due to secular cooling, he should tantalise us with a mere brief statement of his own theory. Perhaps it seems so self-evident to himself, that it needs no elaborate experiments to prove its truth, and no expanded statement to insure its acceptance. That a man at this time of day can honestly persuade himself that the upheaval of mountains, the plication, inversion, and deformation of rocks can be accounted for merely by the effects of subsidence due to the abstraction of materials from below by percolating water seems incredible. But that such a creed should be professed by one who has shown himself so good an observer and so acute a reasoner, is still more astonishing. When, after perusing the greater part of his book, and noting argument after argument, and experiment after experiment brought forward to upset all accepted theories on the subject, one comes suddenly and without warning upon his own theory, it is as if some rogue had incontinently put the lamp out. One does not know what to make of the situation. There is something too ludicrous about it. Serious argument is no longer possible. Dr. Pfaff must be bantered out of his hydropathic geology. His abilities are too great to be lost in a monomania of this kind. We would recommend for his speedy restoration to geological sanity a trip into Switzerland, under the care of Drs. Baltzer and Heim. This treatment, if taken in time, will, no doubt, restore him at least to such measure of health as can be enjoyed by a man who works out his geology in his study and laboratory rather than in the field.

A. G.

THE SWEDISH NORTH-EAST PASSAGE EXPEDITION

THE following notes are taken from a letter from Prof. Nordenskjöld to Mr. Oscar Dickson, dated Ceylon, December 16, 1879, printed in the *Göteborgs Handels Tidning*:—

Dredging was carried on at a number of places on the coast of Japan, but with scanty results, in consequence of the poverty of the sea-bottom in animal life. The same was the case with the dredgings which were carried on between Hongkong, Labuan, and Singapore, and in the Strait of Malacca, although the bottom consisted in some places of clay, in others of sand, coral-sand, or rock, and thus ought, at least at some of the places, to be favourable to the development of a rich animal life. While the trawl-net in the Polar Sea almost always brought up several hundred animals, the zoologist in these southern seas obtained seldom more than one or two at each draw, and frequently not one. By far the most abundant animal life has been found during the Swedish Arctic expeditions, at favourable places in the bottom of the Polar Sea; for example, at a depth of between 20 and 100 fathoms in the middle of Hinloopen Strait in Spitzbergen, on the east coast of Novaya Zemlya, in the sea east of Cape Chelyuskin, and south of Behring's Straits. At these places the temperature of the sea all the year round is between 0° and – 2°·7 C. A temperature at or under the freezing point appears thus to be much more favourable for the development of an abundant animal life at the sea-bottom than one of 15° to 25° C., a very remarkable circumstance, which, as far as Nordenskjöld knows, has not received the attention which it deserves. It is to be remarked, however, that the invertebrate animals in the south are larger and finer than in the north, and that the shore fauna, which is entirely absent in the sea of the high north on account of the destructive action of the drift-ice, is here richly developed.

Japan is so poor in land- and fresh-water crustacea, that one often searches for hours in the most favourably situated places without finding a single specimen. Even in the most northerly part of Scandinavia more land crustacea may in many places be collected in a few hours than in Japan in as many days. Lieut. Nordquist, however, has made a fine collection, which is expected to yield many interesting new contributions to the fauna of Japan.

In the numerous dredgings carried on during the voyage from Japan to Ceylon at depths in which algæ are met with in abundance on the coasts of Scandinavia, *not a single alga was brought up by the dredging apparatus.* Even in the shore belt marine plants are in many places almost wholly wanting. Some places were found, however, more fortunately situated. The observations made here and the information obtained by an examination of the collections in the museums of Tokio have enabled Dr. Kjellman to obtain a general view of the occurrence of algæ on the east coast of Japan of special interest in many respects in connection with researches carried on by him during the preceding part of the voyage, for example, with respect to the boundaries of the areas occupied by different algæ, with respect to the mutual relation between the abundance of individuals and species at different places, and with respect to the types which are to be considered distinctive of the different areas.

The lichen flora of Japan was examined by Dr. Almquist. In the more elevated regions, as on the sides of the mountain Fusijama, 13,000 feet high below the snow limit, at a height of 6,000 to 8,000 feet above the sea, it has a certain resemblance to that of Scandinavia, but in the low country it is limited to a very few localities. In the purely tropical countries, for instance at Labuan and Singapore, the lichens appear to be confined almost exclusively to the bark of trees, and the whole of this division of the vegetable kingdom here consists mainly of a single group, *Sclerolichenes*, which occur in abundance and in very varying types.

Prof. Nordenskjöld and Lieut. Hovgaard ascended the mountain Asamajama, a still active volcano, 8,200 feet high, on October 4.

Prof. Nordenskjöld has made extensive collections of fossil plants from fossiliferous strata at Mogi, a fishing village on the coast of Japan, and from the coal-mine Takasima, both in the neighbourhood of Nagasaki, and from the coal-seams at Labuan. The fossils from Mogi lie in a fine white clay slate, and consist almost exclusively of beautiful leaf impressions. At Takasima the fossils consist principally of water plants imbedded in the brownish-black shale which accompanies the coal. At Labuan the fossils lie imbedded in balls of clay-ironstone found in the sandy beds between the coal-seams. They consist of ferns, *Cycadeæ*, and large-bladed leaf-trees, which appear to have a tropic stamp, while the Mogi fossils, on the other hand, indicate a moderately warm climate.

AN ELECTRO-DYNAMOMETER FOR MEASURING LARGE CURRENTS[1]

THE use of electric machines of large size for the generation of currents of great strength has become extensive, and promises to increase materially. In connection with this, the best mode of measuring the currents obtained is a matter of much importance as well as one of some difficulty.

Of the possible methods the galvanometric is probably the most used, but it is objectionable as shunts of low resistance must be employed. In general, a method depending upon the estimation of a *very small proportional part* of the magnitude to be measured is objectionable, since extreme accuracy is necessary and errors of observation are magnified. The mode of measurement by the electro-dynamometer is to be preferred for many reasons, and it has also the advantage of being applicable to to-and-fro currents, as well as to those in one direction. Weber's electrodynamometer is only suitable for measuring very small currents unless shunts are used. Trow-

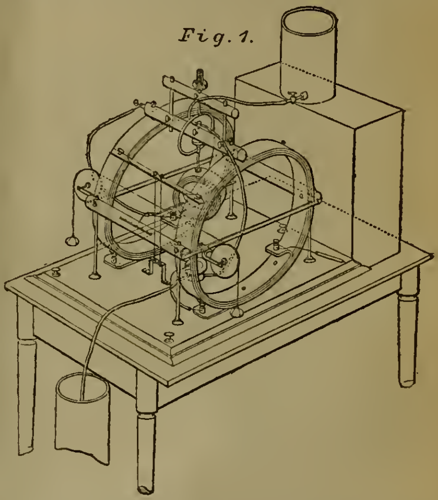


Fig. 1.

bridge has designed an electro-dynamometer through which large currents may be transmitted and directly measured (*Proc.* Am. Acad. Arts and Sci., October 9, 1878). This instrument works well and gives good results.

1. During the past year the writer has been experimenting at the U.S. Torpedo Station with an electro-dynamometer differing from Trowbridge's in the manner of determining the deflective power of the current, and which seems to present some advantages in simplicity and readiness of working, while especially suitable for technical use. In its general plan, particularly in the arrangement by which the entire current may be passed through the instrument, it follows Trowbridge's form.

Fig. 1 is a general view of the instrument. Figs. 2 and 3 show the details of the suspended coil. The large, fixed coils are made of thick copper ribbon. The turns are insulated from each other, and the metal framework is insulated from the coils. The suspension arrangement

[1] By Walter N. Hill, Chemist to the U.S. Torpedo Station, Newport, R.I., U.S.A.

is placed on the top of the fixed coils and insulated from them.

The deflecting coil is made of thick copper ribbon fastened with insulated rivets. In its centre, and parallel with it, is a light brass rod or pointer. A copper rod in connection with the outer end of the coil has an iron or nickel-plated point, which dips in mercury contained in a double-walled metal cup, B, on the base-board. A similar rod from the inner extremity of the coil ends in an iron or nickel-plated cup, C, containing mercury. The coil hangs under the metal cylinder, D, so that a plunger, A, in the latter can dip in the mercury in the cup C of the former. The suspension is of fine sewing silk, waxed or treated with shellac. The thread passes over a little pulley, E, above, with both parts parallel, or nearly so, and close together. As represented in Fig. 1, the large coils are connected in series. The current, after traversing the left-hand coil, is led by a wire to the cylinder, D, thence by the plunger, A, to the cup, C, through the small coil to the cup, B, which is connected by a wire with the right-hand coil. In order to prevent heating of the mercury connections, a stream of cold water is passed through the hollow plunger, A, and between the walls of B, from a jar above, connected by rubber tubes.

When the current passes, the suspended coil is powerfully deflected, but its actual movement is limited by a vertical wire stop, against which the pointer-rod strikes. To the pointer-rod are attached, on opposite sides, two silk threads which lead over pulleys on the side-bars to small pans, one on each side of the instrument (Fig. 1). The pulleys are light, nicely balanced, and turn on hardened steel pivots. When deflection has occurred, weights are added to the pan on the side opposite until the pointer-rod returns to its starting-point. A scale is marked on the cylinder in front of the instrument (Fig. 1), and a pointer of aluminium wire is fastened to the rod in the centre of the movable coil, so that it traverses the scale (a more convenient mode of noting the return of the coil might be taken). The pans are of the same weight, and the threads by which they are hung are silk fibres. The friction of the pulleys is very small and would be trifling if they were made with jewelled bearings. Also one balances or nearly balances the other, so that practically their friction may be neglected, although allowance might be made for it, if extreme nicety were aimed at. The actual observation is made when the coil is in the zero position, the weight taken being that required to *balance* the deflecting force. The movement of the pulleys is then very slight, and the weight acts exactly at right angles to the pointer-rod.

For the measurement of the large currents derived from dynamo-electric machines, minuteness is not demanded, since the variations due to fluctuations in the currents, alterations in resistance, &c., are much greater than the limits of observation in such an instrument as this. Quickness and simplicity of working, together with strength and compactness, are required in the electro-dynamometer, and this instrument possesses these practical advantages, while it is capable of a good degree of accuracy.

The instrument shown in the figures was made for experimental trial, and is defective in certain details; still it was found to be a good working piece of apparatus.

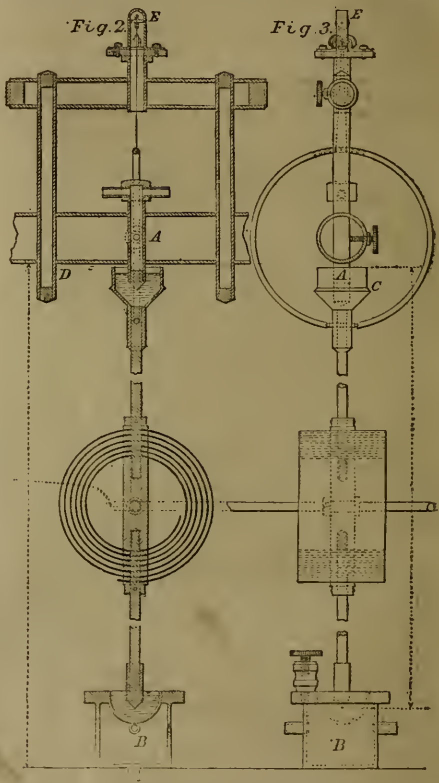
Theory of the Instrument.—The expression for the strength of current is very simple. The weight found is that required to balance the deflective force and is observed at zero, so that the earth's and local attractions are avoided, nor does the torsion of the suspension enter. Let

S = strength of current in webers.
w = weight used in milligrammes.
l = length of weight-arm, or distance from point where weight acts, to centre of system.
G = constant of large coils.
g = constant of small coil.
C = constant of instrument or length of magnetic arm.

By the theory of the electro-dynamometer, the force acting to deflect is represented by the expression $\frac{2\pi n}{r} \times g \times S^2$, in which $\frac{2\pi n}{r}$ is the constant of the large coils or G, and g the constant of deflecting coil. This force acts with the arm C and is balanced by the weight acting with the arm l. Hence

$$S^2 = \frac{lw}{CGg}.$$

The coils being large, G and g are readily ascertained



from measurement, and l is a known distance. With the instrument in question, C was found by passing the same currents through it and through Trowbridge's dynamometer, the constant of which was accurately known.

C, l, G, and g being known, it is evident that from the observed w, S may be obtained with little calculation. Or, a table may be drawn up from which the value desired can be derived by inspection. Also, a set of weights can be prepared which will represent the current in webers directly. Doubtless this will often be convenient.

The instrument described has been worked with currents as small as 10 webers, but it is not quite sensitive enough for such use. With those of 20 webers and upwards it operates satisfactorily. Greater nicety of construction would confer greater sensitiveness, and it is probable that this method of observation can be advantageously applied in the construction of instruments for measuring moderate currents. It is, however, evident that this form of the electro-dynamometer is particularly suitable for *large* currents. We have

$$S : S' :: \sqrt{w} : \sqrt{w'}.$$

That is, as the current increases, the corresponding weights increase more rapidly and greater accuracy and minuteness are attained.

Thus, as the instrument I have experimented with has been arranged, a current of

20 webers requires a weight of			530 mg.		
21	„	„	„	580 „	diff. 50 mg.
49	„	„	„	3,165 „	
50	„	„	„	3,295 „	diff. 130 mg.
80	„	„	„	8,230 „	
81	„	„	„	8,440 „	diff. 210 mg.

while a difference of 10 mg. is sharply indicated.

My best thanks are due to Prof. John Trowbridge, of Harvard, for advice and the use of his apparatus.

NOTES

THE Committee appointed by the French Minister of Public Instruction has awarded the *Prix de Volta*—50,000 francs—to Graham Bell

A TRANSLATION of "The Skies and Weather Forecasts" of Aratus, by Mr. E. Poste, M.A., of Oriel College, Oxford, will shortly be published by Messrs. Macmillan and Co. These poems, apart from a certain charm in the treatment of the subject, are not without interest as belonging to the literature of infant astronomy and infant meteorology. The meteorology of Aratus is of course merely a specimen of the popular weather wisdom of his day. But the faith it shows in the possibility of a science, and the sense of the importance of such a science, gives him a certain claim to the attention of modern scientific men. The notes to Mr. Poste's translation will be addressed merely to novices in astronomical knowledge.

THE *New York Times* announces the death at Waukegan, Ill., on January 6, of Mr. James W. Milner, at the age of thirty-nine. When barely arrived at man's estate he travelled through Minnesota and the adjoining States, engaged in making collections. At Waukegan Mr. Milner made some remarkable discoveries in the peat-beds, and the remains of an elk which he exhumed were exhibited for quite a number of years in the Chicago Academy of Sciences, until they were destroyed by fire. Such papers as Mr. Milner had written on these remains and on other topics of a a similar character, from their singular terseness and excellence, attracted the attention of the Smithsonian Institution. A correspondence, ensuing between the Smithsonian and Mr. Milner eventually led to his engagement by the present secretary, Prof. Spencer F. Baird, and, in 1871, Mr. Milner was appointed Deputy United States Fish Commissioner, with the particular duty of studying the habits, food, method of breeding, and atching of the white-fish. From these labours in what some six or seven years ago was quite unknown ground, resulted a work of the most thorough and exhaustive character, which may be cited as a model of patient and elaborate research. From the period of his entrance into the United States Fish Commission his labours were incessant. In the study and development of practical fish-culture, as understood in its widest sense, Prof. Milner may be said to have done more for it than any one else in the United States. His ingenuity and adaptiveness, combined with his thorough grounding in natural history, permitted him to solve many things in fish culture which before his time had been as problems. The wonderful successes he achieved soon made him a leading authority on these subjects, both at home and abroad.

THE death is announced, at the age of sixty-three years, of Mr. David Thomson, Professor of Natural Philosophy in the University of Aberdeen.

M. WALFERDIN, the inventor of the minimum thermometer, died at Paris at the end of January at the age of eighty-five, after a protracted illness of many years' duration. He was one of the members of the Constituent Assembly of 1848. Since that time he devoted all his leisure to scientific and artistic pursuits. He collected almost every picture drawn by Fragonard, one of the most celebrated French artists of the end of the eighteenth century. He sold his gallery to an English nobleman about twenty years ago, on condition that he should be appointed during his lifetime keeper of the gallery, with a salary of 500*l*. a year, and that the gallery should be exhibited at his own rooms. This precious collection will shortly come to England.

WE regret to state that General Morin, the well-known director of the Conservatoire des Arts et Métiers, is lying in a very precarious state in consequence of a severe cold. Great anxiety is felt for him at the Institute, of which he is one of the most respected and popular members. The General is aged eighty-five years.

ON Monday Prof. W. K. Parker, F.R.S., commences a series of nine lectures at the Royal College of Surgeons, on the Structure and Functions of the Vertebrate Skeleton, to be continued on Mondays, Wednesdays, and Fridays, to the 27th inst. Prof. Flower, in continuation of previous courses, begins his series of nine lectures on the Comparative Anatomy of Man, on March 1, to be continued as above to March 19.

WE are glad to learn that the College of Surgeons have seen their way to the purchase of the Barnard Davis Anthropological Collection, and that Prof. Flower is superintending the removal of the collection to the museum of the College.

THE death is announced of Sir Dominic Corrigan, the well-known Dublin physician, at the age of eighty years.

ON Tuesday afternoon the problem set by the accidental explosion of the 38-ton gun on board the *Thunderer* was solved by the explosion of the sister gun with a double loading. The gun was carefully loaded, and then a diagram was painted outside the gun showing the positions of the two charges and their projectiles. First was rammed home the Palliser cartridge of 110 lbs. of pebble powder, next the Palliser shell of 110 lbs., and the papier-maché wad. The second charge followed—namely, 85 lbs. of powder, a common shell, and another wad, and the double loading was complete. As marked on the outside of the gun, the 85 lbs. of powder lay just in the position where the gun swells in thickness to strengthen the powder chamber. After the firing the little dark cell was found strewn with fragments of the gun, the breech end only of which remained on the carriage, resembling with marvellous fidelity its unfortunate companion now exhibited in the Royal Gun Factories.

WE notice in the January number of the *Archives des Sciences Naturelles* an interesting letter by Col. Ward, on the meteorology of the high regions of Switzerland during December last. Whilst the valleys were covered with a thick fog, and the sun was visible only for very short intervals, bright sunshine glowed about Rossinières (a small town close by Chateau d'Oex, altitude about 3,240 feet); here the sun was seen daily for twenty-seven days, and twenty-one days were absolutely cloudless. On December 25 Col. Ward climbed Mont Cray, a mountain 6,793 feet high, situated between Rossinières and Châteaux d'Oex. The view from the top was never so clear and wide; it reached as far as seventy miles in each direction; the mountains of Lake Constance, the Bernese Oberland, Monte Rosa, Mont Blanc, the Vosges, and even the Black Forest, were quite distinguishable, as well as the plateau north of Mont Cray, with the towers of Friburg and Romont. On the contrary, a thick fog covered

Lakes Geneva, Neuchâtel, Morat, and Bienne, and the neighbouring valleys. The quite level surface of this fog is likened to that of a sea of milk which reached as high as 500 feet beneath the 4,900 feet high Col de Jaman. At Rossinières the planet Venus was seen with the naked eye in daylight from October 23 until the end of December.

ANOTHER interesting note, by Prof. Plantamour, inserted in the same number of the *Archives*, deals with the temperature of the St. Bernard. It happens every year that the temperature on the St. Bernard, during several hours, or even during several days, of December, is higher than at Geneva. But during December, 1879, this anomaly lasted for a far longer period of time than usual; the average temperature of December on the St. Bernard (2,070 metres above Geneva) was 8°·4 Celsius higher than at Geneva; out of the thirty-one days of the month only during fourteen days was it from 0°·04 to 6°·2 Celsius lower than at Geneva, whilst during seventeen days it exceeded this by 2° to 16°·4 (16°·4 on December 1, 13° on December 5, 7, and 31; 11° on the 8th, 13th, and 30th, and so on). Prof. Plantamour observes also how difficult it is in such cases to determine the mean temperature of the stratum of air between the two stations, and how great the error of the barometrical levelling and of the reduction of the observed pressure to the sea-level would be if we applied the barometrical formula to such cases when the usual distribution of heat is inverted as it was during December last. As to the temperature at Geneva, it was, during this month, 6°·9 Celsius lower than the average for fifty years; this difference exceeded four times the probable difference which, when deduced from fifty years' observations, is only ± 1°·72, the probability of such a difference being only 0·005.

THE results of a recent instructive experiment in sylviculture, extending over seventeen years, have been communicated to the French Academy by M. Gurnaud. His conclusions are as follows:—(1) That light when it strikes the ground, after being sifted in the foliage, stimulates the production of carbonic acid in the decompositions which produce humus, and also the decomposition of that gas by the green parts. (2) That the growth of tall trees is retarded, though their green parts expand freely in the atmosphere, under direct impression of the luminous rays, when the lower covert formed by trees of smaller size intercepts too completely the access of light to the ground, and diminishes its reflex action on the tops of the tall trees. (3) That the covert formed by underwood weakens this reflex action of light on the vegetation of tall trees rather by its composition, than in any other way; since, after a clearing which suppresses the oblique shoots, the vertical shoots retained do not offer any obstacle. (4) That humus, under too dense a covert, loses a part of its efficacy, and herein resembles farm-dung, which, too deeply buried, remains inert for several years. *En résumé*, it is demonstrated how the vegetation of tall trees may be improved by operating on the composition, consistence, and duration of the underwood.

A CORRESPONDENT of the *Times* writing from the Royal Mail Steamer *Para* at sea, January 17, records a volcanic eruption in the Island of Dominica, and also disastrous floods in St. Kitts. On Sunday, January 4, at 11.5 a.m., the inhabitants of Roseau, the capital of Dominica, a town situate on its western shores, were suddenly plunged into almost total darkness, for, although it had been raining heavily all the morning, the sky up to half-past ten was fairly clear, and there was no warning of what was to come except a strong smell of sulphur pervading the atmosphere, and this, in an island abounding in sulphur springs, is so usual that few of the inhabitants had even noticed it. With the strange darkness came torrents of milk-white water, mixed with black volcanic sand and ash, flashes of bright red lightning, peal after peal of thunder, while ever and anon between the peals could be heard a strange subterranean noise like the breaking of waves on a lee-shore. This lasted nearly fifteen minutes. When daylight was restored the town was found to be covered with ashes an inch deep, and the surrounding country presented a most abnormal appearance. The cause of this strange volcanic phenomenon did not long remain a mystery, for next morning, during a lull in the deluge of rain, there could be seen hanging over the "Boiling Lake" crater, and in clear outline against the sky, a cloud such as the younger Pliny describes as having hung over Vesuvius in August, 79, of our era. The now famous "Boiling Lake" of Dominica is the centre of a large crater in the southern extremity of the island, called the Grand Souffrière Hills. During the eruption nearly all the rivers in the island overflowed their banks, and in the Point Mulâtre River, which rises from the crater of the "Boiling Lake," all the fish, even those near to the estuary, died, and were subsequently taken out in basketfuls by the natives. The flood in St. Kitts occurred on Sunday, January 11. The storm began about 10 P.M with heavy rain, which gradually increased in intensity until midnight, when it almost seemed to be rain, and seemed to assume the character of a falling waterspout. During this time there were occasionally strong blasts of wind, very vivid lightning, and once or twice a tremulous undulating movement of the earth. There was, however, only one severe shock, and it is said to have occurred about 2.30 A.M. on the 12th, when the full fury of the storm was attained. After this it began to decrease in violence, and at 4.30 all was silent, and the work of destruction was over.

AN international exhibition of plants and flowers will be held at Weisbaden during the approaching summer.

AT Geneva an international exhibition of clocks and watches, and of all machines, implements, utensils relating to clock making, will be held during May and June next.

ICE-BLOCKS have been formed not only at Saumur but also at Lyons. These occurrences are not unexampled, as it appears that in the terrible winter of 1840 the Vistula was also blocked by ice, close to Dantzig; the result was that the stream opened a new bed in a sandy and hilly ground. The channel for preventing the level of water rising higher than the top of the embankments has been bored by explosions in the Saumur iceberg. The work was begun on the 16th and was ended on the 22nd. The section is from 10 to 20 metres. Since that time the engineers have been busy enlarging it, and the work is progressing favourably. The iceberg has been measured carefully, and estimated at 15,000,000 cubic metres. The navigation arm, on the right side, has been hopelessly blocked, and no work has been tried. The weather is splendid, the sun extremely hot during day, but the nights are very cold. On Tuesday morning all the streets were covered with ice.

IT has been noted that during the present weather crisis the Montsouris electrometers have shown not a single negative reading. This positive state has continued for the last three months. The readings are taken eight times a day.

THE recently opened Albert Institute at Windsor made a good beginning on January 20 with an interesting lecture by Mr. F. Drew, of Eton, on "The Objects aimed at by the Institute." Mr. Drew showed the great interest attaching to the study of the various branches of science, giving some useful practical hints as to how the study both of science and of literature may be most effectually carried out.

WE notice a useful Russian work by M. Tchikoleff, on "The Electric Light and its Applications to Military Purposes," being a thorough description, with numerous figures of the various apparatus employed in the armies of various countries.

MR. GORDON HOLMES's work on "Vocal Physiology" is not published at Edinburgh, but by Messrs. Churchill, of London.

THE additions to the Zoological Society's Gardens during the past week include a Feline Douroucouli (*Nyctipithecus vociferans*) from Brazil, presented by the Right Hon. H. Hugh Childers, M.P.; an Ocelot (*Felis pardalis*) from British Guiana, presented by Mr. G. Whitmore Christie; a Little Grebe (*Podiceps minor*), British, presented by Mr. Thos. Edward Pryce; five Undulated Grass Parrakeets (*Melopsittacus undulatus*) from Australia, deposited; a Black Lemur (*Lemur macaco*) from Madagascar, a Tamandua Anteater (*Tamandua tetradactyla*) from Brazil, purchased.

OUR ASTRONOMICAL COLUMN

SOLAR PARALLAX FROM THE VELOCITY OF LIGHT.—Mr. D. P. Todd, of the *American Nautical Almanac* Office, publishes an interesting note upon this subject. Remarking that the opposition of Mars in 1862, when the planet approached near the earth, and the experimental determination of the velocity of light in the same year, mark the beginning of a new era in the history of the determination of the solar parallax, he refers to the many values of this constant which have since been worked out, and the fact that although theoretically the better class of these determinations should yield values in consistent harmony with each other, there are at present singular and unaccountable discordances. Prof. Newcomb's mean value of the parallax, 8″·848, he observes, was regarded with caution only because it was considered too small, the researches of Hansen, Leverrier, Stone, and Winnecke appearing to place the parallax considerably outside Newcomb's value. Within the last two or three years, however, Mr. Todd remarks that "the parallactic pendulum has swung quite to the lesser extremity of the arc until the true value of the solar parallax has appeared possibly below 8″·8, and that, too, with good reason." But now there seems to be a slight gravitation towards a central value, and he thinks it is not possible to say that the mean equatorial horizontal parallax of the sun is so much as the hundredth part of a second different from the old figure, 8″·813 (27″·2 centesimal) adopted by Laplace in the *Mécanique Céleste*, and resulting from the early discussions of the transits of Venus in 1761 and 1769.

Fizeau made the first experimental determination of the velocity of light in 1849, but the earliest which can lay claim to the merit of trustworthiness is that of Foucault in 1862, who found it 298,000 kilometres per second, expressing confidence in it to about one-six-hundredth part, though Mr. Todd estimates the probable error twice as great. Next we have the first determination by Cornu, detailed in the *Journal de l'École Polytechnique*, 1874, which is 298,500 kil. ± 1,000. The second determination by Cornu, related in the *Annales de l'Observatoire de Paris*, t. xiii., 300,400 kil. ± 300; Helmert's rediscussion of these experiments in 1876 assigns 299,990 kil., the probable error of which value Mr. Todd estimates at 200 kil. Then follow two determinations by Mr. A. A. Michelson, U.S. Navy, to the first of which, 300,100 kil., he assigns equal weight with the earlier value of Cornu; the second, briefly described in the *American Journal of Science* for November, 1879, Mr. Todd interprets, giving equal weight to the one hundred separate determinations, to imply a velocity of 299,930 kil. ± 100. Assigning weights to these various values, he finally deduces for the velocity of light, 299,920 kilometres, or 186,360 miles per second.

The next step for the determination of the distance of the sun from the earth is the combination of this value with astronomical constants: (I.) Theory and observation of Jupiter's satellites afford a result of the interval of time required by light in traversing the mean distance of the earth from the sun, but there are only two precise determinations of this interval, astronomically speaking; the first by Delambre in his Tables of the satellites, which was also adopted by Damoiseau in his later tables, published in 1836, the second by M. Glasenapp, of the Observatory of Pulkowa, in 1874, from twenty-five years' observations of the first satellite of Jupiter, ending in 1873; the values are respectively 493·2s., and 500·84s. ± 1·02s.; the latter value rests upon a much smaller number of observations than Delambre's, but Mr. Todd remarks that it is difficult to form a just estimate of the worth of an average observation of an eclipse of a satellite of Jupiter in the last century, and moreover, we have not the means of knowing the process of discussion followed by the French astronomer; he combines the result by giving double weight to Glasenapp's result, which depends upon observations of definite excellence, discussed with modern precision, and thus adopts 498·3s. for the time-interval required for light to reach the earth from the sun at her mean distance; he then combines the distance thus obtained with the value of the equatorial radius of the earth derived by Listing ("Neue geometrische und dynamische Constanten des Erdkörpers," Gottingen, 1878), and there results for the mean equatorial horizontal parallax of the sun 8″·802.

(II.) The velocity of light, the constant of aberration, the excentricity of the earth's orbit, and the earth's mean anomaly, are connected by an equation which Mr. Todd employs for a further determination of the solar parallax, adopting for the constant of aberration Struve's value (20″·445 t), with Listing's value of the earth's equatorial radius, and by this process the sun's parallax is found to be 8″·811. Duly weighing the probable variations of the elements which enter into these computations, Mr. Todd concludes that the experimental determinations of the velocity of light hitherto made, give, when combined with astronomical constants, the mean equatorial horizontal parallax of the sun = 8″·808 ± 0″·006, and hence the corresponding mean radius of the terrestrial orbit = 92,800,000 miles.

FAYE'S COMET.—Although, as lately remarked in this column, the only known comet of short period which will be actually in perihelion during the present year is that discovered by Prof. Winnecke in 1858, Faye's comet will arrive at its least distance from the sun in January, 1881, and may be observed during the last half of 1880. Thanks to the admirable investigations of Prof. Axel Möller, the theory of Faye's comet is known with such precision that the ephemeris for the approaching reappearance, which he communicated to the Swedish Academy in September, 1878, and which has been reproduced in the *Astronomische Nachrichten*, may be expected to deviate in a very slight degree only from the truth, and the comet's discovery will be simply a test of the optical capacity of the telescope. Prof. Axel Möller commences his ephemeris on July 1, 1880, and continues it to the end of the year. On July 1 the theoretical intensity of light is 0·04, about equal to that at the date of the last observation with the 15-inch refractor at Pulkowa in 1844, and the comet in about R.A. 23h. 6m., Decl. + 8°, may be then observable. The maximum intensity will be attained about the middle of October, and will be about the same as at the last observation in 1858 with the 9-inch refractor at Berlin, or 0·21; at the end of the year the intensity of light will have diminished to 0·14. Thus the comet will be always faint, nor does it appear likely to present itself under the favourable circumstances attending its first appearance in 1843 for several revolutions yet to come.

GEOGRAPHICAL NOTES

BY a postscript to the February number of the Geographical Society's periodical we learn that a telegram has been received from Mozambique, announcing the arrival of the East African Expedition at Lake Tanganyika on October 28; the distance from Lake Nyassa was found to be 250 miles, the country level, and the people friendly. Mr. Thomson's account of his journey from Dar-es-Salaam to Uhehe is given in the present number, and his notes of the route, though necessarily somewhat rough, will afford useful material for filling up a blank in the map of East Africa. We have also Mr. Wilfrid S. Blunt's description of his visit to Jebel Shammar (Nejd), and his journey through Northern Arabia, of which he gave but an outline at a recent meeting of the Society. The paper is illustrated by two maps, one of which is a sketch map of Jebel Shammar furnished by Mr. Blunt. Among the geographical notes is an interesting account of Norwegian exploration last year in the Spitzbergen seas, which appears to have hitherto escaped notice in this country. Under the head of obituary we find brief notices of Major Herbert Wood, R.E., and Mr. Hepworth Dixon, while the remainder of the number contains the usual routine matter.

ACCORDING to the *Colonies and India*, Mr. Mitchinson, who has travelled much among the natives of nearly all parts of Africa, and especially in Berguela, Ovampo-, and Damara-lands, &c., states that he saw there wild beasts which had been tamed entirely by the natives, although they are usually supposed never to attempt it. On the River Cunene he found two perfectly tame cow hippopotami, which were not confined in any way, but always returned to the village. In a neighbouring place Mr. Mitchinson also saw an African elephant which had been tamed, and was entirely under control. This certainly goes to show that the plan for utilising African elephants, to which we have before referred, is quite feasible.

AT a meeting which was held at Palmerston, in the Northern Territory, on the arrival of Mr. Alexander Forrest's expedition from West Australia, Mr. Hill, the second in command, and the geologist of the party, stated that it was painful to think how little had been done in the way of prospecting for minerals. He believed that a search in the north and west portions of the territory would well repay the trouble and that there was more mineral wealth in the neighbourhood than was imagined.

M. BRAU DE ST. POL-LIAS, the originator of the "Colons-Explorateur" scheme, has communicated to the French Geographical Society a letter which he has received from Dr. Rück, a missionary in Sumatra, in which he furnished the geographical results of a journey in the Batak country. His examination of Lake Tebah shows that there is no river flowing out at the north-east, as has been previously supposed, and that, contrary to earlier statements, there is a river flowing out of the south end of the lake, which is thought to empty into the sea on the east coast of the island, though its course does not appear to have been examined so far at present.

THE French Government have entrusted M. Th. Lécart with a "gratuitous" mission to investigate the ornithology and entomology of the region between the Senegal and the Niger, and MM. Brau de St. Pol-Lias and E. de Lacroix to collect ethnographical specimens in Sumatra.

M. SAVORGNAN DE BRAZZA, who is now on the west coast of Africa, has been entrusted by the French branch of the International African Association with the formation of their first station, which will probably be located on the upper waters of the Ogowé, where M. de Brazza has already made important geographical discoveries. Capt. Bloyet is to be the founder of the other station on the opposite side of the continent.

THE death at Ujiji is announced, of the French explorer, Abbé Debaize. The Abbé left Paris in March, 1878, with a subsidy of 10,000 francs from the French Government, to cross Africa, from Zanzibar to the west coast. He reached Lake Tanganyika in March of last year, after an unusually rapid and favourable journey. He intended to establish depôts at the north end of the lake, and at the mouth of Stanley's Aruwimi, to explore the country between the lake and the Albert Nyanza, and the region to the north of the Congo. He had started on his journey, but was so badly treated by his followers, that he returned downcast to Ujiji, where he died. The Abbé was well qualified by his scientific knowledge and his experience for the task he undertook, and his death is a real loss to the scientific exploration of Africa.

MR. STANLEY, according to information received by the Lisbon Geographical Society, had reached the last fall of the Congo at Yallala, and was preparing the installation of the first Belgian commercial station on the right bank of that river.

MESSRS. SONNENSCHEIN AND ALLEN have just published a "Primer of the Industrial Geography of Great Britain and Ireland," by Mr. G. Phillips Bevan. The Primer is likely to prove useful not only as a supplement to the ordinary school text-books, but to all who desire to have a knowledge of the geographical distribution of our multifarious industries.

THE Irkutsk mail informs us that M. Potanin returned on December 13 to that city. The results of his expedition are most important. He has thrown a quite new light on the geography and ethnography of North-western Mongolia. His assistant, M. Adrianoff, has made important geological explorations and obtained an interesting collection of ethnographical photographs. Besides, M. Orloff, who was sent to meet M. Potanin, has made several important surveys.

PERTHES, of Gotha, has issued on one large sheet an ingeniously tabulated and useful index to all the maps that have appeared in *Petermann's Mittheilungen*, from its first publication in 1855, down to the present. The index has been designed by Herr Bruno Hassenstein.

GEOLOGICAL NOTES

GEOLOGICAL SURVEY OF THE UNITED STATES.—Mr. Clarence King, the Director of the new Survey, has prepared his estimates for the appropriation of the $330,000 voted by Congress for the year ending June 30, 1880. They show generally how he proposes to distribute the work under his superintendence:—

Geological survey of iron and coal resources of public domain	$30,000
Extending observations on coal and iron into old States	20,000
Survey of agricultural geology on public lands of Mississippi Basin	25,000
Geological survey of gold and silver in Division of Rocky Mountains	35,000
Geological survey of gold and silver in Division of Great Basin	35,000
Survey of geological structure of public lands in Mississippi Basin	25,000
Survey of geological structure and classification of public lands of Rocky Mountains	30,000
Survey of geological structure and classification of public lands in Colorado Basin	40,000
Survey of geological structure and classification of public lands in Great Basin	30,000
Survey of geological structure and classification of public lands in Pacific	25,000
	$330,000

It will be observed that this allotment of the funds quite confirms the view lately expressed in our columns (NATURE, vol. xxi. p. 197) as to the "scare" which some of the geologists in the east have experienced on the subject of a proposed invasion of the old States by the forces of the new Survey. We ventured to point out that in the west Mr. King and his associates had such a vast and untouched field for their labours that they were not very likely to betake themselves to the well-beaten geological pathways of the Eastern States. Mr. King in the foregoing estimates proposes to devote only $20,000 for "extending observations on coal and iron into old States." Assuming that this item is inserted in good faith (and surely there is no reason to do otherwise), it must be regarded by impartial outsiders as reasonable and moderate. Probably the original intention was to secure power to prolong investigations from the public domain into surrounding States where this was required by the necessities of the service. No one will deny the propriety of such a provision. Even if the observations were to be extended into the Eastern States, so long as this was done merely with a view to acquiring information and experience to guide the field-operations in the Territories, it would surely still be within the province of any truly national Survey. That any serious attempt is contemplated to carry on ordinary geological surveying in the old States is simply inconceivable. So that again, in spite of their renewed protests, the geologists of the East may be urged to believe that they have the game in their own hands, and that they have no ground for alarm that the rights either of States or of private individuals will eventually suffer.

CATALOGUE OF OFFICIAL REPORTS OF AMERICAN GEOLOGICAL SURVEYS.—Mr. Frederick Prime, one of the assistant geologists in the Geological Survey of Pennsylvania, has just published, in the *Transactions* of the American Institute of Mining Engineers, a most useful catalogue of all the official reports issued up to the present time by the various geological Surveys of the States and Territories of the American Union, and of British North America. It thus forms a compendious guide to the official sources of information regarding almost all parts of North America, with the names of the authors and dates of publication.

THE PRIMEVAL CELL.—Some twelve years ago the petrographers and mineralogists of Germany were a good deal exercised in their minds by an escapade of one of their number—himself a very able mineralogist—who announced his discovery of a new microscopic fauna and flora in crystalline eruptive rocks, such as basalt and melaphyre. Of course, the presumed organic structures were repudiated by naturalists, and still remain characteristic products of the mineral kingdom. Another vagary of a similar kind has lately been perpetrated by Dr. Otto Hahn, who publishes a thin volume with a large series of plates, under the title of "Die Urzelle," in which he shows that everybody before him has unaccountably misunderstood the much discussed *Eozoon*, that it is neither a mineral nor an animal structure, but belongs to the vegetable kingdom! In the eozoonal limestones he finds numerous primæval sea-weeds, which, with paternal fondness, he takes care to have duly named. What a pity that so much time, labour, and ingenuity had not been more usefully employed!

MICROSCOPIC STRUCTURE OF SCOTTISH ROCKS.—Students of petrography may be interested to know that Mr. Bryson, of Edinburgh, has prepared for sale a series of sections of typical Scottish rocks, which have been selected for him by Prof. Geikie. They illustrate some of the most characteristic aqueous, igneous, and metamorphic rocks of Scotland. They are thirty in number.

MYTHOLOGIC PHILOSOPHY[1]

II.

RAIN.—The Shoshoni philosopher believes the domed firmament to be ice, and surely it is the very colour of ice, and he believes further that a monster serpent-god coils his huge back to the firmament, and with his scales abrades its face and causes the ice-dust to fall upon the earth. In the winter time it falls as snow, but in the summer time it melts and falls as rain, and the Shoshoni philosopher actually sees the serpent of the storm in the rainbow of many colours.

The Oraibi philosopher who lives in a pueblo is acquainted with architecture, and so his world is seven-storied. There is a world below, and five worlds above this one. Muingwa, the rain god who lives in the world immediately above, dips his great brush, made of feathers of the birds of the heavens, into the lakes of the skies, and sprinkles the earth with refreshing rain for the irrigation of the crops tilled by these curious Indians who live on the cliffs of Arizona. In winter Muingwa crushes the ice of the lakes of the heavens, and scatters it over the earth, when we have a snow-fall.

The Hindoo philosopher says that the lightning-bearded Indra breaks the vessels that hold the waters of the skies with his thunderbolts, and the rains descend to irrigate the earth.

The philosopher of civilisation expounds to us the methods by which the waters are evaporated from the land and the surface of the sea, and carried away by the winds and gathered into clouds, to be discharged again upon the earth, keeping up for ever that wonderful circulation of water from the heavens to the earth and from the earth to the heavens, that orderly succession of events in which the waters travel by river, by sea, and by cloud.

Migration of Birds.—The Algonkin philosopher explains the migration of birds by relating the myth of the combat between Ka-bi-no-ke and Shingapis, the prototype or progenitor of the water-hen, one of their animal gods. A fierce battle raged between Ka-bi-no-ke and Shingapis, but the latter could not be conquered.

All the birds were driven from the land but Shingapis, and then was it established that, whenever in the future Wintermaker should come with his cold winds, fierce snows, and frozen waters, all the birds should leave for the south except Shingapis and his friends. So the birds that spend their winters north are called by the Algonkin philosophers "the friends of Shingapis."

In contrast to this explanation of the flight of birds may be placed the explanation of the modern evolutionist, who says that the birds migrate in quest of abundance of food and a genial climate, guided by an instinct of migration which is a cumulation of inherited memories.

Diversity of Languages.—The Kaibabit philosopher accounts for the diversity of languages in this manner: Si-chom-pa Ma-so-its, the grandmother goddess of the Sea, brought up mankind from beneath the waves in a sack, which she delivered to the Shinau-av brothers, the great wolf-gods of his mythology, and told them to carry it from the shores of the sea to the Kaibab Plateau, and there to open it, but they were by no means to open the package ere their arrival, lest some great disaster should befall.

The curiosity of the younger Shinau-av overcame him, and he untied the sack and the people swarmed out, but the elder Shinau-av, the wiser god, ran back and closed the sack while yet not all the people had escaped, and they carried the sack with its remaining contents to the plateau and there opened it.

Those that remained in the sack found a beautiful land, a great plateau covered with mighty forests, through which elk, deer, and antelopes roamed in abundance, and many mountain sheep were found on the bordering crags; *pive*, the nuts of the edible pine, they found on the foot-hills, and *use*, the fruit of the *Yucca*, in sunny glades, and *nant*, the *meschal* crowns, for their feasts, and *chuar*, the cactus-apple, from which to make their wine; reeds grew about the lakes for their arrow-shafts; the rocks were full of flints for their barbs and knives, and away down in the cañon they found a pipestone quarry, and on the hills they found arrarumpive, their tobacco.

Oh! it was a beautiful land that was given to these, the favourites of the gods. The descendants of these people are the present Kaibabits of Northern Arizona. Those who escaped by the way, through the wicked curiosity of the younger Shinau-av, scattered over the country and became Navahoes, Moquis, Sioux, Comanches, Spaniards, Americans—poor, sorry fragments of people, without the original language of the gods, and only able to talk in imperfect jargons.

The Hebrew philosopher tells us that on the plains of Shinar the people of the world were gathered to build a city and erect a tower, the summit of which should reach above the waves of any flood Jehovah might send. But their tongues were confused, as a punishment for their impiety.

The philosopher of science tell us that mankind was widely scattered over the earth anterior to the development of articulate speech, that the languages of which we are cognisant sprang from innumerable centres as each little tribe developed its own language, and that in the study of any language an orderly succession of events may be discovered in its evolution from a few holophrastic locutions to a complex language, with a multiplicity of words and an elaborate grammatic structure, by the differentiation of the parts of speech and the integration of the sentence.

Mythologic Philosophy has Four Stages.—Mythologic philosophy is the subject with which we deal. Its method, as stated in general terms, is this: All phenomena of the outer objective world are interpreted by comparison with those of the inner subjective world. Whatever happens, some one does it. That some one has a will, and works as he wills. The basis of the philosophy is personality. The persons who do the things we observe in the phenomena of the universe, are the gods of mythology—*the cosmos is a pantheon.* Under this system, whatever may be the phenomena observed, the philosopher asks, "Who does it? and why?" and the answer comes, "A god with his design." The winds blow and the interrogatory is answered, "Æolus frees them from the cave to speed the ship of a friend, or destroy the vessel of a foe."

The actors in mythologic philosophy are gods. In the character of these gods four stages of philosophy may be discovered. In the lowest and earliest stage everything has life, everything is endowed with personality, will, and design; animals are endowed with all the wonderful attributes of mankind; all inanimate objects are believed to be animate; trees think and speak; stones have loves and hates; hills and mountains, springs and rivers, and all the bright stars have life. Everything discovered objectively by the senses is looked upon subjectively by the philosopher and endowed with all the attributes supposed to be inherent in himself. In this stage of philosophy everything is a god. Let us call it *hecastotheism.* In the second stage men no longer attribute life indiscriminately to inanimate things, but the same powers and attributes recognised by subjective vision in man are attributed to the animals by which he is surrounded. No line of demarcation is drawn between man and beast; all are great beings endowed with wonderful attributes. Let us call this stage *zootheism,* when men worship beasts. All the phenomena of nature are the doings of these animal gods; all the facts of nature, all the phenomena of the known universe, all the institutions of humanity known to the philosophers of this stage, are accounted for in the mythologic history of these zoomorphic gods.

In the third stage a wide gulf is placed between man and the lower animals. The animal gods are dethroned, and the powers and phenomena of nature are personified and deified. Let us call this stage *physitheism.* The gods are strictly anthropomorphic, having the form as well as the mental, moral, and social attributes of men. Thus we have a god of the sun, a god of the moon, a god of the air, a god of dawn, and a deity of the night. In the fourth stage, mental, moral, and social characteristics are personified and deified. Thus we have a god of war, a god of love, a god of revelry, a god of plenty, and like personages who preside over the institutions and occupations of mankind. Let us call this *psychotheism.* With the mental, moral, and social characteristics in these gods are associated the powers of nature, and they differ from nature gods, chiefly in that they have more distinct psychic characteristics. Psychotheism

[1] From Vice-Presidential Address of Prof. J. W. Powell, of Washington, Vice-President Section B, American Association for the Advancement of Science, Saratoga Meeting, August, 1879. Continued from p. 314.

by the processes of mental integration develops in one direction into monotheism, and in the other into pantheism. When the powers of nature are held predominant in the minds of the philosopher through whose cogitations this evolution of theism is carried on, pantheism, as the highest form of psychotheism, is the final result; but when the moral qualities are held in highest regard in the minds of the men in whom this process of evolution is carried on, *monotheism*, or a god whose essential characteristics are moral qualities, is the final product. The monotheistic god is not nature, but presides over and operates through nature.

Psychotheism has long been recognised. All of the earlier literature of mankind treats largely of these gods, for it is an interesting fact that in the history of any civilised people the evolution of psychotheism is approximately synchronous with the invention of an alphabet. In the earliest writings of the Hebrews, the Egyptians, the Hindoos, and the Greeks, this stage is discovered, and Jehovah, Osiris, Indra, and Zeus are characteristic representatives. As psychotheism and written language appear together in the evolution of culture, this stage of theism is, consciously or unconsciously, a part of the theme of all written history.

The palæontologist, in studying the rocks of the hill and the cliffs of the mountain, discovers in inanimate stones the life forms of the ancient earth. The geologist, in the study of the structure of valleys and mountains, discovers groups of facts that lead him to a knowledge of more ancient mountains and valleys and seas, of geographic features long ago buried, and followed by a new land with new mountains and valleys and new seas. The philologist, in studying the earliest writings of a people, not only discovers the thoughts purposely recorded in those writings, but is able to go back in the history of the people many generations, and discover with even greater certainty the thoughts of the more ancient people who made the words.

Thus the writings of the Greeks, the Hindoos, the Egyptians, and the Hebrews, that give an account of their psychic gods, also contain a description of an earlier theism unconsciously recorded by the writers themselves. Psycotheism prevailed when the sentences were coined, physitheism when the words were coined. So the philologist discovers physitheism in all ancient literature. But the verity of that stage of philosophy does not rest alone upon the evidence derived from the study of fossil philosophies through the science of philology. In the folk-lore of every civilised people having a psychotheic philosophy, an earlier philosophy, with nature gods, is discovered.

The different stages of philosophy which I have attempted to characterise have never been found in purity. We always observe different methods of explanation existing side by side, and the type of a philosophy is determined by the prevailing characteristics of its explanations of phenomena. Fragments of earlier are always found side by side with the greater body of the later philosophy. Man has never clothed himself in new garments of wisdom, but has for ever been patching the old, and the old and the new are blended in the same pattern, and thus we have *atavism* in philosophy. So in the study of any philosophy which has reached the psychotheic age, patches of the earlier philosophy are always seen. Ancient nature gods are found to be living and associating with the supreme psychic deities.

Thus in anthropological science there are three ways by which to go back in the history of any civilised people and learn of its barbaric physitheism. But of the verity of the stage we have further evidence. When Christianity was carried north from Central Europe, the champions of the new philosophy, and its consequent religion, discovered, among those who dwelt by the glaciers of the north, a barbaric philosophy which they have preserved to history in the Eddas and Sagas, and Norse literature is full of a philosophy in a transition state, from physitheism to psychotheism; and mark! the people discovered in this transition state were inventing an alphabet—they were carving Runes.

Then a pure physitheism was discovered in the Aztec barbarism of Mexico, and elsewhere on the globe many people were found in that stage of culture to which this philosophy properly belongs. Thus the existence of physitheism as a stage of philosophy is abundantly attested. Comparative mythologists are agreed in recognising these two stages. They might not agree to throw all of the higher and later philosophies into one group, as I have done, but all recognise the plane of demarcation between the higher and lower groups as I have drawn it. Scholars, too, have come essentially to an agreement that physitheism is earlier and older than psychotheism.

Perhaps there may be left a "doubting Thomas" who believes that the highest stage of psychotheism—that is, monotheism—was the original basis for the philosophy of the world, and that all other forms are degeneracies from that primitive and perfect state. If there be such a man left, to him what I have to say about philosophy is blasphemy.

Again, all students of comparative philosophy, or comparative mythology, or comparative religion, as you may please to approach this subject from different points of view, recognise that there is something else: that there are philosophies, or mythologies, or religions, not included in the two great groups. All that something has been vaguely called *fetishism*.

I have divided it into two parts—*hecastotheism* and *zootheism*. The verity of zootheism as a stage of philosophy rests on abundant evidence. In psychotheism it appears as *devilism* in obedience to a well-known law of comparative theology, viz., that the gods of a lower and superseded stage of culture ofttimes become the devils of a higher stage.

So in the very highest stage of psychotheism we find beast devils. In Norse mythology we have Fenris, the wolf, and Jormungander, the serpent. Dragons appear in Greek mythology, the bull is an Egyptian god, a serpent is found in Zendavesta; and was there not a scaly fellow in the Garden of Eden? So common are these beast-demons in the higher mythologies that they are used in every literature as rhetorical figures. So we find, as a figure of speech, the great red dragon with seven heads and ten horns, with tail that with one brush sweeps away a third of the stars of heaven. And wherever we find nature worship we find it accompanied with beast worship. In the study of higher philosophies, having learned that lower philosophies often exist side by side with them, we might legitimately conclude that a philosophy based upon animal gods had existed previous to the development of physitheism, and philologic research leads to the same conclusion.

But we are not left to base this conclusion upon an induction only, for in the examination of savage philosophies we actually discover zootheism in all its proportions. Many of the Indians of North America, and many of South America, and many of the tribes of Africa, are found to be zootheists. Their supreme gods are animals—tigers, bears, wolves, serpents, birds. Having discovered this, with a vast accumulation of evidence, we are enabled to carry philosophy back one stage beyond physitheism, and can confidently assert that all the philosophies of civilisation have come up through these three stages.

And yet there are fragments of philosophy discovered which are not zootheistic, physitheistic, nor psychotheistic. What are they? We find running through all three stages of higher philosophy that phenomena are sometimes explained by regarding them as the acts of persons who do not belong to any of the classes of gods found in the higher stages. We find fragments of philosophy everywhere which seem to assume that all inanimate nature is animate; that mountains and hills, and rivers and springs, that trees and grasses, that stones, and all fragments of things are endowed with life, and with will, and act for a purpose. These fragments of philosophy lead to the discovery of hecastotheism.

Philology also leads us back to that state when the animate and inanimate were confounded; for the holophrastic roots into which words are finally resolved show us that all inanimate things were represented in language as actors.

Such is the evidence on which we predicate the existence of hecastotheism as a veritable stage of philosophy. Unlike the three higher stages, it has no people extant on the face of the globe known to be in this stage of culture. The philosophies of many of the lowest tribes of mankind are yet unknown, and hecastotheism may be discovered, but, at the present time we are not warranted in saying that any tribe entertains this philosophy as its highest wisdom.

THE NATURE OF ELECTRICITY[1]

On surveying the wide sea upon which the numerous and varied practical applications of electricity are launched for the subject of this evening's address, I have been puzzled to steer a course that shall avoid the dazzling shoals of theory on the one hand, and the dry hard rocks of practice on the other.

[1] Abstract of the Inaugural address to the Society of Telegraph Engineers, by Mr. William Henry Preece (President), delivered January 28, 1880. Revised by the Author.

Hypothesis is a veritable Scylla that captivates the imagination and often sends the visionary to destruction, while practice alone is a hard-hearted Charybdis that lures the matter-of-fact practical man to folly and expense. Practice must be tempered with theory to utilize advantageously the great forces of nature, and theory itself must be based on practice, or on facts, to be comprehensive and acceptable. Hence success is the offspring of the marriage of practice and theory, and, therefore, as the two are so intimately connected, I have determined to steer a middle course to-night to survey the progress of each in our profession, and to show their mutual relationship.

What is theory? It is an explanation of the hidden cause of certain effects that are evident to the senses. It is an effort of the imagination to account for operations that are in themselves invisible and insensible, but which result in facts that are observable and known. Thus the movements of all those bright bodies by which

> "the floor of heaven
> Is thick inlaid with patines of bright gold,"

are explained by the theory of gravity. Their appearance, vagaries, and beauties are accounted for by the undulatory theory of light. The warmth that the monarch of them all shed upon this earth countless ages ago, and that is now restored to us in our household fires, is explicable on the molecular theory of heat. The constitution of matter and its various states of solid, liquid, and gas, are completely explained by the atomic theory of Democritus and Dalton, and the modern kinetic theory of gases.

It is impossible for a practical man who has devoted more than a quarter of a century to the application of electricity to useful purposes, to avoid devoting much contemplation to the nature of the agent which he has to make use of. Is there a member of this society who has not striven to peer into the region of the unknown, who has not speculated on the power he uses, or who has not formed some conception in his mind of the nature of electricity? Yet it is remarkable that the answer to the question, What is electricity? cannot even now be given with authority. Faraday, our great apostle, whose researches should be every electrician's bible, declined to venture an answer, nor did he ever directly formulate his ideas on the subject, though his publications indicate pretty clearly and with no uncertain sound what they were. Clerk-Maxwell, who, while he overthrew all existing theories, failed to supply their place before he was so untimely removed from us. Sir William Thomson, in his published papers, always carefully eschews the consideration of any physical theory of electricity. The French electricians simply use the one-fluid theory as a convenience of language, while the Germans, as a rule, employ the two-fluid theory merely for mathematical purposes. Hence there is no recognised theory of electricity. Some maintain with Du Fay or with Franklin, that it is a form of matter—a substance; others, following Faraday and Grove, consider it a form of force—a motion—like heat and light. It must be either one or the other. There is no other category in which to class it. If it is not a form of matter it must be a form of force. The question I propose to discuss is, therefore, Is electricity a form of matter, or is it a form of force?

In discussing such a vexed question it is necessary to be very precise in language to avoid any misconception of my meaning, therefore I will define both matter and force in the sense in which I use those terms. *Matter* is that which can be perceived by the senses, or can be acted upon by force. It is characterised by weight, inertia, and elasticity. *Force* is that which produces, or tends to produce, the motion of matter. It may be pressure, tension, attraction, repulsion, or anything capable of causing alteration in the natural state of rest or of existing motion of matter.

Matter is found in either the solid, liquid, gaseous, or ultra-gaseous state, and it occupies space. It consists of molecules and atoms. The *atom* is the smallest indivisible part of an element, and a group of atoms of the same or of different elements forms the *molecule*, which has a definite magnitude and is unalterable in form for each substance. The *mass* of a substance is the aggregate of the molecules of which it is composed. There is no generation or destruction of atoms. The indestructibility of matter is a fixed law in nature. The size of the molecule is approximately known. Sir William Thomson says:—"If we conceive a sphere of water as large as a pea to be magnified to the size of the earth, each molecule being magnified to the same extent, the magnified structure would be coarser-grained than a heap of small lead shot, but less coarse-grained than a heap of cricket balls." Fifty million molecules ranged in single file would occupy an inch. They are highly elastic, and unless interfered with would move with constant velocity in straight lines. When they can move about freely without interfering with each other's proceedings, we have the ultra-gaseous state of Crookes, a state found only in very high vacua and under certain adventitious circumstances. When they collide and impinge on each other according to the law of the impact of elastic bodies, interfering with each other's path, we have *gases* as we know them; when their mean free path is so reduced as to bring them within the sphere of mutual attraction, without too narrowly restricting their play, we have *liquids;* when the attraction becomes cohesion and the motion of the molecule is confined to its own sphere, we have *solids*. The number of molecules in a given volume of gas is known, and their velocity calculated. In hydrogen the velocity at 0° Cent. is 6,097 feet per second, the number being 10^{23} per cubic inch. The mean free path of a molecule in air at ordinary pressures is the ten-thousandth part of a millimetre. Besides their constant motion in straight lines the molecules may be set in vibration, rotation, or any other kind of relative motion whatever.

This is the atomic theory of matter born in the brain of Democritus, "the laughing philosopher," 2,300 years ago; preached by Epicurus in Athens, and taught by Lucretius in Rome before the Christian era; lying dormant for eighteen centuries, until it was formulated by Dalton in the last century, and removed from the region of pure speculation by Joule, Clausius, Clerk-Maxwell, and Crookes during our days.

The definition of force shows us that whatever changes or tends to change the motion of matter (or of the molecules of which it is composed), by altering either its direction or its magnitude, is a form of force. Thus gravity is a form of force, for it attracts all matter to the centre of the earth, and it is measured by the rate per second at which a body acquires a velocity in this direction when falling freely at a given spot. Heat is a form of force, for it throws the molecules of matter into violent vibration, or it increases the velocity of their motion in straight lines, which thus becomes the measure of its heat or its *temperature*. Light is a form of force, for it is produced by the undulation of the molecules of matter, and it is transmitted by the undulations of that medium called Ether, which fills all space.

When we take a given free mass and impress upon it a given force, we throw that mass into motion; for instance, when we fire a loaded cannon, we have imparted to the ball "*energy*," and in virtue of the motion of the ball, this energy is called "*kinetic*." Again, if we lift the ball to a certain height above the earth's surface—say to the top of a tower—and let it remain there, we have again imparted to it "energy," but this time it is called "*potential*," for it is dormant or resting. In each case the energy possessed by the ball is the exact equivalent of the work done upon it, that is, of the force impressed and the distance through which it has acted. The motion of the ball is readily transferred to the motion of the individual molecules of the ball. When, in the first case adduced, the ball strikes the side of a ship or a target, its kinetic energy is thus converted into light and heat, which is molecular motion; or, in the second case, when it is allowed to fall, its potential energy is converted into kinetic energy, which again, on coming in contact with the ground, is converted into molecular motion or heat. Energy is always either potential or kinetic, and one of the most remarkable generalisations of modern days is the grand principle of the conservation of energy, which implies that the total energy of the universe is a quantity which can neither be increased nor diminished, though it may be transformed into any of the forms of which energy is susceptible. Energy is therefore as indestructible as matter. All the recent advances in the science of heat have been due to the discovery of this principle, and its application to electricity has gone far to remove that science from the hypothetical state in which it has existed so long.

My purpose is to contend that electricity is not a form of matter but a form of force, and that all its effects are evident to us in one or other of the several forms of energy characterised by the motions of molecules or of mass.

It is interesting to trace the historical growth of theories. The uncultivated human intellect cannot soar above its own limited sphere of childish observation. Whatever is mysterious and incomprehensible in nature is attributed to that which is equally mysterious and incomprehensible. Life has ever been of this character, and heat, magnetism, electricity, and many other unaccountable physical phenomena, have each in their turn been supposed to be causes of life. Even now there are those who would attribute exceptional and peculiar phenomena to spiritual agencies.

Heat was thought by the Greeks to be an animal that bit. It was then for many centuries thought to be a fluid which, entering into bodies, like mercury, made them swell, and this idea existed until this generation, when Rumford showed it to be a kind of motion, and Joule made it a quantitative form of energy.

Thales of Miletus thought that the magnet was endowed with a sort of immaterial spirit, and to possess a species of animation. The Greeks knew also that rubbed amber attracted bits of straw, and supposed it to be endowed with life. Even Boyle, as late as 1675, imagined it to emit a sort of glutinous effluvium which laid hold of small bodies and pulled them towards the excited body. Du Fay in 1733 conceived the double fluid theory, and Franklin in 1747 invented the single fluid theory. Cavendish in 1771 supplied some of the deficiencies of Franklin's theory, but it was Faraday who first exploded the fluid notion and originated the molecular theory of electricity, while Grove boldly classed electricity with light and heat as correlated forces and mere modes of motion.

Light was thought by the Platonists to be the consequence of something emitted from the eye meeting with certain emanations from the surface of things, but no theory of light properly so-called was attempted until Newton produced his celebrated corpuscular theory in 1670, which has lasted until the present day. Even as late as 1816 Faraday himself said—"The conclusion that is now generally received appears to be, that light consists of minute atoms of matter of an octahedral form, possessing polarity, and varying in size or in velocity."[1] Although Huyghens in Newton's own time conceived the undulatory theory, the superior authority of the great English philosopher overshadowed the lesser light, and it was not until Young and Fresnel at the commencement of this century took the matter up, that the present theory of light took firm root.

Thus we see that all these sciences have passed through the same stages of mystery and fancy, and it is only within the present generation that they have emerged from the mythical to the natural, from mere hypothesis to true theory. *Hypothesis* is an imaginary explanation of the cause of certain phenomena which remains to be shown probable or to be proved true. *Theory* is this supposition when it has been shown to be highly probable and all known facts are in agreement with its truth.

A theory, therefore, to be valid and true, must agree with every observed fact; it must not conflict with natural laws; it must suggest new experience, and it should lead to further developments. A theory is absurd if it supposes an agent to act in a manner unknown in all other cases. The fluid theories of electricity are merely descriptive, they do not agree with every observed fact; they have never prompted the invention of a single new experiment, or led to any development. They suppose an agent unknown in other cases and opposed to natural laws. Incomplete theories die a natural death: thus Descartes' vortices, Newton's corpuscular theory of light, the fluid theory of heat, Stahl's phlogiston, Nature abhorring a vacuum, have all disappeared, while complete theories, such as that of gravity, the laws of motion, the conservation of energy, the undulatory theory of light, not only remain, but suggest new fields of inquiry, open out fresh pastures, carry truth and conviction with them, and have led to the most wonderful predictions. The fluid theories of electricity are certainly incomplete, and they deserve a speedy interment. We have to assume the existence of two substances of opposite qualities which mutually annihilate each other on combination—a self-evident absurdity, for the conception of matter involves indestructibility. Franklin imagined his one fluid to be an element of glass; remove electricity, and glass would lose its virtues and properties, and thus glass was to give out its electricity for ever and a day, without loss of weight or sensible diminution. It was to be devoid of dimensions, inertia, weight, and elasticity, and is therefore outside the pale of our definition.

Electricity is therefore not a form of matter. Hence, according to our reasoning, it must be a form of force.

But can we not prove that it is a form of force? Certainly.

Let us first argue from analogy. We know that sound, heat, and light are modes of motion; in what respects does electricity agree with these forms of force?

[1] "Life," vol. i. p. 216.

The fundamental law of electrostatics is that two bodies charged with opposite electricities attract each other with a force dependent on the square of the distance separating them. Whatever influence or power spreads from a point and expands uniformly through space varies in intensity as the square of the distance for the area over which it is spread increases as the square of the radius. This is the case with gravity, light, sound, and heat, which are known forms of force. It is also the case with electricity and magnetism, which ought therefore to be similar forms of force.

If we regard the velocity of transmission of certain electrical disturbances through space, we have every reason to believe that it is the same as that of radiant heat and light. In 1859 two observers in different parts of the country (Messrs. Carrington and Hodgson) saw simultaneously a bright spot break out on the face of the sun, whose duration was only five minutes. Exactly at this time the magnetic needles at Kew were jerked, and the telegraph wires all over the world were disturbed. Telegraphists were shocked, and an apparatus in Norway was set on fire. Auroras followed, and all the effects of powerful magnetic storms. Moreover, the periods of sun-spots, earth currents, and magnetic storms follow the same cycle of about eleven years. Dr. Hopkinson has shown that this electric disturbance through space is as mechanical as its action through short distances, and is therefore identical with the ordinary strains of elastic matter subject to distortion by mechanical force. But Clerk-Maxwell has gone beyond this, and has shown that the velocity of light is identical with that of the propagation of electrical disturbances through space as well as through air and other transparent media. Hence, as light is admitted to be a mode of motion identical with radiant heat, electricity must be of the same category.

There is such a remarkable analogy between the conductivity of the different metals for heat and for electricity—indeed, there is every reason to believe that if the metals were pure, the order and ratio of conductivity would be identical—that it is impossible to resist the conclusion that the mode of transmission in each case is the same. Mr. Chandler Roberts, who, using Prof. Hughes' beautiful induction-balance, showed, by experiments on a comprehensive series of alloys, that the curves indicating the induction-balance effect closely resemble their curves of electrical resistance. He was also able to demonstrate that the induction-balance curve of the copper-tin alloys is almost identical with the curve of the conductivity of heat:—a conclusion of much interest; and he pointed out that we might look with confidence to being able to ascertain, by the aid of the induction-balance, whether the relation between the conductivity of heat and electricity is really as simple as it has hitherto been supposed to be. Moreover, when a wire conveys a current of electricity it is warmed, as the strength of current is increased it is heated and eventually rendered incandescent. The ultimate form which every electric current takes is heat. The wire of every telegraph is warmed in proportion to the currents it transmits. Joule showed that when this heat is produced by a current generated in a battery by chemical force, its amount is exactly equivalent to that which would have been evolved by the direct combination of the atoms. The conducting power of all bodies is affected by heat, and some even, like selenium, by light. Hence, as we know that in the case of heat and light conduction is molecular vibration, we reasonably conclude that it is the same with electricity. In fact, it is impossible to account for these phenomena except on the assumption of the motion of the molecules.

The magnificent researches of Dr. Warren de la Rue and Dr. Hugo Müller on the electric discharge with the 11,000 cells of chloride of silvery battery that the former philosopher has provided himself with in his celebrated laboratory, have shown indisputably that the discharge in air or in gases under various pressures is a function of the molecules filling the space through which the discharge occurs. In fact, the resistance of the discharge between parallel flat surfaces is as the number of molecules intervening between them; and they show that during electrical discharge in a gas there is a sudden and considerable pressure produced by a projection of the molecules against the sides of the containing vessel distinct from that caused by heat, and unquestionably due to the molecular action of electrification. The long-continued and patient researches which these eminent physicists are carrying out prove beyond doubt that electrical discharge is simply molecular disturbance. In reality, the fact that no discharge occurs through a perfect vacuum is a crucial proof of the molecnlar theory.

Some recent very remarkable researches of M. Planté with his rheostatic machine[1] have shown that fine wires conveying powerful currents are wrinkled up into well-defined regular nodes, that these effects are accompanied by a peculiar crackling, and that the wire itself becomes brittle, giving clear indication of the vibratory motion of the molecules. He gives as the result of his inquiry that electrical transmission is the result of a series of very rapid vibration of the more or less elastic matter which it traverses, and he points out certain analogies between electric motion and sonorous vibrations. This view is supported by the researches of Professors Ayrton and Perry[2] on the viscosity of dielectrics.

Prof. Challis, of Cambridge, has extended this view so far as to embrace magnetism, electricity, light, heat, and gravity in one category of physical force, and to assert that they all result from motions and pressures of a uniform elastic fluid medium pervading all space not occupied by atoms. His views, however, have not received much attention, for they are not based on the foundation of any new facts, and they are utterly subversive of many cherished principles deeply rooted in the scientific mind. It is to be observed, however, that he regards electricity as a form of force.

Mr. Crookes, in his recent beautiful experimental researches into molecular physics in high vacua, has still more conclusively proved the connection that exists between electrical action and molecular motion. In fact, his experiments are so brilliant, his expositions so lucid, that one can fancy one sees with the eye of the body that peculiar play of the molecules which can be evident only to the eye of the mind. Not only has Mr. Crookes established as a physical fact the kinetic theory of gases and the molecular constitution of matter, but he has indicated the existence of a fourth state of matter where the molecules fly about without mutual let or hindrance. He has also led us to doubt the truth of the generally received opinion that an electric current flows from the positive to the negative electrode. It would appear from his investigations that the reverse is the case. Be that as it may, he has added one story to the structure of the molecular theory of electricity.

The criterion of a good theory is, however, its power of prediction. A false theory has never led to prevision. Neither the corpuscular theory of light, nor the fluid theories of heat and electricity, ever led to the prediction of something of which eyes had not seen nor ears heard. The triumphs of prediction in astronomy, sound, light, and heat are innumerable. Faraday predicted the effect of induction in lowering the velocity of currents of electricity and the action of magnetism on a ray of light. Sir William Thomson predicted that a current in passing from a hot to a cold part of a copper bar would heat the point of contact, while in an iron bar it cools it. Peltier predicted the cooling effect of currents on the junctions of thermoelectric pairs.

But the true identity of these physical effects is conclusively shown by their quantitative character and by their adhesion to the law of the conservation of energy. Take the case of the electric light: the consumption of coal in a furnace generates steam, the steam works an engine, the engine rotates a coil of wire in a magnetic field, the motion of the coil in this field induces currents of electricity in the wire, these currents of electricity produce an arc, and thereby heat and light. The energy of the coal is transformed into heat and light through the intermediate agency of electricity. Is it possible to conceive that this intermediate agency is anything but a form of energy? Take the case of the Bell telephone: the energy of the voice produces the energy of sonorous vibration in the air, the vibrations of the air cause the vibrations of the iron disk, the vibrations of the disk vary the magnetism of the magnetic field, this produces currents of electricity in a small coil in this field which vary the magnetism of the distant magnet, which in its turn throws its disk armature into vibration, and thereby repeats at the distant station the sonorous vibrations of the air, and thus reproduces the energy of the voice. A tuning fork comes to rest sooner in front of a telephone than when it is allowed to vibrate freely in air. Here we have the energy of the fork passing through the several stages indicated above, and ultimately coming out in its original form. The energy of sonorous vibrations at the distant station is that lost by the vibrating tuning fork.

Is it possible to assume that in this cycle of changes energy has been transformed into matter and matter again formed into energy? It is impossible and absurd. Clerk-Maxwell said—

[1] *Comptes Rendus*, lxxxix., pp. 76–80, 1879.
[2] *Proc.* Roy. Soc. pp. 7–8, 1878.

"When the appearance of one thing is strictly connected with the disappearance of another, so that the amount which exists of the one thing depends on and can be calculated from the amount of the other which has disappeared, we conclude that the one has been formed at the expense of the other, and that they are both forms of the same thing."

Would it be possible to light the streets of New York by the energy of the falling water at Niagara, as has been suggested by our Past President, Dr. Siemens, if the cycle of changes from the one spot to the other were not all different forms of this same energy? Would it be possible to plough a field a mile away from the source of motive power of the transmitting medium if the electric currents were not forms of the same power? Electricity in its effects is and must be a form of energy.

The final stage into which any physical theory grows is that in which every action can be expressed in mathematical language, where every phenomenon is calculated upon an absolute physical basis, and where we can foretell exactly what will occur under any possible emergency. This is the present condition of the science of electricity. We can calculate exactly how much steam power is required to generate a given current to produce a given light. We can tell precisely what dimensions of cable are necessary to give a certain number of words per minute on the other side of the globe. If a fault develop itself in a long cable through the gastronomic propensities of a thoughtless young teredo, we can calculate to within a few fathoms the locality of his edacious depredation.

Clerk-Maxwell,[1] in his classical work on electricity, has used a somewhat curious argument to show that electricity is not, like heat, a form of energy. He says that energy is produced by the multiplication of "electricity" and "potential," and that it is impossible that electricity and energy should be quantities of the same category, for electricity is only one of the factors of energy, the other factor being "potential." But this does not militate in any way against the force of the argument, for in nature we can no more do so than we can separate heat and temperature. Energy usually appears as the product of two factors, and it is the equivalent of the work done. Thus, *Potential energy* is the product of mass and gravitation acting through a distance. *Kinetic energy* is the product of mass and the half-square of velocity. The energy of fluids is the product of volume and pressure. The energy of heat is made up of heat and temperature, and the energy of electricity is the product of electricity and potential. Hence it is that electricity, *per se*, may be said to be a form of force, while all its effects as known to us are forms of energy. Force alone cannot produce energy; it must be force and something else. Force is the power of producing energy, and it must have something on which to produce it. Hence matter is always present; and thus, though heat, light, and electricity are forms of motion, they are in reality properties of matter from which they are inseparable. They are evident to us through the play of the molecules of matter, and thus are properly called molecular forces.

Earth currents have been a favorite subject of inquiry of mine for many years. I have always entertained the idea that they are directly due to the action of the sun. Some disturbance in the sun causes, by induction, a variation in the distribution of the lines of potential on the earth's surface, and produces the conditions required for these currents. I have many facts to support this hypothesis, but I want more to confirm it. Profs. Ayrton and Perry have developed a theory of terrestrial magnetism based on the assumption that the earth is a highly electrified sphere, which not only coincides well with facts, but which tends greatly to support my views. I want observers to record the times of daily maxima and minima. I want them especially to note during those periods of unusual disturbance the direction of the circuits which are *not* affected, for they would give the direction of the lines of equi-potential. This not only offers a useful field of observation, but its failure or success will illustrate the modern method of scientific research, when the brain suggests to the hand and the eye what they have to do, and what they have to look for.

Mr. Preece then went on to speak of the educational work of the Society and to notice some of the recent practical applications of electricity, and in speaking of the telephone stated that litigation has commenced between the Post-Office and the telephone companies not to restrict or in any way to interfere with the use of the telephone, but to prevent the establishment of a

[1] Vol. i., p. 30.

particular branch of post-office telegraph business with its licence or consent.

Mr. Preece in conclusion congratulated the Society on its great success.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Cambridge mathematical tripos this year contains 102 names. There are 33 classed as wranglers, 33 as senior optimes, 33 as junior optimes, and 3 ægrotant. In 1879 the list contained 91 names: 28 wranglers, 33 senior optimes, 29 junior optimes, and 1 ægrotat. The senior wrangler, Mr. Joseph Larmor, of St. John's, is a native of Belfast, and was born in 1857. He was educated at the Royal Academical Institution and Queen's College, Belfast. In 1874 he graduated at the Queen's University, Belfast, obtaining a double first in mathematical and experimental sciences, with two gold medals and exhibitions. He obtained similar distinction when he became M.A. In 1876 he entered the University of London, where he obtained an exhibition for mathematics, subsequently being awarded the Arnott exhibition and medal in experimental physics. At the first B.A. examination in 1878 he obtained the University scholarship in mathematics. He subsequently proceeded to the degree of B.Sc. In 1876 he obtained an open scholarship at St. John's, and has been on several occasions a prizeman at the college examinations. The next in order are Mr. Joseph John Thomson, of Trinity College; Mr. Walter Burt Allcock, a scholar of Emmanuel; and Mr. Homersham Cox, of Trinity. It is remarkable that the senior wranglers of two successive years have been from Queen's College, Belfast.

Among the wranglers this year, if the list had been complete, Miss Scott of Girton College would have been bracketed eighth wrangler. Moreover, she is younger than many of the wranglers, being still under twenty-two. Possibly she may go in for the Smith's Prize examination, although in the present state of regulations it would be impossible to award it to a lady. Nevertheless this achievement must be one more blow to those who would persistently keep ladies from having Cambridge degrees. Miss Scott intends to proceed to a degree at London University in physics. The fourth place in the first class of the recent moral sciences tripos was secured by Miss Martin of Newnham; and it is said that the only names in the first class in the historical tripos were those of two lady students, also of Newnham. No men were placed in the first class in this tripos.

Prof. Stuart reopens his workshop at Cambridge this term, and there will be practical instruction in the use of tools in iron and wood which will be provided, and also more advanced classes for those who have already acquired a knowledge of the use of tools. Classes will be formed in mechanism, engineering, drawing, applied mechanics, theory of structures and the application of higher mathematics to engineering. The professor means to found a first-class school for civil and mechanical engineering, and evidently intends to leave no stone unturned to accomplish this object, as well as to teach candidates for the University examinations.

Mr. Garnett will lecture on heat in the Cavendish Laboratory on Mondays, Wednesdays, and Fridays, this term.

OXFORD.—In a congregation held on the afternoon of February 3, Mr. Vernon Harcourt's amendment to the form of statute, respecting degrees in Natural Science came on for discussion. It will be remembered that the preamble of the statute alone remains, enacting that it is expedient for the University to grant degrees in Natural Science. When it appeared by counsel's opinion that the new degree in Natural Science would not confer on the graduate the privileges of a member of convocation, all the clauses of the proposed statute were rejected after a close division last term. Mr. Harcourt's proposal was to insert a clause in the statute to the effect that "every person who shall have been admitted to the degree of Natural Science shall also be admitted to the degree of Master of Arts." This proposal was defeated by a large majority, 27 voting for it, and 110 against it.

The examiners for the Burdett-Coutts geological scholarship have given notice that the examination will commence on Monday, February 16, at 10 a.m. The scholarship is tenable for two years, and is open to all members of the University who have passed all the necessary examinations for the B.A. degree, and shall not have exceeded their twenty-seventh term. The examiners are Prof. Prestwich, Dr. Odling, and Mr. Hatchett Jackson.

There will be an election to at least one junior studentship in natural science at Christ Church, on February 21. Candidates must not have exceeded the age of twenty on January 1, 1880. Papers will be set in chemistry, biology, and physics, but no candidate will be allowed to offer himself in more than two of these subjects. The examination begins on February 11.

The composition of the governing body of the French University has been the occasion of protracted and violent debates in the French Senate. It was only by a few votes that M. Ferry obtained its secularisation and expelled all ministers of every denomination.

The Geneva University numbers now 525 students and assistants, 134 more than last year, of whom 106 are in the faculty of science, 208 in that of literature, 35 in philosophy, 15 in theology, 54 in law, and 107 in medicine; 125 are Swiss, strangers to Geneva, and 200 foreigners.

We learn from a paper just published in the *Journal* of the Russian Ministry of Public Instruction that the number of scholars in all Russian colleges (gymnasia) reached 53,072 in 1878. But the figures as to the number of scholars who have terminated their studies in colleges are very unsatisfactory. Out of 57,917 scholars who entered the colleges during six years (1872 to 1877), only 6,511, *i.e.*, 2·5 per cent. terminated their studies, 51,406 having left the colleges without having received attestations of maturity. In "Real" schools, where the whole education is based on the study of natural science instead of that of language, the percentage is far more satisfactory.

SCIENTIFIC SERIALS

Zeitschrift für wissenschaftliche Zoologie, 33 Bd. 3 Heft, December, 1879, contains:—Conrad Keller, studies on the organisation and development of *Chalinula fertilis*, pl. 18 to 20.—Dr. G. Haller, contributions towards a knowledge of the *Læmodipodes filiformes*; commencing with a very careful and detailed account of the anatomical details to be met with in that group, it proceeds to an account of the life-history of the species, with a paragraph on their mimicry, under the heading "Darwinia": among the epizootic animals described is a very curious new species of Podophrya, with a long tapering and transversely striated stalk, and possessing a nucleus, with nucleolus, and to this follows the systematic portion, in which several new species of Proto, Caprella, and Podalirius are described and figured, pl. 21 to 23.—Olga Metschnikoff, on the morphology of the pelvic and shoulder girdles in cartilaginous fishes, pl. 25 and 26.—A. Gruber, on new infusoria, describes a number of new genera of fresh water infusoria.—Prof. Selenka, on a siliceous sponge with an octoradiate structure, and on the development of sponge-offsets, pl. 27 and 28.

Nyt Magazin for Naturvidenskaberne, 25de Binds, 2det Hefte, 1879.—D. C. Danielssen and J. Koren, the echinoderms of the Norwegian North Sea Expedition. Several very remarkable new genera and species belonging to the Holothuriadæ are described and excellently figured in this part.—Leonard Stejneger, contributions towards the Western ornithological fauna.

Journal de Physique, January.—On the thermal laws of the electric spark in gases, by Prof. Villari.—Projection of images formed between two plane mirrors, by Prof. Bibart.—On the compressibility of air and carbonic acid at 100°, according to M. Regnault's experiments, by M. Bouty.—Chloride of lime battery, by M. Niaudet.—Photometric researches on coloured flames, by M. Gouy.—New producer of electricity based on capillarity, by M. Debrun.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xii., fasc. xx.—On the structure of the peripheric and central medullated nerve fibres, by Prof. Golgi.—On the temperature and humidity of the air, and the formation of dew in the neighbourhood of great lakes, by Prof. Cantoni.—On the conditions of most suitable form and exposure of evaporimeters, by the same.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 15.—"Results of an Inquiry into the Periodicity of Rainfall." By G. M. Whipple.

The author has collected the following series of rainfall observations, all of which contain more than fifty years' records.

Station.	Periods.	No. of years.	Authority.
Paris	1639—96, 1699—1754, 1773—97, 1804—75..	161	Annuaire de l'Observatoire de Montsouris, 1879.
Padua...	1725 to 1878	154	MSS. from P. Denza.
England (Symons' table)	1726 to 1865	140	B.A. Report, 1866.
Milan	1764 to 1878	115	MSS. from P. Denza.
London	1813 to 1878	66	Dines and Symons.
Madras	1813 to 1877	65	NATURE, vol. xviii. p. 565.
Philadelphia ...	1810 to 1867	58	Smithsonian Tables, p. 97.
Edinburgh	1822 to 1878	57	NATURE, vol. xviii. p. 97.
New Bedford ...	1814 to 1867	54	Smithsonian Tables, p. 90.
Rome	1825 to 1878	54	MSS. from P. Denza.

To these he added an eleventh, forming a series by combining together the annual rainfall for 1822 to 1875 at London, Paris, and Edinburgh, which increased the total number of years of observations to 978.

These he has discussed after a method described at length in the paper, and determined for every series the curves which represent the variation in the means of the amount of annual rainfall for each of the years comprising the series on the assumption of the presence of a cycle, which he varies in duration from five to thirteen years.

The computed curves are then compared with the actual curves representing the observations, and the number of coincidences and non-coincidences in the epoch of maximum and minimum determined.

The results show that in no one case is there any indication of a period of any integral number of years from five to thirteen inclusive running through them.

It also became evident that for the same epoch the curves of variation differ widely for localities comparatively close together. For example, taking the eleven-year cycle for Padua and Milan, stations only about 130 miles apart, both well situated for observing rain, and no mountain range intervening, the variation curves are as follows:—

Year...	1800 $+11n$	1801 $+11n$	1802 $+11n$	1803 $+11n$	1804 $+11n$	1805 $+11n$	1806 $+11n$	1807 $+11n$	1808 $+11n$	1809 $+11n$	1810 $+11n$
Padua.	−1·3	−0·3	−1·7	+1·1	+4·2	+4·2	−4·9	+3·4	−2·8	−2·8	+1·7
Milan.	−5·0	+1·5	+0·2	−1·9	−2·5	0·0	+3·0	+4·7	−5·6	+2·6	+3·3

These show that the years of greatest rainfall at Padua are represented by the formula [1804 or $5 + 11n$], and of least by [$1806 + 11n$], whilst for Milan the maximum occurs at [$1807 + 11n$], and the minimum at [$1808 + 11n$].

Numerous other instances of incongruity are found in every one of the cycles, leading forcibly to the conclusion that either no short term of exactly five, six, seven, eight, nine, ten, eleven, twelve, or thirteen years exists in the annual amount of rainfall at any of the stations whose observations have been discussed in the paper, or that the effect of abnormal falls is so great that it cannot be eliminated by upwards of a hundred years' observations.

In any case the author thinks it may now be stated with certainty that all predictions as to rainy or dry years, based upon existing materials, must in future be considered as utterly valueless.

Zoological Society, January 20.—Prof. Flower, F.R.S., president, in the chair.—Mr. H. N. Moseley exhibited and made remarks on some microscopic preparations of corals made by a new method invented by Dr. G. V. Koch.—Prof. Flower, F.R.S., read a letter addressed to him by Col. Heysham, of the Madras Commissariat Staff, giving particulars of two cases of female elephants, in India, having produced young in captivity.—Dr. A. Günther, F.R.S., exhibited and made remarks on a drawing of a West Indian fish (*Holacanthus tricolor*) obtained on the coast of the Island of Lewis, and believed to have been found for the first time in the British Seas.—Mr. P. L. Sclater read some remarks on the species of the genus *Tyrannus*, in relation to a paper on this subject recently published by Mr. Ridgway, in America.—A communication was read from Mr. Roland Trimen, containing an account of a new species of Roller (*Coracias*), from the Zambesi, which he proposed to name *C. spatulata*, from its long spatulated tail.—A communication was read from Mr. Alexander Agassiz, of Cambridge, Mass., containing notes on some points in the history of the synonomy of Echini, in reference to some papers recently published by Mr. Bell in the Society's *Proceedings*.—A paper was read by Mr. F. Moore on the genera and species of the lepidopterous sub-family *Ophiderinæ*, inhabiting the Indian region.

Physical Society, January 24.—Prof. W. G. Adams in the chair.—New member, Mr. W. Ellis.—Mr. Grant read a paper and exhibited experiments on induction and telephonic circuits. He was led to these experiments by a former observation that when an induction coil primary was placed in a circuit consisting of a telephone, microphone, and battery, the microphonic sounds heard in the telephone were increased on closing the secondary circuit of the coil. Employing a double round coil, that is having primary and secondary side by side, he found that the latter could act as a condenser, and "relay" or translate messages into a second circuit, the microphone and battery being in the circuit of one wire (*i.e.*, the primary), the other wire (or secondary) containing a telephone. He also inserted a double normal coil in the latter or secondary circuit, and caused the induced or translated current to flow through both of the wires of this double coil one after another in the same direction. The effect was weak; but on reversing the current in one-half of the double coil by means of a commutator, so as to make it double on itself as it were, the weakening effect of induction was neutralised, and the sounds heard were as loud as if no coil had been inserted in the secondary circuit at all, as was proved by short circuiting the double coil altogether.—Dr. O. J. Lodge read a paper on intermittent currents and the theory of the induction balance. The telephone, as a scientific instrument, seems destined to play an important part as a detector of minute currents of rapidly changing intensity, and the general theory of intermittent currents is being brought into prominence by its use. The equations to which most attention has been hitherto directed have been those relating to the steady flow of a current after the initial inductive or inertia-like effects have subsided. The galvanometer is essentially an instrument for measuring steady currents or for giving the algebraically integrated expression for the total quantity of electricity which has passed in the case of transient currents. But the telephone plate has a very small period of swing compared to a needle, and, moreover, the plate is not limited to one mode of vibration like the needle. The induction balance was used experimentally by Dove and Felici, but was not appreciated as an instrument of research till Prof. Hughes applied it to the telephone and an intermittent current. The general theory of the establishment of a current in circuits of known resistance was given by Thomson, and is to be found in Maxwell's "Electricity." Dr. Lodge used this theory in order to work out the theory of the induction balance and one or two other cases of intermittent currents as completely as possible without taking into account the electrostatic capacity of wires and leakage. The current in either primary of the balance is the same, and the current in either secondary is the same at every instant of time. In fact, the separating of the two halves of the circuits is immaterial to the theory. The current induced in the secondary circuit is a tertiary current induced from the piece of conducting matter inserted between the primary and secondary, an expression being got for the strength of current in the telephone at any instant after a change in the resistance of the primary has occurred. The author deduces among other things the law according to which a small coin, by its position and size, disturbs the balance. Dr. Lodge remarked that Prof. Hughes, either by inventive intuition or great pains, had hit upon the best form of the apparatus for his purpose. The paper, which is very complete, is to be published in the *Philosophical Magazine* for February.—Herr Faber then exhibited his new speaking machine which is designed to imitate mechanically the utterances of the human voice by means of artificial organs of articulation, made on the human model, and actuated by an operator who depresses certain keys as in playing a musical instrument. These organs are a bellows made of wood and india-rubber, which answers to the lungs; a small windmill brought in front of the latter to give the "r," or trilling sounds, a larynx of hippopotamus hide and india-rubber having a vibrating end, to give the "drone" or basic tone of the voice, a mouth with two lips, a tongue, and a nose or proboscis made of india-rubber tubing, placed below the mouth, but curving up towards it. Fourteen distinct vocal sounds can be uttered by the instrument, but in combining these, any word in any language can be played by the keys. Thus Herr Faber caused his machine to say such words as "Mariana," "Eliza," "Philadelphia," "Constantinople," and various sentences in French, English, and German, more or less distinctly. Laughing and whispering were also produced, and the voice of the instrument which was ordinarily loud and clear, and resembling that of a girl, was lowered in pitch and loudness to a more masculine tone.—Mr. C. Boys exhibited "a liquid voltaic arc" formed of a liquid bead of oxide of iron between two platinum electrodes connected to the poles of twelve Grove cells. The arc emitted a brilliant light, which was intensified by tincturing the glowing drop with glass so as to form a compound silicate of iron.

Manchester

Literary and Philosophical Society, December 16, 1879.—J. P. Joule, LL.D., D.C.L., F.R.S., &c., president, in the chair.—On a new form of marine rain gauge, by W. J. Black. Communicated by J. B. Dancer, F.R.A.S.—On screw propulsion, Part III., by Robert Rawson, Assoc. I.N.A., Hon. Member of the Manchester Literary and Philosophical Society, Member of the Mathematical Society.—On the anal respiration of the copepoda, by Marcus H. Hartog, M.A., B.Sc., F.L.S.

Edinburgh

Royal Society, January 19.—Prof. H. C. Fleeming Jenkin, vice-president, in the chair.—Part of the material employed by Principal Forbes in tamping the bore for his earth-thermometers was exhibited in its metamorphosed state. An explanatory note from Prof. Piazzi Smyth, Astronomer-Royal for Scotland, was read, and the various specimens of rock and hardened "clay-puddle" were committed to the care of Mr. Murray, of the *Challenger* Expedition, who offered to prepare microscopic sections for the Society.—Mr. J. D. H. Dickson, M.A., Fellow and Tutor, Peterhouse, Cambridge, communicated a new method of investigating relations between functions of the roots of an equation and its coefficients.—Prof. G. Forbes exhibited some of the more striking electrical experiments with Mr. Crookes's high vacua. The deflection by approach of a magnet of the molecular stream from the negative electrode formed the point of greatest interest; and in the course of the subsequent remarks Prof. Chrystal mentioned that he had investigated mathematically to a first approximation the curve which the otherwise straight stream of charged molecules would take if projected at right angles to magnetic lines of force. To the degree of approximation considered this curve was a circular arc, whose plane was perpendicular to the lines of magnetic force. Prof. Tait communicated an additional note on Minding's theorem, which had been partly suggested by Prof. Chrystal's investigation.

Paris

Academy of Sciences, January 26.—M. Edm. Becquerel in the chair.—The following papers were read:—Influence of temperature and of elasticity on the cables of suspension bridges, by M. Resal.—On the levulosate of lime, by M. Peligot. He finds its composition very different from that attributed to it. The products of action of alkalis on levulose are those of the same substances on glucose got by saccharification of starch; and they are the more complex because of the intervention of air in the successive transformations they effect.—On the acids which arise when raw fatty acids are redistilled in a current of superheated steam, by MM. Cahours and Demarçay. Acids of the fatty series, from acetic acid to caprylic acid were obtained, and probably much higher terms were present; acids belonging to the succinic series seem also to be produced.—On variations of the force of the heart, by M. Marey. He connected the isolated heart of a tortoise in a tube system representing the circulation, and to measure its *possible* force (ordinary experiments giving only the heart's *actual* effort), he compressed the arterial tube beyond the manometer (which was near the heart), which then rose to twice or thrice the height corresponding to functional action. The maximum effort is at commencement of systole, and it decreases towards the end. The heart has more force the fuller it is. When an obstacle increases the resistance the movements become slower and the ventricle has more time to fill, and thus acquires more force in systole.—Remarks on chlorophyll, by M. Pringsheim. A *résumé* of researches lately described to the Berlin Academy. Chlorophyll is not directly related to decomposition of carbonic acid, but plays rather a regulative *rôle* in the respiratory act of plants.—A letter from M. de Lesseps announced his arrival on the American coast (December 30), and his receptions *en route*, at Martinique, &c.—On a new voltaic condenser, by M. D'Arsonval. Studying Planté's battery, he conceived the idea of substituting liberation of a *solid* metal, zinc, for that of a *gaseous* metal, hydrogen; electrolysing a salt of zinc (the sulphate). To present more lead-surface for oxidation, he uses dust-shot, surrounding a carbon plate. A zinc plate is also inserted, and when a voltaic current passes from the carbon to the zinc the latter plate has zinc deposited on it, and the oxygen forms peroxide of lead with the lead, the sulphuric acid remaining free. With a small couple containing only 1 kg. dust-shot he worked a Deprez motor four hours. A layer of mercury does still better than the zinc plate. The maximum electromotive force was 2·1 volts.—Use of sulphide of carbon for destruction of phylloxera, by M. Boiteau.—On the resistance of phylloxera to low temperatures, by M. Girard.—On functions of two variables with three or four pairs of periods, by M. Appell.—On doubly periodic functions of the second species, by M. Mittag-Leffler.—On the determination of numerical equations having a given number of imaginary roots, by M. Laguerre.—On photography of the infra-red portion of the solar spectrum, by Capt. Abney.—On the density of chlorine at high temperatures, by M. Crafts. Improving MM. Meyer's apparatus, he finds, with them, that at the highest temperature of the Pernot furnace, iodine diminishes in density, and increases in volume in the proportion of about 1 : 1·5 compared with air. The proportion for bromine is about 1 : 1·2; but for chlorine he has not found more increase of volume than a few hundredths, in place of the 50 per cent. of MM. Meyer.—On some facts relative to urinary secretion, by MM. Richet and Moutard-Martin. Diuretic medicaments should be sought chiefly among substances found normally in the urine (as urea, chlorides, phosphates, &c.; they become diuretic, whenever in excess of the normal quantity), or substances which pass easily into the urine (as sugar). Distilled water injected into the veins diminishes or arrests urinary secretion.—On lesions of the kidney and the bladder in rapid poisoning by Cantharidine, by M. Cornil.—Researches on the mode of formation of otocephalian monsters, by M. Dareste.—On the structure, development, and pathological signification of tubercle, by MM. Kiener and Poulet.—On the crateriform disposition of solar faculæ and granulations, by Dom Lamey. A reply to M. Janssen.—On the temperature of the subterranean waters of Paris during December, 1879. The temperature of the drainage was always considerably above zero; this affected the freezing of the Seine considerably, near where the sewage entered the river, and the author suggests directing the waters along the quays a few days in extreme cold. Some farmers in the Gennevilliers plain had the sewage applied in December to freeing their fields of snow.

CONTENTS

THURSDAY, FEBRUARY 12, 1880

EDISON AND THE ELECTRIC LIGHT

MR. EDISON has once more come forward with an electric lamp, which we are assured solves the problem of the economic subdivision of the electric light. We have heard this statement so many times with respect to one form or other of lamp devised by this most ingenious and indefatigable inventor, each of which in turn has come to no tangible result, that it becomes harder than ever to trust to the rash announcements flourished so airily by the newspaper press on both sides of the Atlantic.

What is then the nature of the inventions thus heralded before the world? Regarded quietly, and without prejudice, from a scientific standpoint, what is the value of the discoveries which can thus play havoc on the Stock Exchange?

A recent number of the *New York Herald* contained a long and detailed history of Edison's experiments on electric lighting, from which the following description of the new lamp is taken:—

"With a suitable punch there is cut from a piece of 'Bristol' cardboard a strip of the same in the form of a miniature horseshoe, about two inches in length and one-eighth of an inch in width. A number of these strips are laid flatwise in a wrought iron mould about the size of the hand and separated from each other by tissue paper. The mould is then covered and placed in an oven, where it is gradually raised to a temperature of about six hundred degrees Fahrenheit. This allows the volatile portions of the paper to pass away. The mould is then placed in a furnace and heated almost to a white heat, and then removed and allowed to cool gradually. On opening the mould the charred remains of the little horseshoe cardboard are found. It (*sic*) must be taken out with the greatest care, else it will fall to pieces. After being removed from the mould it is placed in a little globe and attached to the wires leading to the generating machine. The globe is then connected with an air-pump, and the latter is at once set to work extracting the air. After the air has been extracted the globe is sealed, and the lamp is ready for use. . . . The entire cost of constructing them is not more than twenty-five cents."

Since the date of this article a paper has been published in *Scribner's Monthly Magazine* for February, written by Mr. Upton ("Mr. Edison's mathematician") but attested by Mr. Edison's signature as the "first correct and authoritative account" of the invention, which confirms the *Herald* article to the minutest details.

We fear Mr. Edison is thirty-five years behind the time in his new invention. The patent-roll of Great Britain for 1845 contains the specification of a lamp invented by King, in which a thin rod of carbon was placed in an exhausted globe; and the inventor specially dwells on the advantage of the Torricellian vacuum for the purpose. A similar lamp was designed by Lodyguine in 1873. The only difference between these lamps and that now brought forward is that Edison prefers a different, and apparently less durable, kind of prepared carbon to that employed by his predecessors, though, again, in the employment of carbonised paper he has been more than once anticipated.

We need not animadvert on the reckless and amusing statements made by newspaper correspondents and interviewers; for these accounts, we believe, Mr. Edison cannot be held responsible. Mr. Edison's first steps in electric lighting, we are told, were to invent a lamp and a generator. The lamp consisted of a piece of platinum to be made incandescent, and so arranged that any excess of heat would cause a small lever to cut off the current. It was an old device described by Draper in 1847. The generator was, on the other hand, a startling novelty. Instead of causing, as in all ordinary dynamo-electric machines, a set of coils to revolve about an axis in a magnetic field, Edison proposed to mount the coils upon the prongs of a huge tuning-fork which should be vibrated by a steam-engine. The friction and waste of power inseparable from rotation was to be completely abolished. Unfortunately "the machine was not practical, and it was laid aside." In other words it was a hopeless failure, wrong in design, wrong in principle, useful only in showing how singularly devoid of sound scientific knowledge a clever practical man may be. The next idea was to make the incandescent metallic strip give light by proxy, causing it to communicate its heat, either directly or by the intervention of reflectors, to a piece of lime or zircon. The fusible nature of platinum, however, spoiled his efforts, and he proposed expensive alloys of iridium and osmium, only to find, what all experimenters with incandescent metals had long known, that there is a constant disintegration going on at the surface and a consequent waste. Mr. Edison discovered, what is for every student of the theory of electricity the most simple and obvious conclusion from Joule's law, namely, "that economy in the production of light from incandescence demanded that the incandescent substance should offer a very great resistance to the passage of the electric current." Forthwith the spirals of platinum, iridium, and iridio-osmium were thrown aside. A carbon filament prepared from charred paper, as described, was adopted. It will be difficult to convince us that the fragile horseshoe paper cinder will resist disintegration better than the carbon used in exhausted tubes by dozens of other experimenters; indeed the invention is avowedly so recent that no lamp can have been tried for a period of time long enough to warrant an assertion of its permanence. The latest telegrams from the States inform us that Edison finds great difficulty in maintaining good vacua, and that further experiments are necessary. It must not be forgotten that even in a globe exhausted to one-millionth of an atmosphere, there yet remain many millions of millions of molecules of air enough to make the disintegration of the incandescent carbon fibre only a question of time.

Meantime Edison had "discovered"—what had been known in Europe for many months—that mercurial air-pumps could be constructed to exhaust to one-millionth of an atmosphere; and, what is more to the point, he found a workman formerly in the employ of the late Herr Geissler, of Bonn, to make his pumps and glass bulbs for him. The tuning-fork generator had already been abandoned in favour of a new generator, christened the Faradic machine, which embodied no new principle nor indeed any very important improvement in construction, being essentially a modification of the well known Siemens' machine, having a longitudinally-wound armature rotating between the poles of a powerful electro-magnet, which in this new form is vertical and provided with unusually massive cheeks. One detail of construction is, however, singular, though it seems to have escaped the notice of electricians. Beneath the longitudinal strands of covered wire the central core of the armature, which is of wood, is overspun with a few layers of iron wire wound transversely. This layer of iron resembles in a kind of way the iron ring in the armature of the Gramme machine, and though no conducting wires traverse the interior of it, it clearly may serve one of the important functions of the iron ring in the Gramme machine in concentrating the lines of force in the field. In support of the allegation that this machine gives out in electricity 90 per cent. of the energy it receives from the driving engine, Mr. Edison caused certain calculations by Mr. Upton to be published in the *Scientific American*. We have examined these calculations and find that they are based on the supposition that the electromotive force of the generator is a constant quantity when the speed of revolution is constant, and independent of the resistances of the circuit and of the quantity of current generated. This can only be true if the field magnets are excited by a separate current and generator. Now, in the numerical calculations which have thus been put forth *in proof* of the above assertion, there is no statement made as to the power necessary to supply this auxiliary current, nor indeed are any statistics whatever given of the actual power (in foot pounds or any other measure) delivered by the driving engine to the generator; only a cut-and-dry calculation to show that if the external resistance be greater than the internal the machine will theoretically work more economically when not generating the maximum current! In the *Scribner* article it is explicitly stated that a second Faradic machine is used to render active the magnets of the machine which supplies the light, and in two admirable pictures, one of which is a view of the battery of Faradic machines set up in a "central station," the nature of the arrangements is shown.

We need not refer in detail to the enthusiastic inconsistencies in the *Times* correspondent's accounts. Upon Edison's own data, electricity, instead of costing one-fortieth of the price of gas, costs at least seven-eighths as much, or about thirty-five times as dear as the *Times* correspondent declares. As to the cost of the lamp itself, with its carefully incinerated horseshoe of paper, its glass globe exhausted to one-millionth of an atmosphere, and its platinum-connecting wires, we confess we do not know where the work could be done for anything like the cost of a shilling. "The current can be transmitted on wire as small as No. 36," says the *Times* reporter, who, probably being unaware that the resistance of a yard of such wire is at least half an ohm, avoids saying what length of such wire may be used. With a generating machine "in a central station, perhaps a half-mile away," the introduction of 400 ohms' resistance would be serious—to the light.

But apart from the mild absurdities of newspaper correspondents, the more we study the detailed accounts of the new inventions the more we regret that Mr. Edison does not devote some time to learn what has been already done in this field. An inventor who ignores what has been done ought not to be mortified to find himself occasionally forestalled by others in some discovery which he prides himself is his own. Possibly this may explain the inability sometimes shown by an inventor to credit the good faith of a rival who has priority. The worst feature of such a course of thought lies in its absolute incompatibility with a truly scientific spirit. Here the scientific man and the inventor part company; since the habits of accurate thinking and the necessary candour of the scientific method preclude the truly scientific man from ignoring, even for the sake of scientific discovery, that which is already a part of scientific truth. We are doing no injustice to Mr. Edison's splendid genius when we say that it is to the character of the inventor, not to that of the scientific thinker, that he aspires.

What shall we say, finally, to the whole system of these reckless newspaper announcements—for which, as we have said, we ought not to hold Mr. Edison responsible—by which the public mind is periodically fluttered?

The remedy to these things is obvious enough. Let scientific men once and for all repudiate these false and unwholesome displays of ignorance. Let public opinion insist that the inventor shall be allowed to pursue his way unhampered by the officious interference of the unprincipled speculators whom his soul abhors, or by the irrepressible unscientific reporter who is only one degree less reprehensible for the part he plays. Whether the latest forms of the invention are doomed to the fate of their predecessors or not, the man who can struggle against failures and discouragements as indomitably as Edison has done deserves to succeed, however erratic his methods. But if he succeeds ultimately, it will be in spite of the vampires of the Stock Exchange and the hangers-on of the New York press, who dog his steps for their own selfish ends.

THE MOTION OF FLUIDS

A Treatise on the Mathematical Theory of the Motion of Fluids. By Horace Lamb, M.A., formerly Fellow and Assistant Tutor of Trinity College, Cambridge; Professor of Mathematics in the University of Adelaide. (Cambridge University Press, 1879.)

NOT the least part of the good that must be attributed to the publication of the first volume of Thomson's and Tait's "Natural Philosophy" is that, as in the cases of Maxwell's "Electricity" and Lord Rayleigh's "Sound," it has led and prepared the way for the complete revision and great advancement of several branches of mathematical physics at the hands of those who have made a special study of these branches. Lamb's "Theory of the Motion of Fluids" must be looked upon as another, and for the most part a worthy, offshoot of this wonderful volume. Although it would be too much to expect that one so young as Mr. Lamb should display the same masterly knowledge of his subject as has been displayed by the authors of the two previously-mentioned works, still the thoroughness with which the very difficult and somewhat extensive literature has been handled, and the appreciation of the mathematical points displayed by the author, together with a rare facility in abbreviating and expressing, render this in most respects about the best possible text-book of which the present state of the subject admits. Having said this, it will be seen that I do not make the following remarks with any view of disparaging the book. These remarks, although directed to the matter in the book, do not, excepting one rather important case, refer unfavourably to anything for which the author is responsible.

Of all subjects on which to produce a satisfactory text-book, perhaps the theory of the motion of fluids, as actual fluids, presents the greatest difficulties. The phenomena of fluid motion, at once commonplace and very obscure, have excited so little interest and called forth such slight observation that at the present time a writer is unable to set before his readers any adequate description of the phenomena which it is his implied object to explain. And as regards the theory, he has to begin by apologising for his fundamental assumptions as being obviously contrary to facts, and after carrying his readers through most difficult and complex mathematics, he has again to apologise for his conclusions, which are in general contrary to experience. As applied to one class of phenomena—that of waves—it is true the theoretical results accord closely with facts; but the satisfaction to be derived from this is largely mitigated for want of a sufficient reason why the theoretical conclusions should be right in this case while they are entirely wrong in others, such as the flow of fluids and the resistance offered to the motion of solids. The usual explanation, that in the theory no account is taken of the friction or viscosity of actual fluids, is hardly satisfactory since no reason has been found why friction should play any other part than the altogether unimportant part which it plays in the case of waves.

It is, however, only in its application to actual fluids that the theory is unsatisfactory. If it be cut adrift from its origin, and be considered as a branch of abstract mathematics relating only to ideal matter having the properties assigned, it occupies the place of one of the most advanced as well as the most important branches of philosophy. It has been partially viewed in this light since the middle of the last century, when Euler and Lagrange founded the modern theory, and the tendency so to regard it has greatly increased of late with the development of the theory. The greatest success, indeed the only real success, has been obtained by the rigorous development of the theory of the motions in a perfect fluid, as it is called, regardless of whether or not these motions take place in actual fluids. Certain of the motions are then seen to agree with the actual motions, and wherever this is the case the theoretical motions have taught many things about the actual motions, as, for instance, the trochoidal motion of the fluid elements in a wave, for which we might, otherwise, have groped for ever without apprehending them. It is, however, the observed motions of actual fluids which suggest the problems; and of course the greater and truer the knowledge of actual phenomena the more chance there is of success in the study of the ideal fluids. But what tends to retard its development and greatly to confuse the subject is the mixing up, with the rigorous reasoning, of surmises as to the behaviour of actual fluids, as, for example, that the non-divergence of a stream of water when flowing from a pipe into a large vessel is owing to an actual opening having been formed in the fluid; a surmise which is at once negatived by the fact that the same phenomenon occurs in the case of air in which such discontinuity is impossible. The present work is in the main free from such surmises, and such as there are, are not the work of the author, but even these he would have done well to have omitted.

In his description of the methods by which the equations of motion are obtained the author has included (Art. 12) a very important method first given by Maxwell, which method is given at greater length in Note A at the end of the volume, otherwise he has followed previous writers as far back as Laplace. Considering its difficulty, the fundamental reasoning is, on the whole, well put. But there is a considerable amount of vagueness attending the author's use of the term *particle*. Having rightly defined fluids as being such "that the properties of the smallest portions into which we can conceive them divided are the same as those of the substance in bulk," he proceeds to reason about a particle as though it were a discrete quantity, the position of which is defined by some point, thus ignoring the fact that, according to his definition, the same particle of fluid may at one time be a sphere, at another a filament of indefinite length, or a sheet of indefinite breadth. This vagueness appears to have led him into error in Art. 11.

Art. 8 on the equation of continuity seems to be unnecessarily bare of explanation. There used to be an impression that, as the name implied, the equation of continuity did in some mysterious way involve the condition that the fluid should be continuous in space. Thomson and Tait, however, have in Art. 191 of their volume effectually dispelled this notion. They say:—

"As there can be neither annihilation nor generation of matter in any natural motion or action, the whole quantity of matter within any space at any time must be equal to the quantity originally in that space, increased by the whole quantity that has entered it, and diminished by the whole quantity that has left it. This idea, when expressed in a perfectly comprehensive manner for every portion of a fluid in motion constitutes what is called the *equation of continuity*, a needlessly confusing expression."

The meaning of this can be nothing less than that the equation of continuity has nothing to do with continuity in space; for certainly there is no creation or annihilation of matter amongst the stars, probably fluids, and yet we should hardly consider them continuous in space. As this Art. 191 stands the last sentence is erroneous, and is certainly calculated to increase the confusion. To render it true, the term *fluid* must be understood *continuous fluid*. In deriving the equation, the constancy of mass is certainly taken as an axiom, but that is not all; when it is said that the mass in a certain volume V is ρV, ρ is understood to be the ratio of the mass to the volume in a space, so small that it may be neglected as compared with V, at any point within V. And hence the assumption, fundamental to the equation of continuity, that the mass within V is ρV is equivalent to assuming that the matter is uniformly distributed through V, and therefore cannot be discontinuous. Nevertheless, it would have been better to have called the general equation the *equation of density*. But it is clear that this general equation was an afterthought, and that the name originated from consideration of water or an incompressible fluid, in the case of which the equation does not involve the density, and simply expresses space continuity within a substance of constant volume.

Another point of fundamental importance, on which a remark is called for, is the proof of the permanence of the velocity potential. Mr. Lamb has offered a proof of this now historic theorem, which, if judged by the space it occupies, should be much simpler than the acknowledged proofs of Cauchy and Stokes. As no authority is cited, it would appear that this proof is here given for the first time. If so, the author has done himself great injustice in not examining or explaining his reasoning more closely. For, as it stands, it suggests the idea that he has ignored the fact that dx, dy, dz on the left of his equation, are integrals through a finite time, and hence, inasmuch as he has given no reason to the contrary, may be of a different order of magnitude from their initial values, da, db, dc, which appear on the right of his equation. If this is not so, it is a peculiarity of the motion of continuous fluid, and needs establishing, otherwise we might infer that two people who had once shaken hands could never after be so much as a mile apart. If this proof is found to be unsound, it is an unnecessary blemish in the book, for even if true, it would not replace the more elaborate, but much more physically instructive, proofs given by Stokes and Thomson, which the author has given further on in the book.

These remarks only carry us into the second chapter. The rest of the book, with the exception of the last chapter, is devoted to the account of what has been done in the way of integrating the equations of motion, and this may be taken as the purpose of the book.

This part of the theory, which is now very extensive, has almost all been developed within the last fifty years, and most of it within a much shorter period. It is the work of the very ablest mathematician, and is of the highest and most difficult kind, and in general incomplete. It was only to be found in isolated memoirs in various languages. The collecting, abbreviating, and arranging this into a systematic treatise has been no ordinary task, and the result shows that, in addition to his mathematical power, the author must possess the gift of compiling. One of the most striking features of the book, considering the variety of sources from which the matter was collected, is the uniformity of the notation. There is, however, one departure from this which is important, although evidently an oversight. The term *stream-lines*, carefully defined in Art. 28, as applicable only to steady motion, is freely used throughout the book in the sense of *lines of motion*, as applied to cases in which the motion is not steady.

The advance which has been made of late years has not been by the discovery of any general method of integrating the equations of motion, but by the discovery of certain general relations between the motion within certain regions of space, and the shape and motion of the boundaries to those regions. The steps in the discovery of these kinematical relations are principally due to Green, Stokes, and Helmholtz, but they have been generalised and elaborated by Thomson and Maxwell, and to these latter the present method of expression is due. An extremely lucid account of these relations is given in Chapter III., by which the author has cleared his ground for the treatment of such integrations as have been effected. These comprise many cases of steady flow, the method being that of the stream-line function first given by Stokes, but afterwards reduced to a geometrical form by Maxwell, and largely applied by Rankine. They also comprise cases of vortex motion treated by Helmholtz's well-known method, and the theory of waves, as worked out principally by Stokes, Green, and Rankine. Only one chapter of the book is devoted to elastic fluids, and this, under the shadow of Lord Rayleigh's complete work, does not call for special comment.

The last chapter is on viscosity, and is taken from Prof. Stokes's paper on this part of the subject. Although this paper has been published thirty-three years, this is the first treatise in which any adequate account of its very important contents has appeared in a general treatise.

Throughout the book the various steps are carefully ascribed to their different authors, a very difficult task, and one in which the author appears to have been generally successful. There are, however, two instances of failure which call for notice. Equation 10, Art. 29, is known by modern French writers as Bernoulli's theorem ("Théorème de Daniel Bernoulli, Bresse," vol. ii. p. 25). Example 11, Art. 97—The fact that the contraction from a canal projecting inwards is ½ was proved long ago and the results verified by Borda.

In respect of diagrams Mr. Lamb's book might certainly have been improved. The great difficulty in the study of the subject is to obtain a conception of the lines of motion, and in this, diagrams such as those given by Rankine, Maxwell, and Sir William Thomson, are invaluable. The graphic method of obtaining the lines of motion developed by Maxwell and Rankine, has led to most important steps, but without diagrams it is as impossible to form a conception of this method, as of the lines of motion themselves.

The omission in this respect, as well as a tendency to reduce verbal explanations, would have shown without the examples at the end of the volume, that the author has been influenced by a desire to adapt the book to the requirements of the mathematical tripos, in which desire he has certainly succeeded. Whether it is well to introduce students to such a difficult, complex, and incomplete subject in such a concise, not to say cut and dry form, is a question which the author probably did not feel it necessary to consider. He has, however, by the numerous references throughout the work, and in the table of authorities at the end, done all in his power to put the students in the way of consulting the original works. This is aid of which students will do well to avail themselves, for nothing can equal work from the master's hand, and however carefully the general features may have been studied, the reading of such papers as those of Stokes, Rankine, and Helmholtz cannot fail to shed, what may be called, the light of life over the whole subject.

OSBORNE REYNOLDS

THE INTERIOR OF GREENLAND

Meddelelser om Grönland, udgivne af Commissionen for Ledelsen af de geologiske og geographiske Undersogelser i Grönland. Fors. Hefte. (Copenhagen, 1879.)

SO large an amount of interest has been awakened during recent years concerning the nature of the interior of the vast island of Greenland that the publication of this first instalment of the researches carried on under the auspices of the Danish Government will be welcomed by geographers and geologists all over the world. The work is written in the Danish language, but a *résumé* in French, by M. F. Johnstrup, enables readers unacquainted with the former language to become possessed of the interesting facts contained in the volume. The work contains four memoirs of great interest: an account of the expedition upon the inland ice, made by Lieut. Jensen in 1878; a record of the astronomical and meteorological observations made during this journey; notes on the geology of the west coast of Greenland, by M. Kornerup; and remarks upon the plants collected by the last-named explorer, by M. Lange.

In the year 1870 Prof. Nordenskjöld, setting out from the vicinity of Disco Bay in company with Dr. Berggren, was able to penetrate to a distance of thirty miles into the interior, at which point the continental ice was found to attain a height of 2,200 feet. Starting from the neighbourhood of Frederikshaab, in South Greenland, Lieut. Jensen traversed a distance of forty-six miles over the continental ice. Here he found, as did Dalager, who made a similar attempt from the same point in 1751, that a number of islands of rock (Nunatakker) rise above the general level of the great sea of ice, and upon these rocky islets no less than fifty-four species of plants were collected.

The observations of most general interest, however, which were made by this expedition, were those which relate to the condition and movements of the great sheet of ice that covers the interior of the island. We cannot do better than give the *résumé* of these observations, which is furnished by M. Johnstrup; it is as follows:—

1. At a distance of 75 to 76 kilometres from the shore, the continental ice attains a height of 1,570 metres (5,115 feet), and must be of considerable thickness, since its inclination to the east from the Isblink of Frederikshaab averages only 49′.

2. On that part of the continental ice which has been explored even at a great distance from the shore, are found many "Nunatakker," which influence to a great extent the movement of the ice, in some cases actually bringing about a reversal of the direction.

3. The surfaces of dislocation resulting from the movement of the ice are almost vertical in the midst of the continental ice, but they incline at the edge and near the "Nunatakker," where the slope of the ground is great, and the upper parts of the ice, in consequence, move more rapidly.

4. The crevasses are partly perpendicular, partly parallel to the direction of the movements, following the nature of the inequalities of the rocky bed, and in places where the ice takes a fan-like disposition, both radial and tangential crevasses are observed.

5. Around the "Nunatakker" and the rocks near the shore, the surface of the continental ice is impregnated with fine rocky *débris* (sand and clay) which are brought there by tempests, and which brooks carry from a distance to the cavities of the continental ice. The masses of clay thus collected give rise to the pyramids of ice which near the Isblink of Frederikshaab, attain an elevation of nearly 60 feet.

6. Moraines of different form are found on the continental ice, especially near the "Nunatakker," and they must be referred to the classes of ground "moraines and terminal" moraines. They frequently form curved or semi-circular lines, and inclose well-rounded masses of stone of no great magnitude, which in their advance fall into the crevasses.

Next in interest and importance to the investigations upon the continental ice of Greenland, we must regard the new facts on the geology of the few portions of the country uncovered by the great ice mantle, with which this work furnishes us. A geological map of the West Coast of Greenland from Godthaab to Tingingnertok shows the rocks exposed along the coast and in the islets which rise above the great ice-sheet to be mostly composed of gneiss with some mica-, talc-, and hornblende-schists, and occasional patches of granite.

New proofs of the gradual elevation going on in past times on the West Coast of Greenland are furnished in the work before us. Five sets of raised-beaches are described occurring at heights of 28, 57, 94, 192, and 326 feet above the sea-level respectively. On the other hand there is clear evidence that the land is, at the present time, slowly subsiding, the extent of this movement being shown to have been at Lichtenfels from 6 to 8 feet since the year 1789.

The work we have been noticing is illustrated with several valuable maps and plates, together with numerous woodcuts; and the succeeding parts will be looked forward to with much interest by those who desire to know more concerning that veritable *terra incognita*, the interior of Greenland.

OUR BOOK SHELF

A History of the Tin Trade. By P. W. Flower. (London: George Bell and Sons, 1880.)

THE author, who is well known as one of the largest manufacturers of tin plates, and also as having introduced into this country the French method of decorating tin plates by lithographic printing, has in this volume collected numerous interesting facts in connection with the early history of the manufacture in South Wales, and, what is of more value, has reprinted those parts of the scarce work of Andrew Yarranton, "England's Greatness," 1677, that refer to his journey into Saxony for the purpose of learning the method of tinning sheet-iron. With these are associated extracts from other not very well known works, translations of the accounts of tin-plate making published at various times in the last century by Réaumur, Diderot (in the "Encyclopédie") and Jars, and those of Parkes, 1818, and Ebenezer Rogers, 1857, the latter from the *Transactions* of the South Wales Institute of Engineers. No notice, however, is taken of the later and more complete account published in Percy's "Iron and Steel." An introductory chapter on the metallurgy of tin, and a subsequent one on the modern manufacture of tin plate, are exceedingly feeble. The former is derived from such sources of information as Dodd's "Manufactures in Metal" and the "Beauties of England and Wales," and the latter, though containing matter that may interest those who are acquainted with the details of the process, will not convey much information to those who are not. The final portion of the volume deals with economic details and statistics; the latter of some elaboration, but from four to six years after date, and the prices in different European seats of manufacture are represented by prices current in 1872–73–74. There are several curious errors which can scarcely have been expected to be found, as, for instance, the "Lamb and Flag" brand on tin ingots is said to be the stamp of the

Duchy of Cornwall; vitriol is the fume given off by heated sulphur; and the refinery in the tin-plate forge is only a melting-furnace. Altogether the author treats the South Wales forge process, one of the most subtle and delicate in the whole range of iron metallurgy, somewhat scantily.

H. B.

Mathematical Tables, chiefly to Four Figures. First Series. By James Mills Peirce, University Professor of Mathematics in Harvard University. (Boston, U.S.: Ginn and Heath, 1879.)

THIS is a well-arranged and clearly printed book of forty-three octavo pages. Besides four figure logarithms of numbers and of circular functions, and the circular functions themselves, it contains a table of logarithms of hyperbolic functions, occupying three pages, Gaussian logarithms of sums and differences, inverse circular functions (the argument being the log. sine, &c.), and a special table for finding the logarithms of circular functions of small angles, which is to be used by reducing the angle to minutes, and then adding its logarithm to a logarithm given in the table. There is no table of antilogarithms, but it is not needed, as the logarithms of numbers extend over more than a complete cycle, beginning with the number 100, and ending with 1999, so that the differences between successive logarithms are always small. A saving of space, without loss of utility, has been obtained by carrying the proportional parts only as far as 5 instead of to 9 as usual. This involves subtraction for 6, 7, 8, and 9, but the quantity to be subtracted is so small that the operation can be performed mentally. The sixteen pages of "Explanation of the Tables," including a page and a half on Hyperbolic Functions, are remarkably clear and good.

J. D. E.

Eight Months in an Ox Waggon. By E. F. Sandeman. (London: Griffith and Farran, 1880.)

MR. SANDEMAN has written a most interesting volume on his experience in South Africa. His party made their expedition to the Transvaal in an ox waggon. It is the story of their adventures, during the time they were hunting there, that is told in this volume. The book is, however, by no means a diary of the daily doings in the Transvaal. It abounds in reminiscences of Boer life, and accounts of the natural history of the country. In the latter respect Mr. Sandeman has shown that he is a good observer. We can only give a few extracts. Speaking of ant-bears, he says:—

"The holes of the ant-bear are sometimes five or six feet deep, and large enough to engulf horse and rider; but as they are generally conspicuous, they do not prove so dangerous as the smaller holes of the mere-cat, a pretty little animal between a rat and a stoat, found all over South Africa."

The various changes in the bird and insect-life in the Transvaal, as the day passes on, seems to be very much marked and curious. "As the heat of the day comes on, the game of all descriptions retires to the shade, and is neither to be seen nor heard, and the air is full of gorgeous insects of every size and colour, from the large butterfly, flitting from reed to reed, to the sphinxes and sand-flies, whose movements as they dart and glance through the sunlight are too quick for the eye to follow. Darting after these, and glancing like little bolts of shiny gold or silver, set with emeralds and rubies, are innumerably brilliantly plumaged small birds, who again retire into the reeds when the butterflies shut up their wings as the heat of the sun ceases to warm them into activity. But the cooling atmosphere is far from being tenantless; for, as the sun goes down, myriads of clear-winged long-bodied flies swarm up from the ground, and after these there dart out from their hiding-places of the day a devouring crowd of black-birds with white tails, who gobble up the flies by the dozen. A large kind with gold feathers in their wings also assist at the banquet; and a smart little wagtail has a larger share perhaps than either of the others, for he is quicker in his movements, and never misses his dart. When these go to bed later on, owls, night-hawks, bats, crickets, frogs, and jackals, combine to break the stillness of the night with their harsh discordant cries and croakings."

Farther on in the book we have a long account of how a honeybird led the author and his friends to find honey. From the description one must think this bird had reasoning powers almost human. Throughout the book are descriptions of the scenery of the country. We only quote one paragraph:—

"The scenery became wilder as we advanced. The hills were loftier and more broken up, and here and there covered up with thick brushwood. The veldt itself was strewn with quartz rocks, and rugged boulders. The streams were full of beautiful quartz pebbles worn smooth by the constant friction. Many of the rocks have streaks of pure iron in them, and on every side are relics of the volcanic action, which must have formed the greater part of the Transvaal."

The book is written in a simple and attractive style. It will be of considerable interest to naturalists and to those who may meditate a similar hunting expedition in the Transvaal. We would recommend it as an interesting and instructive record of a holiday. It contains a large, useful map of the Transvaal and the surrounding territories.

The Countries of the World. By Robert Brown, M.A. (London: Cassell, Petter, Galpin, and Co., 1879.)

THE present volume of "The Countries of the World" is devoted to Polynesia, Australasia, Malaysia, and Japan. The people who inhabit these islands having been fully discussed in another volume, there is only a brief sketch of them given here. The author, in his compilation, takes us first through the Polynesian islands, gives a general idea of the plants and animals peculiar to them, short accounts of the mode of government and the present state of the country. All this is done in a pleasant and interesting manner. New Zealand, Australia, and Japan are treated in the same way. Our Australian colonies are described more fully. The numerous illustrations throughout the book will be a great attraction to it. They are very well done.

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.]

Light of Webb's Planetary Nebula (DM. + 41° 4004)

THE recent discovery by the Rev. T. W. Webb, that the star DM. + 41° 4004 is a planetary nebula, and the attention which has consequently been attracted to this object, induce me to send herewith the result of a measurement of its light made at the Harvard College Observatory. Observations are in progress upon the light, dimensions, and spectra of all known planetary nebulæ visible in this latitude. To avoid the repetition of similar errors, two or three observers take part in the work, and each makes only one series of observations upon the same nebula in a single evening.

The photometric measurements are made by throwing the image of a star out of focus to such an extent that its intrinsic brightness becomes apparently equal to that of the nebula which is simultaneously observed with the same eye-piece. Each determination consists in six comparisons made alternately inside and outside of the focus of the auxiliary telescope through which the star is seen. The light of the nebula is expressed by the magnitude of a star, the light of which, if diffused over a circle one minute of arc in diameter, would be equal in brightness to that of the nebula.

The star employed as a standard in the present instance was *α Cygni*. The comparisons were made upon three evenings, and three observers took part in the measurements. The number of determinations is six. If we assume the magnitude of *α Cygni* to be 1·7, as in the *Durchmusterung*, that of the nebula is 4·6 on the system just explained. The average deviation of the separate results is 0·4, and the probable error of the mean 0·2. The scale of stellar magnitudes here adopted is that of Pogson, in which the ratio of light corresponding to one magnitude is that the logarithm of which is 0·4. Accordingly, it appears that the brightness of *α Cygni* would be equal to that of the nebula, if the light of the star were diffused over a circle 3'·8 in diameter.

In the position angle 140°, the diameter of the nebula is about 11", and the diameter perpendicular to this is about 8". The border of the nebula is not sharply defined, and the fainter light around it is not very regularly distributed about its central portions. In a smaller telescope it would probably look smaller and more nearly circular.

From the measured dimensions and brightness of this nebula, its total light may be computed. The result is that, according to these observations, we receive 590 times as much light from *α Cygni* as from the nebula. Hence, regarding the nebula as a star, its magnitude may be expressed by $1·7 + \frac{2·77}{0·4}$, or 8·6. The magnitude assigned to it in the *Durchmusterung* is 8·5. This close agreement must of course be regarded as accidental.

Like most of the planetary nebulæ observed here, this nebula shows a faint continuous spectrum, not due to the light of the sky, in addition to the lines denoting its gaseous character. This continuous spectrum is largely due to the nucleus.

EDWARD C. PICKERING

Cambridge, U.S., January 24

Electricity of the Blowpipe Flame

COL. ROSS's experiment on the above subject seemed of such importance that I thought it advisable to repeat it, and it may be of interest to some of your readers to hear of the result and of the way in which my experiment was conducted.

A compass in a closed box, to prevent the influence of air currents, was placed close to a brass Herapath blowpipe, and after the position of the needle was noted the gas was lighted and air was blown through the flame; no deflection of the needle was observed. As the compass is an old one and there was probably some friction on the pivot, it was replaced by a piece of magnetised watch-spring attached to a mirror, and suspended in a glass case by a single silk fibre; this apparatus being placed on a stone slab, light from a lamp was reflected from the mirror on to a screen. The arrangement was so delicate that the needle was set in oscillation by the movement of the iron rod connecting the blowpipe with the treadle; so, to avoid any possible disturbing cause, the air was supplied by water pressure from a copper gas holder. When the jet was brought near the needle, the flame being either in the magnetic meridian or at right angles to it, not the least movement of the spot of light was perceived, although the screen was at a distance of about eight feet from the mirror.

As this result is so much at variance with that of Col. Ross, it would be interesting to know exactly how his experiment was performed.

HERBERT M'LEOD

Cooper's Hill, February 4

Triassic Footprints

IN the *Quarterly Journal* of the Geological Society for August last there is an interesting notice by Mr. Sollas, accompanied by a figure, of a set of footprints from the Triassic beds of South Wales. These footprints Mr. Sollas says he has compared with those of the emu taken in modelling-clay; and so complete was the agreement that, other considerations out of the question, he would not have felt much hesitation in declaring for the avian, and indeed ratitous, character of the animal that produced them; but that because no remains of birds have occurred in the trias of the south-west of England, while those of reptiles have, he refers them to either *Thecodontosaurus* or *Palæosaurus*.

I wish, therefore, to call attention to the fact that in these footprints there is shown that character of the crossing of one leg over the other, and of turning out the toe, which persons who have kept poultry may have noticed as conspicuous in the walk of the domestic fowl; that is to say, it places the foot, not directly forward, but across the opposite leg, turning the toe well out. Now this is distinctly shown in the relative positions of these Triassic footprints. The first, or lowermost in the figure, is that of the right foot, and the toes point to the right; the next (2) is that of the left foot, and crosses the median line of the animal's path, and the toe of this (for only the middle one remains unobliterated), points well to the left; the third, being that of the right foot, crosses the median line in the same way, its toes pointing well to the right; but the fourth (left), though it thus crosses, has not the toe turned out, because the animal at that point began to bend its course to the right hand.

This track is thus, I venture to say, one made by the jaunty step of the light-limbed bird, and not by the slouching stride of the heavy-limbed dinosaur, even if this kind of reptile did (as has not yet, notwithstanding its ornithic affinities, been shown) walk erect, and exclusively on two legs; and I am induced to trouble you with these remarks, because just twenty years ago (*Quart. Jour. Geol. Soc.*, vol. xvi. p. 328) I contended that the existing *Ratitæ* and other wingless (or, more accurately, flightless) birds are the direct, and but little altered, descendants of those which inhabited Triassic continents in the southern hemisphere, of which one portion, that formed by Australia and New Zealand, has been preserved in complete, and other portions, such as South Africa and South America, in less complete isolation since that remote period; and it seems to me that the footprints figured by Mr. Sollas furnish very satisfactory evidence of the case.

SEARLES V. WOOD, Jun.

Martlesham, near Woodbridge, January 30

Rainfall in the Tropics

MY studies on the distribution of rain on the earth have often caused me to regret our want of knowledge about the quantity of water falling on the oceans, especially in the tropics. The observations on the continents and large islands are very apt to mislead us as to what takes place on the open sea. As there seem to be very great difficulties about observing rain-gauges at sea, I have thought it would be possible to gain some insight into the matter by placing rain-gauges on the smallest and lowest islands to be found on the ocean, the meteorological conditions of which differ but very little, if at all, from those of the ocean. In the Pacific such islands are to be found in plenty; in the Atlantic I would especially recommend the island of St. Paul ½° N. and 29½° W.; in the Indian Ocean, the Southern Maledives, the Chagos, and Keeling Islands, &c.

The rain-gauges for this purpose should be made of strong metal, the lower part, instead of the ordinary glass measuring-vessel, being also of metal. Such rain-gauges could be put on islands, especially uninhabited, and taken up and the amount of water fallen measured after some months, or even a year or more. The measurement would be but a rough one, as the evaporation could not be strictly accounted for, and we would certainly know very little as to the distribution of rain during the year; but with all these drawbacks, even an approximate knowledge of the quantity of water falling in strictly oceanic climates, far from the disturbing influence of land, would be very important for meteorology. Even a few figures as to the total annual rainfall in parts of the ocean, which are for some months included in the "doldrums," and those where the trade-winds blow steadily the whole year, would very much increase our knowledge, more than a great number of observations taken on mountainous islands, where local conditions modify the quantity in the extreme.

I refrain from further practical details, as these will be better provided for by British meteorologists and seamen, in case they should accept my suggestion.

A. WOEIKOF

St. Petersburg, January 21

Mountain Ranges

THE reply which Mr. H. B. Medlicott has made to me in NATURE, vol. xxi. p. 301, seems only to obscure rather than set aside or remove my objections. In the second sentence it is said that I "take geologists to task for not making their descriptions to fit in with my delineation of purely superficial features." But my complaint was based, not on my delineation, but on a trigonometrical survey; and it was caused by a description—not of the geology, but of the physical geography of India, in connection with a map of its hill ranges, that has nothing geological about it. It is in this expressly geographical part of the manual that I find the greatest range of snowy peaks in the world omitted from a geographical notice and delineation of the Himalaya. I did not allude at all to geology.

Mr. Medlicott contends that the omission was due to the irrelevancy of the great range to the matter in hand. But how can a great range of the Himalaya be irrelevant to a geographical description of that mass, or to a special map of the hill ranges of India? And why should a prominent and leading feature be treated as a mere incident? In fact the omission was plainly due to the survival of an old error or "antiquated theory," which confused the snowy peaks seen from the Indian plains for the most part with the water-parting of the Sanpu and Ganges basins, although the latter really forms a distinct but parallel range further to the north. In these days a clear understanding of the superficial or geographical aspects of the mountains on the frontier of India cannot be overrated. The statesman, the warrior, and the trader alike stand in need of it; and misleading or confused representations of the subject may become of serious moment. The ignored range is indeed to a great extent the limit of the Tibetan Plateau and of the Chinese Empire, the relations of which with India are rapidly rising into importance.

Mr. Medlicott's appeal to "the great gneissic axis" is not less unfortunate than the argument which he derives from "irrelevancy." If "the great gneissic axis" divides on the west of the Sutlej, it may be presumed to be intact on the east of that river, where in consequence it would be the more entitled to delineation and notice. But the only parts of the Southern Himalaya inserted in Mr. Medlicott's map of the Hill Ranges, are the Pir Panjal and Dhauladhar, on the west of the Sutlej. Is there any ground for identifying "the great gneissic axis" with the Northern Himalaya, which alone is delineated east of the Sutlej, in preference to the Southern Himalaya which is omitted? It is enough to say that neither of those ranges has been sufficiently explored, to admit of a general conclusion on the subject. Therefore it is fair to add that even geologists must refrain for the present from accepting Mr. Medlicott's dictum in that respect.

Mr. Medlicott's penultimate sentence baffles my best efforts to understand it. It seems to be meant to be applicable somehow to the region between the Indus and Sutlej.

In conclusion I can find no good ground for treating the views of geographers and geologists as wide apart, merely because a great geographical fact has been neglected in an important geological work; and I hope that the omission will be rectified in future editions.
TRELAWNY SAUNDERS

On Halley's Mount

PERMIT me to mention two suggestions which have been made with reference to the article "On Halley's Mount" in NATURE, vol. xxi. p. 303, viz.:—

1. That some mention should have been made therein relative to Dr. Halley's official investigations (*vide Phil. Trans.*, vol. xvii. p. 960, 1693).

2. That it was *not* at Dr. Halley's private expense[1] that the "Principia" was published, although it was in consequence of his urgent persuasion that Newton produced his great work (*cf.* Preface to the "Principia").

It may be remarked that there is a biographical sketch of Edmund Halley in Mr. Crookes's *Monthly Journal of Science* for February, and that the Astronomer-Royal has signified his hearty approval of the idea of the proposed monument in St. Helena.

THE WRITER OF THE ARTICLE "ON HALLEY'S MOUNT"
2, Eastern Villas, Anglesea, Gosport

"A Speculation Regarding the Senses"

IN a letter bearing this title (NATURE, vol. xxi. p. 323) your correspondent, "M.," while indulging in a most extraordinary "speculation," observes that it is "not without some encouragement in actual fact." He then adds: "The ascertained facts of *clairvoyance* and *mesmerism* are what I have more especially in view," &c. Now, whatever may be the case with clairvoyants, I think, to quote from "M.," that it must certainly "require some peculiar state of mental calm" to enable a man, when writing in a journal professedly scientific, thus quietly to assume the truth of all the astounding class of phenomena to which he alludes as "ascertained facts." Clairvoyants, spiritualists, *et hoc genus omne*, often complain that scientific men are arrogant in their treatment of, or allusions to, the alleged marvels of the modern *séance*; and if we have regard to the jaunty manner in which Dr. Carpenter rides his favourite hobby along "the high *priori* road," I do not deny that the spiritualists have sufficiently good ground for complaint. But let them not meet arrogance with arrogance, or speak about facts which, at the best, are highly doubtful as facts which have been "ascertained."

[1] As inferred from Whewell's "History of Inductive Sciences."

My object, however, in writing this letter is not controversial. I desire merely to represent to "M.," and any other of your readers who may believe in the alleged phenomena of clairvoyance, that it is their duty to have these "facts" properly sifted, examined, and published. I have myself taken a good deal of trouble to investigate the subject, and, while meeting with a vast amount of humbug, have also met with one or two things that I am unable satisfactorily to explain. I therefore desire to prosecute my researches in this direction, without either bias or prejudice, should I be able to meet with suitable material. If "M." and his friends are right, and if I should satisfy myself that they are so, I should give a wide publicity to my methods and my results. If the phenomena should admit of repetition, I should have them witnessed and attested to by a selected number of the leading scientific men of the day. It would then be time for "M." to speak about such "facts" as "ascertained."

Here, then, is a fair offer by "a man of science" to investigate any or all of "the powers of darkness" without any feelings of animosity against them. Will any clairvoyant or spiritualist who really believes in his own belief supply me with an opportunity of so doing? Any letters addressed to the care of the Editor of NATURE will be forwarded to me.
F.R.S.

Perforated Stones in River Beds

TRAVELLING some months ago among the Cumberland lakes, I was walking with a friend in advance of our conveyance through a narrow road, when my attention was suddenly arrested by the presence of some interesting shells and stones on the window-sill of a peasant's cottage. Stopping to admire them, or rather having taken some of them up in my hand, the woman of the house—an intelligent person—came out, whereupon I apologised for my seeming rudeness, and asked where she got them. She at once accepted my apology, and added that they, pointing to the shells and stones, were often looked at by other travellers. She further added that they were common enough in the Derwent River hard by, and she made no difficulty at all about accepting sixpence for the two of them I selected.

Now as I have travelled a good deal in the public service and otherwise, and seen many mountain and other streams in my day, without ever meeting any of these perforated stones, I would like to know if they occur elsewhere, and if so under what circumstances. The Derwent, a comparatively small and gentle stream, flows, as we all know, through the beautiful valley of Borradale into the pretty lake of the same name, near Keswick. I do not know anything of the geology of the district, but there are slate quarries and lead mines in the vicinity, and one of my stones partakes indubitably of the former quality. The other is as clearly a piece of granite, and if water be the sole tunnelling agent in these substances, both well illustrate the truth of the old Latin prase, "Gutta cavat lapidem, non vi, sed sæpe cadendo."

Another thing that struck me in connection with them was the extraordinary likeness of one of them, at least, to the stone axes or hatchets (I forget just now the technical name) figured by Sir John Lubbock in his "Prehistoric Times." This was so striking and obvious that, holding up the specimen, I said to my friend—a gentleman connected with the Press—"Surely Lubbock must have made a mistake, and taken one of these for a prehistoric implement." Further observation only tends to confirm this first impression, and I shall be glad to hear if any similar doubt has occurred to others on sight of these objects. I will also be anxious to hear if they are as common in the Derwent or other rivers as this woman's language would imply, and I will otherwise feel obliged for such information respecting them as the courtesy or curiosity of your readers may enable them to supply.

Warrington
WM. CURRAN

Politics and Science

THE Duke of Somerset, after "considering all the oppressions that are done under the sun," writes about them all, whether limited monarchy, aristocracy, or democracy, in much the same dissatisfied and despairing tone in which the Preacher of old did. But he concludes his book with drawing comfort from a source which his predecessor of old pronounced impossible. He says :—

"There is yet one branch of human progress which we may contemplate with unmixed satisfaction, and that is, the progress of science, both in its discoveries and its adaptations to the convenience and civilisation of mankind. It may be hoped that the acquisitions of science may become an enduring benefit to the world, not to be again obliterated and lost amid the political convulsions to which society may be subjected.

"To this progress the scientific men of every country may contribute, whether they live under a despotism or under a constitutional government. The pursuit of truth for its own sake is the noblest occupation of the human mind, and from this pursuit it seems probable that mankind will reap the richest reward."

A fairer comment fr m a more qualified and disinterested writer was never made upon the motto of this journal—

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

W. O.

Scientific Jokes

You can hardly expect *all* your readers to see through the jokes at p. 337 of your last number. I instance only two out of many.

"The energy of heat is made up of heat and temperature"! This may set some earnest but i norant students to find *how* Joule's Equivalent depends on temperature : and it would be well to warn them.

"Profs. Ayrton and Perry have developed a theory of terrestrial magnetism . . . which coincides well with facts." Here the reader should have been told that Rowland has proved that, according to this theory, the moon would have been repelled into the profundity of space, and the greater part of the earth's surface, including its atmosphere, torn off by the enormous electric forces involved.

G. H.

Stags' Horns

Concerning the disappearance of cast horns, the theory that stags retire to secluded spots, about the time for shedding their horns, mentioned by B. W. Barton in Nature, vol. xxi. p. 325, may be perfectly correct where the animals have woods to go to, but this opinion cannot hold good with the thousands of reindeer that frequent the barren lands of the north-east part of America ; yet it is rare to find on these "barrens" the *shed* horn of either buck or doe, although the latter drop their horns in May or June, when at or on their way to their far north summer quarters.

As far as I have observed, the new horns of the male reindeer (in the wild state) do not begin to grow until weeks after the old ones have dropped off, and there is no danger of one stag "disturbing" another, when *all* have their horns in the tender velvety stage ; in fact, no animals can be less pugnacious than these fine creatures are during eight months of the year.

2, Addison Gardens, South Kensington, Feb. 7 J. Rae

Apropos of the question of stags' horns, I have just come upon the following in Miss Bird's "Life in the Rocky Mountains."

Describing the so-called "Parks" of the Rocky Mountains as "high-lying valleys large and small, at heights varying from 6,000 to 11,000 feet," she says, "Parks innumerable are scattered throughout the mountains. . . . They always lie far within the Foot Hills. . . . Hundreds can only be reached by riding in the bed of a stream, or by scrambling up some narrow cañon till it debouches on the fairy-like stretch above. These parks are the feeding-grounds of innumerable wild animals, *and some, like one three miles off, seem chosen for the process of antler-casting, the grass being covered for at least a square mile with the magnificent branching horns of the elk.*" P. 122. B. W. S.

"Song of the Screw"

Prof. Tait has inadvertently attributed to the late lamented Prof. Clerk Maxwell (Nature, vol. xxi. p. 321) an effusion of mine consisting of a synopsis of Dr. Ball's Treatise on Screws, which appeared in Nature, vol. xiv. p. 30, under the above title.

As a very humble poet, the occurrence of such a mistake has satisfied my highest ambition ; and I feel like a second Chatterton.

J. D. Everett

The Post Office and the Telephone

Pray allow me to correct an important misprint which has occurred in the last paragraph of the abstract of my address which you were good enough to insert in your last number. I said that the Post Office did not wish to restrict or in any way to interfere with the use of the telephone ; our only object was to prevent the establishment of a particular branch of Post Office telegraph business *without*, not *with*, its licence or consent.

General Post Office, February 9 W. H. Preece

KARL VON SEEBACH

Geologists will learn with universal regret of the death, after a painful illness, of the distinguished Professor of Geology at Göttingen, Karl von Seebach. Although Prof. von Seebach was still a young man at the time of his death, he had already made his mark in science, and his career promised a distinguished future. Von Seebach's earliest studies were devoted to stratigraphical geology and palæontology, and he devoted much time to the preparation of a geological map of the kingdom of Hanover, and to his earnest labours much of the excellence of this map is due. The result of Prof. von Seebach's studies of the stratified rocks of Hanover are embodied in a number of separate memoirs and in his well known treatise "Die Hannoverischer Jura."

During his later years Karl von Seebach's studies were devoted to wider questions, and the investigation of volcanic phenomena occupied his attention. He visited the island of Santorin and wrote an important work on the eruption of 1866. He also published several interesting memoirs on the volcanoes of Central America, a district which he visited in 1865. Geological science has sustained a heavy loss by his early death.

ARTHUR JULES MORIN

The serious illness of General Morin to which we alluded in our last number, was followed by his death at Paris on Saturday, February 7, in his eighty-fifth year. Arthur Jules Morin was born at Paris, October 17, 1795. He entered at an early age the famous École Polytechnique, but was summoned from his studies during the fatal campaign of 1814 to assist in the defence of Paris, and rendered good service in the brigade of artillery. At the conclusion of peace he devoted four years to practical studies in military engineering at the École d'Application of Metz, and entered the army as lieutenant in a pontoon regiment. His military career was marked by a rapid and regular promotion through the different grades, terminating in his appointment as an Artillery General of Division in 1855.

General Morin's reputation rests however chiefly on his achievements in the peaceful departments of physical research, as well as on unusual executive abilities in the same connection. As an investigator his attention was directed almost entirely to the solution of problems in mechanics. In a remarkable series of memoirs presented to the Academy at Paris, during the years 1833–1835, Morin gave the results of exhaustive experiments on friction, and established the three general laws of this part of mechanics, viz. :—Friction is proportional to the pressure exerted by a body on the supporting surface ; depends on the nature and smoothness of the surfaces in contact, but not on their superficies ; and is independent of the rapidity of the motion. Equally well-known is his ingenious apparatus for determining the laws of falling bodies, in which a pencil attached to a falling weight, describes a curve on a perpendicular cylinder, rotating alongside the path of the descending body. The parabolic curve obtained by this simple but exact contrivance, demonstrates most perfectly the proportionality of the spaces described to the squares of the times employed in their description. In this connection should also be mentioned his valuable inventions of the dynameter of rotation, and the dynametric crank. In 1853-1854, Morin communicated a most valuable series of experimental results on the resistance of building materials, by means of which he established several important principles of practical application in the solution of architectural problems. Among less prominent researches, mention should be made of those on gun-cotton (1849), on the production of carbon monoxide in rooms heated by iron stoves (1869), and on the preservation of flour (1870).

As an author, General Morin is best known by his two works "Leçons de Mécanique pratique" and "Résistance des Matériaux" (1853); as well as by able reports on various technical and military inventions referred to him by the French War Department and the Academy of Sciences.

General Morin's executive abilities have long been appreciated and utilised at Paris. After occupying for some time the chair of mechanics at the Conservatoire des Arts et Métiers, he was appointed director of this important establishment in 1849. Under the thirty years of his *régime* the efficiency and influence of the Conservatoire has been vastly increased and strengthened, until it has become the chief auxiliary in elevating and educating the artisan classes of the French capital. In 1855, General Morin occupied the difficult and trying position of president of the commission for the first Universal Exhibition held at Paris. In 1862 he was elected president of the French Society of Civil Engineers. Since 1858, he has been a grand officer in the Legion of Honour. He was elected a member of the French Academy of Sciences in 1843, as successor to Coriolis in the section of mechanics, and has always maintained an influential position in the actions of that body.

T. H N.

PRE-HISTORIC MAN IN JAPAN[1]

MR. MORSE seems to claim for the shell-mounds lately investigated by him at Ômori (wrongly spelled Omori throughout his monograph), a small village a few miles from Yedo, an antiquity as high as that of the Danish kitchen-middens. I cannot help thinking the conclusion a hasty one, or, at least, not warranted by the facts set forth in the monograph in question. The shell-mounds are therein described as situate about half a mile from the shore, and the principal heap is stated to be some ninety metres in length by about four metres in breadth. It is now, I believe, completely swept away.

These mounds consist for the most part of shells, little, if at all, distinguishable from what are still to be found in abundance along the shores of the Gulf of Yedo, mixed with fragments of pottery, implements of stone and horn, clay ornaments and "tablets," together with bones of the monkey, bear, deer, dog, wild boar, and of man, the human bones or their fragments being nearly as numerous as those of the remaining mammals. Of the eighteen lithographed plates with which the monograph is embellished, fifteen are devoted to the delineation of fragments of pottery, and one cannot but regret that some of this space was not used for drawings of the bones and shells, especially of such of the latter as are stated to belong to extinct species. A figure, too, of the right lower jaw of the "large baboon-like ape" alleged to be "certainly unlike anything found in Japan to day," and supposed to belong to a species of cynopithicus (*sic*), would have been a most welcome addition. The fragments of pottery, of which drawings are given, do not tell us much. A coarse ware, with not very dissimilar ornamentation, is not hard to meet with in country villages, and inferior specimens of the well-known "banko" faience are commonly adorned with lines, strokes, dots, and "hatchings," that bear no little resemblance to those delineated in Mr. Morse's figures. The drawings and descriptions of the stone implements do not help us towards pronouncing upon their antiquity. The distance of the shell-mounds from the shore is in no way remarkable, and does not of itself prove any change of level since the period of their accumulation. Clear evidence, however, but of a very different nature, may be found in the neighbourhood of Yedo and Yokohama, of alternate elevations and depressions of the land, and it is probable that at the present day the waters of the Gulf of Yedo are slowly receding. Remains and traces of shell-heaps of quite modern date are common enough in the provinces of Musashi and Sagami, and doubtless elsewhere also, at a considerable distance from the shore, even far inland. I am inclined to believe that the dog is not indigenous to Japan, but has been introduced from China. The Japanese name "inu," indeed, seems to be connected with the Chinese word for dog "Kiuen" (cf. Greek κύων, Latin canis).[1] Lastly, the "adzuma," or eastern region of the main island was probably peopled chiefly by an Aino race, up to the fourteenth or fifteenth centuries. Yedo was not founded before the close of the sixteenth century. Legend, indeed, tells us that Nikkô was "opened" by the Buddhist saint, Shôdô shônin, in the eighth century, and that shrines were erected there towards the middle of the ninth century; but it seems probable that up to at least as late as the fourteenth century the country east of the Hakoné Pass was principally inhabited by an aboriginal race.

Upon these grounds, and in the absence of materials for instituting a comparison between the mound-shells and recent forms, I should hesitate to assign a higher antiquity to the Ômori heaps than the thirteenth or fourteenth century, and it seems to me more probable that they were the work of an Aino race than of contemporaries of the builders of the Danish middens. The question of cannibalism I have not space to discuss. We know so little about the Ainos and their customs that it is impossible to say whether these might or might not explain the occurrence of human bones in the heaps without loading the memory of a docile and gentle folk with the odious charge of anthropophagism.

Some of Mr. Morse's statements require considerable modification. The chronicles of Japan do not run back for 1,500 years, or for anything like that period. The legends run back, it is true, much farther, some millions of years indeed, but the oldest Japanese book extant, the "Kojiki," a mere collection of myths, was compiled in the eighth century of our era. The art of writing was introduced from China, hardly earlier than the sixth century, and the annals of Japan up to quite recently presented such a mixture of fact and fable that they are of but small historical value. I must add that the statement in the preface that "there is no other country in the world where so great a number of gentlemen interested in archæology can be found as in Japan," is to me a most surprising one.

The lithographs are excellent, and the paper and typography are good; but surely Mr. Morse will hardly please his Japanese friends by patting them upon the back, as if they were clever savages, because they have performed the not very extraordinary feat of making paper with European machinery, and under European superintendence or instruction, and the still more insignificant one, for some ten or fifteen years familiar to the native compositors of a dozen printing offices in Yokohama, of printing a few score pages of English with tolerable clearness and accuracy.

FREDK. V. DICKINS

[1] "Memoirs of the Science Department, University of Tokio, Japan," vol. i. part 1. "Shell-mounds of Omori." By E. S. Morse, Professor of Zoology, University of Tokio, Japan. Published by the University of Tokio, Japan. Nisshusha Printing Office, 2539 (1879).

[1] Dog's flesh is still eaten in some provinces.

THE STUDY OF EARTHQUAKES IN SWITZERLAND

ALTHOUGH much has already been done for the investigation of earthquakes, it must be admitted that yet more remains to be done, and that we are very far from what might be considered as a scientifically organised system of observations of earthquakes. Therefore all lovers of science will be much pleased to see that the sixty-first meeting of Swiss Naturalists, which was held in 1878 at Bern, appointed a special commission for the study of this important subject. The Commission, which consisted of Prof. Forster, of Bern, as president, Prof. Albert Heim, of Zurich, as secretary, Professors Amsler, of Schaffhausen, Forel, of Morges, Hagenbach, of Basel, Soret, of Geneva, and M. Billwiller, Director of the Statistical Board of Zurich, chose the telluric Observatory at Bern as its central board, and, after having put itself into communication with foreign observers, it began with the elaboration of a scheme for the organisation of a wide system of observations on earthquakes in Switzerland.

The scheme elaborated by the Commission is to provide two or three chief stations (Bern, Basel, and, if possible, Geneva) with first-class seismometers, and then to organise a wide net of second-class stations provided with simpler instruments. As to the latter three different apparatus were proposed, and will be submitted to experiment. Prof. Amsler's seismometer is a pendulum, provided at its extremity with a pencil which draws a line on a blackened paper when it is set in motion by a shock of earthquake; the time of the shock is determined by connecting the pendulum with a clock which is stopped by means of an electrical current as soon as the pendulum is set into motion. The apparatus of Prof. Forster is the common mercury seismometer, but the usual cup with mercury is replaced by two Y-like glass tubes, the upper branches of which are directed to the four chief points of the horizon. Finally, the seismometer of Prof. Hagenbach is the simplest one; it consists of three hollow metallic cylinders with heavy tops, which are placed vertically like skittles; on a simple plank, when the plank is brought into motion by a shock, the cylinders fall down, and show the direction of the shock (rolling being prevented by a layer of sand which is strewn on the plank), and as they are of different sizes, it is only the smaller one which falls when the shock is feeble, and all three when the shock is a strong one. We do not know what results might be attained by means of the cylinders, but we fear that the pendulum and the mercury seismometers will prove far more difficult to manage, and that they will give less satisfactory results than might be expected. In every case these seismometers will be submitted to a thorough trial before being introduced into practice, and Prof. Forster has already constructed a special apparatus for trying them. A thick plank, 150 lbs. weight, is suspended in a room on three strings, and, the seismometer being placed on it, shocks of various intensity are communicated to the plank by means of a heavy lead-pendulum; moreover, we daresay that an earthquake will not be long in coming to tell what is the practical value of the new instruments.

Besides, the Commission has taken steps to interest the public in this class of observations, and Prof. Heim has just published a pamphlet on the nature and causes of earthquakes, and on the means of observing them without instruments. This pamphlet, which will be translated into French by Prof. Forel, will be sent to all members of the Swiss Society of Naturalists and of the Alpine Club, as well as to the meteorological and telegraphic stations and to the editors of all Swiss newspapers. Further, special leaves, containing each a series of questions on the chief features of an earthquake, are printed, and they will be sent in great quantities throughout Switzerland. The whole country is divided into seven regions, each member of the Commission being intrusted with one of them; and as soon as the newspapers announce an earthquake, the member of the Commission in whose region it has occurred immediately sends the printed leaflets with questions to all persons who might give any information about it. All information is represented on a map and inscribed in a special book, another book being used for collecting all information about former earthquakes.

Such are the important steps taken up to the present by the Commission, and we hope that soon a widely-spread organisation will afford us detailed and accurate information on all earthquakes in Switzerland.

THE HISTORY OF VESUVIUS DURING THE YEAR 1879

PROF. JOHN PHILLIPS, in his admirable monograph on Vesuvius, has given a history of the mountain from the earliest times to the end of the year 1868. Palmieri, in his detailed description of the eruption of 1871-72, continued the history to the end of the latter year; and in NATURE, vol. xix. p. 343, the present writer has described the comparatively uneventful life of the volcano from 1873 to the end of 1878. The past year, although unmarked by any special and paroxysmal disturbance, has furnished facts not unworthy of record.

It will be remembered by readers of the former article on the subject, that at the conclusion of the great eruption of 1872, a vast abyssmal crater, 250 metres deep, and nearly as many in diameter, was left in the great cone of Vesuvius. After three years of comparative rest, during which carbonic acid, sulphurous acid, and ultimately hydrochloric acid, were evolved from fumeroles in the bottom and sides of the crater, a deep chasm opened on December 18, 1875, from which dense volumes of smoke issued. At night the smoke could be seen to be illuminated by the reflection of the light emitted by the molten lava within. A small eruptive cone was soon formed over a portion of this chasm, which increased in energy, and emitted small quantities of lava. On the night of November 1, 1878, the lava which had spread itself over the floor of the crater of 1872, rose to the lowest portion of the edge of the crater, and commenced to flow down the great cone in a north-westerly direction, towards the Atrio del Cavallo. The secondary cone rose to a height of about 20 metres, and exhibited a fair amount of dynamic activity when I visited it on December 29, 1878 (*v.* p. 344, *loc. cit.*).

During 1879 small lava streams appeared from time to time on the sides of the great cone, sometimes flowing a little distance downwards in a north-westerly direction, and occasionally towards the north-east. Prof. Palmieri, in a MS. account of "Il Vesuvio nel 1879," with which he has been so good as to furnish me, asserts that the energy is markedly greater at the time of the new and full moon. On December 17 the energy increased considerably, and a small stream of lava flowed down into the Atrio del Cavallo. When I saw the mountain during the last days of the year it emitted great volumes of smoke, but there was no lava flowing, and but slight illumination of the smoke at night. Towards the 11th of this month, however (new moon), the energy increased, and on the 13th I ascended the mountain, and witnessed a considerable augmentation of activity.

We reached the observatory at 11 a.m., when we found that a tramontana, which was blowing strongly at the foot of the mountain, was here so violent that it was questionable whether it would be advisable to attempt the ascent. Moreover, the temperature of the wind was − 3° C. (26·4° F.), and it blew with intermittent gusts of great violence. However, the guide determined to make the attempt, but he asserted that it would be impossible to ascend the cone by the usual path which proceeds nearly due west from the observatory, as the wind was blowing from the north-west, and we should be more or less in the teeth of it. Accordingly we bore to the south-west, so as to get the mountain between us and the wind. Even thus the ascent was very trying; violent gusts of wind sometimes caught us, and volcanic sand and small stones were blown across our path. On arriving at the summit I saw that the small cone, which, when I had seen it a year before, was no larger than an iron furnace, had in the course of the year increased both in bulk and height. It now reaches to a height of more than fifty feet above the rim of the great crater, and very large masses of cinders have accumulated around it. Moreover, it has almost filled up the great crater of 1872 by masses of lava and scoriæ. When the crater gets quite filled up, and the throat of the small cone choked with lava, we may look for a grand paroxysmal outburst like that of 1631 or 1872.

The cone of November, 1878, was giving off dense volumes of white steam and reddish smoke. Its dynamic activity was considerably greater than it had been the year before, and large masses of scoriæ were ejected to a considerable height at frequent intervals. The lava surged up within the throat of the cone very frequently, from the sudden disengagement of vapours within the seething mass. Near the base of this cone a small hole, apparently about five feet in diameter, had opened to give vent to lava, the great pressure of which had prevented it from rising high in the cone, and had caused the latter to give way at the point of least resistance. Two streams had recently flowed from this; a small one towards the south-west had not reached the rim of the crater; it was red-hot, not more than two inches beneath the surface, but we ran over it with no worse result than scorching our boots. The other stream—the main stream of December 17, 1879—(*vide* the accompanying woodcut) had flowed towards the north-west, and had found its way into the Atrio del Cavallo.

As we watched the lateral *bocca*, the lava within it

became furiously agitated; it was thrown up three or four feet above the opening, *exactly in every respect resembling small geysers which I have seen at Reykir, and at Haukadalr in Iceland;* and presently the liquid mass filled completely the *bocca*, and flowed over as a very fluid stream along the course of the lava of December 17. By the time we reached the Observatory again, the stream, which was about twenty-five feet wide, was seen to have flowed over the rim of the crater; by ten o'clock the same evening it had flowed half way down the great cone, and by 1 A.M. the next morning it had reached the Atrio del Cavallo, presenting an appearance almost precisely similar to that of the stream of December 17. Dense clouds of vapours marked the course of the stream; a good deal of hydrochloric acid was disengaged; and the icy tramontana in blowing over the liquid mass was converted into an unbearably hot furnace-breath. The next day (January 14) the energy of the mountain appeared to have slackened; and on the morning of the 15th a good deal of snow fell, and the course of the lava stream was well shown by a jet black line through the snow.

The lava is very leucitic, and is somewhat similar to that of 1871. The fumeroles have afforded copious sublimations of chlorides and sulphates, in which the spectroscope has revealed the presence of lithium and thallium. The gases evoked nearest to the centre of activity are sulphurous acid and hydrochloric acid. Carbonic acid still appears in some of the remoter sources of emanations.

Prof. Palmieri, in the MS. to which I have alluded above, writes as follows:—"This long and mild eruptive period, in which Vesuvius has become a mere imitator of Stromboli, will not in our opinion come to an end without displaying more decided activity. The whole history of Vesuvius, though its greater eruptions only have been chronicled by ancient writers, may be divided into periods of activity, with occasional phases of violence, and short intervals of rest. And the greatest eruptions have generally indicated the last phase of long periods of moderate activity, periods that escaped the notice of the early writers. The true history of Vesuvius could not have been written until after the establishment of the present observatory. The seismograph of the observatory gives the most accurate indications of the eruptive attempts (*dei conati eruttivi*) of the mountain and of the degree of its dynamic activity."

Two other facts require to be alluded to before we close the history of Vesuvius in 1879. The one is the alleged discovery by Prof. Scacchi of a new element in the yellow and green incrustations found on the lava of 1631. The former of these he believes to be vesbiate of aluminium, the latter vesbiate of copper. The element is named *Vesbium*, from an old name of Vesuvius mentioned by Galen. The subject requires further investigation before we can assert with any confidence that a new element has been discovered.

The second fact is tbat the Vesuvius railway, from the base to the summit of the cone, more than 1,000 feet, with an average slope of 32°, has been commenced, and is progressing thus far favourably. The work is slow, but labour is cheap; we saw fifteen men dragging a single beam of wood up the cone. We are inclined to regard the whole thing as a very hazardous commercial undertaking. For to begin with, if the company charges 20 lire for each ascent, it will be long before a fair interest can be paid on the original cost and the working expenses. Moreover, the property is insecure, a stream of lava on the south-west side of the cone would destroy the line at once, and a violent earthquake would throw all the machinery out of gear.

G. F. RODWELL

THE CRAYFISH[1]

"COMMON and lowly as most may think the crayfish, it is yet so full of wonders that the greatest naturalist may be puzzled to give a clear account of it." These words from von Rosenhof, who in 1755 contributed his share to our knowledge of the animal in question, are cited by Prof. Huxley in the preface to the careful account of the English crayfish and its immediate congeners, which forms the latest volume of the International Scientific Series. The book is not designed for "general readers," those somewhat luxurious but presumably intelligent persons for whom so much scientific knowledge is chopped and spiced at the present day. It is, as we gather from the author's statement, intended as an introduction to serious zoological study, for those who will turn over its pages, crayfish in hand, and carefully verify its statements as to details of structure with scalpel and microscope. To these and also to those who are already well versed in crustacean anatomy, the book will have great value and interest; to the latter more especially, as showing how in the careful study of one organism we are "brought face to face with all the great zoological questions which excite so lively an interest at the present day," and as an exhibition of that "method by which alone we can hope to attain to satisfactory answers of these questions."

A crayfish is treated in this volume from the point of view of "science," and in the first pages we have some excellent observations (recalling earlier remarks of the author's in the same sense) directed to clearing up that mystery which good people will insist on throwing around that ever-more-widely-heard term. "Common sense," says Prof. Huxley, "is science exactly in so far as it fulfils the ideal of common sense; that is, sees facts as they are, or, at any rate, without the distortion of prejudice, and reasons from them in accordance with the dictates of sound judgment. And science is simply common sense at its best, that is, rigidly accurate in observation, and merciless to fallacy in logic." In the preceding quotation Prof. Huxley is (in a legitimate and intelligible way) using the word "science" in place of "that quality of mental activity by which science is produced." Immediately afterwards he speaks of science as the product of certain mental operations, in a passage which possesses great beauty whilst setting forth fundamental but neglected truths as to the source and scope of human knowledge. "In its earliest development knowledge is self-sown. Impressions force themselves upon men's senses whether they will or not, and often against their will. The amount of interest which these impressions awaken is determined by the coarser pains and pleasures which they carry in their train or by mere curiosity; and reason deals with the materials supplied to it as far as that interest carries it, and no farther. Such common knowledge is rather brought than sought; and such ratiocination is little more than the working of a blind intellectual instinct. It is only when the mind passes beyond this condition that it begins to evolve science.

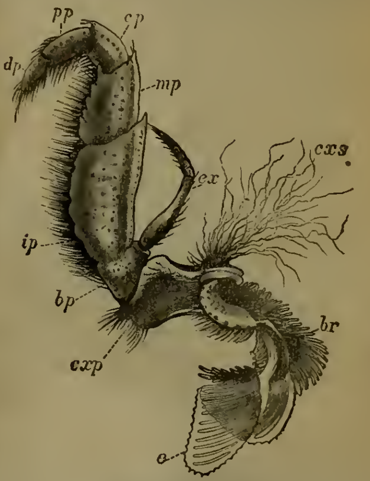


FIG 1.—*Astacus fluviatilis.*—The third or external maxillipede of the left side (× 3). *e*, lamina, and *br*, branchial filaments of the podobranchia; *cxp*, coxopodite; *cxs*, coxopoditic setæ; *bp*, basipodite; *ex*, exopodite; *ip*, ischiopodite; *mp*, meropodite; *cp*, carpopodite; *pp*, propodite; *dp*, dactylopodite.

When simple curiosity passes into the love of knowledge as such, and the gratification of the æsthetic sense of the beauty of completeness and accuracy seems more desirable than the easy indolence of ignorance; when the finding out of the causes of things becomes a source of joy, and he is accounted happy who is successful in the search, common knowledge passes into what our forefathers called natural history, from whence there is but a step to that which used to be termed natural philosophy, and now passes by the name of physical science.

"In this final state of knowledge the phenomena of nature are regarded as one continuous series of causes and effects; and the ultimate object of science is to trace out that series, from the term which is nearest to us, to that which is at the farthest limit accessible to our means of investigation.

"The course of nature as it is, as it has been, and as it will be, is the object of scientific inquiry; whatever lies beyond, above, or below this, is outside science. But the philosopher need not despair at the limitation of his

[1] "The Crayfish: an Introduction to the Study of Zoology." By T. H. Huxley, F.R.S. (London: Kegan Paul, 1880.)

field of labour; in relation to the human mind nature is boundless; and though nowhere inaccessible, she is everywhere unfathomable."

It is, then, with the object of arriving at a satisfactory conclusion as to the crayfish's place in nature, and to educe from the study of it such conclusions as may tend to throw light on the place in nature of other living things, that the reader is supposed to enter upon the consideration of the facts which Prof. Huxley lays before him.

No pains have been spared in the illustration of the text—the woodcuts (eighty-one in number) reflecting great credit both on the artist for his skill, and on the publisher for his enterprise. We have, after a general disquisition on the natural history of the crayfish (by no means the least interesting in the book), two devoted to

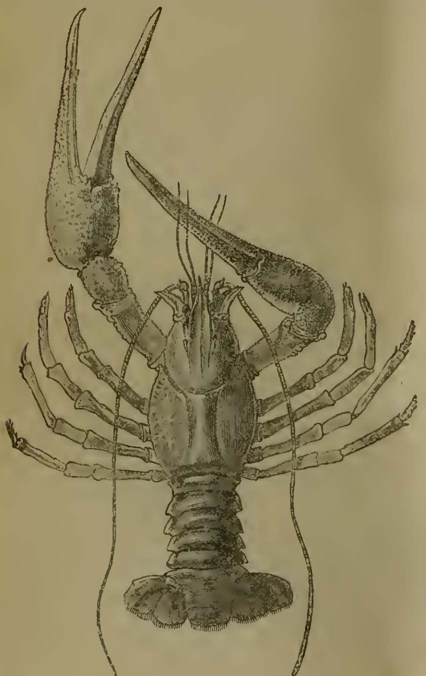


Fig. 2.—*Astacus leptodactylus* (after Rathke, ⅓ nat. size).

the consideration of the crayfish as a mechanism—in fact its physiology. Here a good deal of the anatomy is given and considered from the point of view involved in the question "What does it do?" Then we have the morphology of the English crayfish—the structure and development of the individual minutely set forth, even each joint of each leg, and each tuft on each gill, and each group of hairs, being described and figured. We are enabled by the courtesy of the publishers to reproduce one of these highly-finished engravings representing the most fully-developed of the crayfish's limbs (Fig. 1), and some others which give a fair notion of the excellence of the illustrations of Prof. Huxley's book.

To this follows a chapter in which the English crayfish is compared in a variety of points with crayfishes of other lands, such as those of Russia (Fig. 2), of Australia (Fig. 3), and of North America (Fig. 4), with lobsters and prawns, and it is explained how the amount of likeness and difference between these various but closely similar animals may be expressed by the method of classification in groups. Finally we have a chapter on the geographical distribution of crayfishes, and the facts therein narrated, together with those adduced in the previous chapter, enable the author to sketch the probable pedigree of crayfishes, that is, to *refer them to their causes*, viz., to the action of such physical agencies as flowing rivers, land and climatic barriers, brought to bear upon successive generations of the offspring of *marine* lobster-like ancestors which had a wide distribution in the earlier tertiary and later mesozoic periods, and before taking to fluviatile life had separated into two dis-

Fig. 3.—Australian Crayfish (⅓ nat. size).

tinct races characterised by differences of form, the one giving rise to the crayfish of the northern hemisphere (the Potamobiidæ), and the other to the crayfishes of the southern hemisphere (the Parastacidæ).

The novel portion of this book (novel at least to those who do not study the transactions of learned societies) is that in which Prof. Huxley details the very interesting results which he has obtained by a minute examination of the gills attached to the bases of the legs and sides of the body in all crayfish and allied forms. Three series of these gill-plumes may be distinguished according as they are attached to the leg, to the joint-membrane, or to the side of the body (Fig. 5). An ideally perfect crayfish would have all three series complete on each ring of the body in the branchial region (including the region occupied by the three pairs of maxillipedes and the five pairs of walking and nipping legs). But no such realisation of the ideal can be found in Astacine nature, any more than in that of the higher Catarrhines. In some crayfish more or less of the leg-gills are suppressed; in others, the body-gills; in others, the joint-gills; and so ringing the changes on the combination of these elements, it is possible to construct clearly-distinguished groups amongst the crayfishes of many climes, which at first sight seem to differ very little from one another. Further, Prof. Huxley shows that crayfishes and lobsters differ from prawns, shrimps, and crabs, in having villous gills instead of laminated gills, in being "trichobranchiate" in place of "phyllobranchiate."

It will probably not be welcome news to some of our readers that the English crayfish is in all probability not entitled to the current title of *Astacus fluviatilis*. This name appears to belong to a larger species, sometimes called *A. nobilis*, hardly distinguishable from the English one, which in France lives side by side with it. The smaller crayfish, which alone occurs in England, is known as *A. torrentium*. This specific title will, it is to be feared, have to be adopted, although it by implication casts a slur upon the River

FIG. 4.

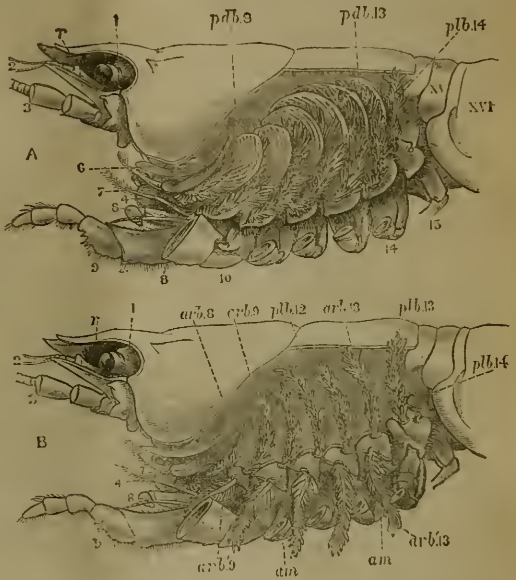


FIG. 5.

FIG. 4.—*Cambarus clarkii*, male (½ nat. size), after Hagen. FIG 5.—*Astacus fluviatilis*.—In A, the gills, exposed by the removal of the branchiostegite, are seen in their natural position; in B, the podobranchiæ are removed, and the anterior set of arthrobranchiæ turned downwards (× 2): 1, eye-stalk; 2, antennule; 3, antenna; 4, mandible; 6, scaphognathite; 7, first maxillipede, in B the epipodite, to which the line points, is partly removed: 8, second maxillipede; 9, third maxillipede; 10, forceps; 14, fourth ambulatory leg; 15, first abdominal appendage; xv., first, and xvi., second abdominal somite; *arb*. 8, *arb*. 9, *arb*. 13, the posterior arthrobranchiæ of the second and third maxillipedes and of the third ambulatory leg; *arb'*. 9, *arb'*. 13, the anterior arthrobranchiæ of the third maxillipede and of the third ambulatory leg; *pbd*. 8, podobranchiæ of the second maxillipede; *pbd*. 13, that of the third ambulatory leg; *plb*. 12, *plb*. 13, the two rudimentary pleurobranchiæ; *plb*. 14, the functional pleurobranchiæ; *r*, rostrum.

Isis. *A. fluviatilis* has red tips to its legs and a rostrum which differs by a notch or two from that of *A. torrentium*. Further, and this is very curious, *A. torrentium* never has been found to be infested by that very interesting parasite (more interesting even than the crayfish itself), the crab-leech, Astacobdella, or Branchiobdella, whilst it is quite abundant on the *A. fluviatilis*, at any rate in some rivers (*e.g.*, the Saale, in North Germany).

A. fluviatilis is largely eaten in France, attaining to the very respectable size of 5 inches or so in length, whilst our smaller *A. torrentium* is neglected from this point of view. We can recommend it, however, when boiled in salt and water, as nearly if not quite equalling the prawn.

The poisonous properties of the flesh of crayfish might perhaps be considered as justly falling within the scope of the first chapter of Prof. Huxley's treatise. As in the case of many mollusca and some true fishes, there appears to be a substance present which acts as an irritant poison upon the human organism, and to its action some persons are more liable than are others, whilst certain conditions of the crayfish seem to favour the development of a large amount of this poisonous body. A case was recently reported in a French medical journal, of the poisoning of six persons who partook of a dish of crayfishes—in one case with fatal result.

E. RAY LANKESTER

FOGS

THERE are fogs and fogs,—from the one extreme of the dry fog of continental meteorologists which merely blurs the sky with a bluish-tinted mist and shears the sun of its brilliancy as it nears the horizon, so that the eye can look on its disk undisturbed, to the other extreme of our genuine London fog which at times condenses to a consistency so thick as to give point to the sketch in *Punch* some years ago, representing a street-boy springing into the air, exclaiming "I am monarch of all I survey."

Fogs appear under widely different conditions. Thus the waters of the Arne occasionally appear for some distance after issuing from their icy cavern, like a steaming torrent of heated water. In this case, the fog which is seen to rise from the river is caused by the cold water condensing the vapour of the warmer air above it, which at the time happens to be near the point of saturation. Similarly, the Mississippi, which flows directly from colder into warmer latitudes, is often enveloped in mists or fogs. On the other hand, when the waters of a river are considerably warmer than the air over them, the vapour rising from them is condensed into fog by the colder air through which it ascends; and in such cases the fog will be the denser in proportion to the stillness of the air and its nearness to the point of saturation.

What have been called radiation fogs make their appearance during calm clear nights when the air in contact with the ground gets cooled by radiation, and becoming thereby heavier necessarily flows downwards in much the same way as water, towards the lowest levels, and floods all the low-lying grounds, mingling with and diffusing itself through the moister air of the low grounds, and condensing its more abundant vapour into fog.

Still further in such calm cold weather as has been prevalent for some weeks in the south of England, the temperature of the land falls at a greatly more accelerated rate than that of the sea. When this happens the interchange of light airs and light breezes which set in from the sea landwards and *vice versâ* along a considerable extent of coast, mixes the colder with the warmer and more humid air-currents, and thereby lays a thick covering of fog over the surface.

There is yet another fog of great significance in the study of atmospheric circulation, which spreads over a much wider extent than any of the other fogs referred to. This is the fog which is frequently found in the region of the outskirts of the anticyclone, or rather in the debatable region between the cyclone and the anticyclone. The most probable explanation of it is that it arises from the diffusion of the vapour brought up by the cyclone outwards and through the colder and drier air of those parts of the anticyclone contiguous to it, where it is condensed into immense breadths of fog frequently stretching several hundred miles in length. Much yet remains to be done in instituting, even, an exact and systematic observation of this important weather phenomenon from the results of which we might hope to come at some knowledge of its true meaning and its significance in forecasting weather, particularly those changes of weather which terminate long tracts of fine dry weather.

Now if we examine the weather charts from new year's day to the present time, it is seen that the south-east of England has been constantly either within anticyclones or under their immediate influence, the centres of which kept shifting to and fro over a rudely shaped quadrilateral marked off by Corunna, Sligo, Copenhagen, and Bucharest. During nearly the whole of this time, London has been within the belt of fog and mist which continuously, or discontinuously, has been skirting the margin of these anticyclones. At the same time the air has been unusually calm. Thus at Greenwich for the four weeks ending January 31, the mean daily horizontal movement of the air was only 144 miles, being 182 miles less than the average; and during the five foggy days in the last week of January the daily movement of the air was 269 miles under the average.

Hence, then, the fogs which London has had in common with the south of England and parts of the continent opposite, have been intensified by the low temperatures and still atmosphere bringing from time to time their contributions of radiation fogs and other fogs, still denser, drifting ever and anon through the heart of the city from the adjoining sheets of salt and fresh water. The last touch in the production of the very worst character of these fogs was doubtless given by the smoke of London, in the manner explained by Sir John Herschel in his "Meteorology," whereby each particle of soot acting as an insulated radiant, collects dew on itself, and sinks rapidly down through the fog as a heavy body, thus giving to these fogs their yellow thick consistency and the suffocating and unwholesome sensation experienced in breathing them.

In the weekly reports of the Registrar-General for December, 1873, several deaths are certified as having been more or less directly caused by the extraordinarily dense fogs which then prevailed; and in one of the reports it is remarked that "In the large provincial towns, where the same cold weather was unaccompanied by fog, the increase in the mortality was slight compared with that which occurred in London." In the last week of January, when the fog was so dense, the deaths in London from whooping-cough rose to 193,—a fatality from this disease hitherto unexampled in the London bills of mortality. A careful examination of the weather and health of London, particularly as regards the deaths resulting from throat and nervous complaints, could not fail to contribute materially to the diffusion of a better knowledge than we yet possess of the influence of these fogs on the public health.

NOTES

Dr. Broca, the eminent anthropologist, has been elected a life member of the French Senate by a majority of eight. This election has created some sensation, Dr. Broca's nomination having been opposed on the ground of his Darwinist opinions. Dr. Broca opened the last meeting of the Anthropological Society by a short address, in which he considered his election as a victory gained not only by his political, but also by his scientific opinions.

Almost a panic has occurred amongst the wine-growers of Cape Colony, in consequence of the supposition that not only was the *Phylloxera* causing the destruction of some of the choicest vines, but that it had existed there, undetected, for several years. An influential, and somewhat animated, meeting was held at Cape Town to discuss the subject. We understand that samples of the vines, supposed to have been attacked by the pest, were forwarded to the Colonial Office and sent on to Kew, and that these have been examined by Mr. McLachlan, who is of opinion that all the characteristic signs of the action of *Phylloxera* are absent, and that nothing is shown to induce uneasiness in the minds of South African wine-growers on this score. The samples had been packed in the worst possible condition for minute examination; but according to a report in a Cape paper, Mr. Roland Trimen, of Cape Town, had examined samples submitted to him on the spot, and pronounced a similar opinion. Some of the vines are undoubtedly in an unhealthy condition, from unexplained causes. It is to be hoped our Cape colonists will not allow panic to take possession of them, and, under its influence, rush into extremes. It is probable that some of the South European nationalities that have carried the absurdity of panic to its highest limit—to the extent of confiscating a bouquet of wild flowers in the hands of unsuspecting ramblers—unwittingly permit the importation of "contraband" vines to a large extent.

According to the report of the French Phylloxera Commission, the pernicious insect has spread in a deplorable manner during the last two years, in spite of all measures to the contrary. The black patches on the maps of the Commission, and which represent those districts over which the plague has a complete hold, must be enlarged year after year. Great hope was placed in snow, but it proved futile, inasmuch as snow must cover the ground for at least forty-five days to destroy the insects, and nowhere has the snow lasted so long as that. About one-quarter of the French wine-growing districts are now destroyed. All disinfectants prove useless, and it seems hopeless to attempt to arrest the progress of the plague. Prof. Rayual of Poitiers proposes, as a last remedy, the radical destruction of all vineyards situated at the boundary of the infected districts, and the establishment of a "neutral" zone.

THE Chair of Chemistry in the newly established Agricultural College of Berlin, is to be filled by Prof. H. Landolt, of Aix-la-Chapelle, well known by his exhaustive studies on the relations between the optical properties of bodies and their chemical constitution. His wide experience in saccharimetry has likewise led to his simultaneous appointment as director of the Chemical Laboratory established at Berlin by the German *Verein für Rübenzucker-Industrie.* Prof. Landolt is succeeded in the Polytechnic of Aix-la-Chapelle by Prof. A. Classen, who has recently published two favourably-received laboratory manuals on Qualitative and Quantitative Chemistry.

IT will be a surprise to many to learn, the *Gardeners' Chronicle* tells us, that General Munro, C.B., whose decease occurred on the 29th ult., had claims on the respect of his countrymen as a learned botanist as well as a distinguished soldier. He contrived to combine with his military duties such a knowledge of general botany and horticulture, and so close a study, so searching an investigation of the characters, affinities, nomenclature, and classification of grasses, as to have been for many years the most trustworthy referee in that difficult order. With the exception of a monograph on the Bamboos in the *Transactions* of the Linnean Society, General Munro found time to publish but little. That monograph, however, affords sufficient evidence of his ability, industry, and profound knowledge of his subject. It was elaborated, we believe, in one of the intervals of active service. When, two or three years since, he retired from the army and established himself near Taunton, he at once commenced a general monograph of the whole order. This was intended to form one of the monographs in the series of such works now being issued in continuation of the *Prodromus* by MM. Alphonse and Casimir de Candolle. To the abiding loss of botany this monograph remains incomplete. It is to be feared that a long time must elapse ere any competent monographer will take upon himself the irksome labour of elaborating such a work.

M. BERROT, the director of the École Normale Supérieure died at Paris on February 3, at the age of fifty-six.

THE *Photographic News* informs us that Prince Leopold is a good chemist and has a practical knowledge of photography.

THE fragments of the 38-ton gun destroyed for experimental purposes in the bursting-cell in the proof-grounds, Government Marshes, adjoining the Royal Arsenal, Woolwich, on Tuesday last, have all been recovered, and are found to number about 120 pieces. They have all been marked, and are being washed and arranged for inspection. The two projectiles were taken from the sand-butt in front of the gun, both broken in pieces, and it is evident from the appearance of the bore that they broke up before leaving the gun, the marks of the rifling being in parts quite effaced. The muzzle end of the steel tube, about 3 feet in length, is intact, with parts of the wrought iron super-coil remaining attached, and a singular appearance is presented by the rearmost end of this fragment, the steel having been violently rent and incurved as though a shot or lighter fragment, moving faster than itself, had overtaken it and struck it with considerable force. The crusher gauges fixed on both projectiles have been recovered, but give no positive data respecting the pressure produced by the explosion. A very great pressure had been expected, and the copper crushers had consequently been subjected to a pressure of thirty-five tons to the square inch before being inserted in the plugs. This pressure was not exceeded in the explosion, and the only apparent deduction arrived at of importance is that a strain which would not be alarming in the powder chamber has sufficed to burst the gun a the spot where its thickness and strength suddenly diminished.

THE publication is announced of a magnificently illustrated "Iconographical History of the Orchid," by M. E. de Puydt, Secretary of the Royal Society of Agriculturists at Mons.

THE *New York Herald* publishes a despatch from Havannah, of date January 28, stating that the recent earthquake was felt in San Diego, Santiago de las Vegas, Pinar del Rio, Cienfuegos, Mariel, and other places. The small town of San Cristobal was almost destroyed. On January 24, at 7.45 P.M., an earthquake was felt at Karlsruhe, Rastadt, and Spier. It appears to have consisted of three different shocks, the direction being from west to east, and the duration about ten seconds. The shock was also felt in Durlach, Mühlburg, Daxlanden, Eggenstein, Sollinger, Lenkenheim, Weingarten, Hittenheim, Philippsburg. The commotion was very great, principally in Pletteersdorf, close to Rastadt, where the inhabitants were so frightened that they left their houses. It appears that in the vicinity of Spier a second shock was felt on the 28th, from 3 to 4 A.M. A severe shock of earthquake occurred in the Kurrum Valley, Afghanistan, on the 8th inst. Smart shocks of earthquake were felt at Sion, in the Valais, on Saturday week.

AT a recent meeting of the Boston Society of Natural History, Mr. F. W. Putnam remarked on the character of the shell-heaps of the Atlantic and Pacific coasts of North America, and stated that there had been received at the Peabody Museum a small collection of articles taken from rude dolmens (or chambered barrows, as they would be called in England), recently opened by Mr. E. Curtiss, who is now engaged, under his direction, in exploration for the Peabody Museum. These chambered mounds are situated in the eastern part of Clay Co., Missouri, and form a large group on both sides of the Missouri River. The chambers are, in the three opened by Mr. Curtiss, about 8 feet square, and from 4½ to 5 feet high, each chamber having a passage-way several feet in length, and two in width, leading from the southern side, and opening on the edge of the mound formed by covering the chamber and passage-way with earth. The walls of the chambered passages were about 2 feet thick, vertical, and well made of stones which were evenly laid without clay or mortar of any kind. The top of one of the chambers had a covering of large flat rocks, but the others seem to have been closed over with wood. The chambers were filled with clay which had been burnt, and appeared as if it had fallen in from above. The inside walls of the chambers also showed signs of fire. Under the burnt clay, in each chamber, were found the remains of several human skeletons, all of which had been burnt to such an extent as to leave but small fragments of the bones, which were mixed with the ashes and charcoal. Mr. Curtiss thought that in one chamber he found the remains of five skeletons, and in another thirteen. With these skeletons there were a few flint implements and minute fragments of vessels of clay. A large mound near the chambered mounds was also opened, but in this no chambers were found. Neither had the bodies been burnt. This mound proved remarkably rich in large flint implements, and also contained well-made pottery and a peculiar "gorget" of red stone. The connection of the people who placed the ashes of their dead in the stone chambers with those who buried their dead in the earth-mounds is, of course, yet to be determined.

HER MAJESTY'S Consul at Hakodate, Japan, states in his just published report that a botanical garden has been started at that place. The matter originated with private individuals as the suggestion of a foreign lady, but the Kaitakushi, or Colonisation Department, has taken the matter in hand, and has started a public garden. In order to give it the character of a public undertaking, every ward in the town was induced to work there one whole day, in addition to the regular workmen employed. The paths were smoothed by the singing girls and others, and finally all the officials took part in constructing the Fusiyama of the garden, without which no Japanese garden is complete.

As evidence of the enlightened condition of the Japanese as compared with their neighbours in China, it is interesting to learn from the *Hiogo News* that the duplex system of telegraphy with the Morse instrument has been in successful working for some months past on one of the longest of the Government lines, that between Yokohama, Kobe, and Nagasaki.

The *North China Herald* understands that the investigations made by Mr. Chaloner Alabaster, H.M.'s Consul at Hankow, into the ancient religions and philosophies of China, have led him to the discovery that there is a very evident connection between them and modern masonry.

The *Jahrbuch der Erfindungen*, by H. Gretschel and G. Wunder, 1879, does not profess to deal with the whole of the wide field of science. It discusses especially the progress of chemical technology, and of chemistry, which occupy nearly a half of the book; then, with the chief acquisitions of physics, and analyses several important works in astronomy and meteorology. The departments of chemistry and of physics are the best; without attempting to render science popular, the *Jahrbuch* of MM. Gretschel and Wunder gives a good scientific summary of the work accomplished, and it will be most useful for those who, without being specialists in chemistry and physics, wish to have trustworthy information as to the progress realised in these branches during the year.

We have had occasion during the past year (Nature, vol. xix. p. 398) to describe in detail the novel and interesting chemical industry, created by Prof. C. Vincent of Paris, which consists in the manufacture of methyl chloride from beet-root vinasses. The ingenious inventor has sought to increase the applications of the final product of his manufacture, hitherto confined to the production of methylated aniline colours and artificial cold, and has discovered a profitable and valuable employment for it in the extraction of the odoriferous principles of flowers for use in perfumery. For this purpose the gaseous methyl chloride is thoroughly purified by passing it through concentrated sulphuric acid, and then liquefied by strong pressure. The liquid chloride is introduced into the apparatus containing the flowers, and after remaining a few minutes in contact with them, passes into another apparatus where a vacuum has been produced. A rapid vaporisation followed by a renewed condensation brings the chloride back to its original state, while the odoriferous principles in company with waxy and fatty extracts are left behind. They are entirely freed from the latter and obtained in a high state of purity by simple treatment with cold alcohol. Apart from the ease and rapidity of the new method, it seems to cause much less change in natural perfumes than has hitherto been the case in distilling the flowers with water. The new process has already been mounted on a scale for treating a ton of flowers daily.

The Emperor William has recently conferred the Order of the Red Eagle on Prof. Heeren, of the Hanover Polytechnic, Prof. Hattendorf, of the Polytechnic at Aix-la-Chapelle, and Professors Roth, Websky, and Wichelhaus, of the University of Berlin. Most of these decorations are in recognition of special services in developing the mineral resources of the country.

We have received, as the first publication of the Willughby Society, a reduced photolithographic reproduction of Tunstall's "Ornithologia Britannica," edited by Prof. Alfred Newton, F.R.S. Other works in hand for the Society are Sir Andrew Smith's papers in the *South African Journal* and "Report" of his Exploring Expedition, and Defontaine's "Mémoire sur quelques nouvelles Espèces d'Oiseaux des Côtes de Barbarie" from "Hist. de l'Acad. des Sciences," 1787. The Secretary of the Society is Mr. F. Du Cane Godman, 10, Chandos Street, Cavendish Square, W.

M. W. de Fonvielle writes us that the works for disincumbering the Loire of ice at Saumur are progressing favourably. It is estimated that on February 7 not less than 50,000 cubic metres of ice blocks were exploded and sent adrift with the current. M. Varoy, the Minister of Public Works, has communicated to his colleagues in council despatches announcing that no danger is to be now apprehended from the impending swelling of the Loire. One of the greatest difficulties in demolishing the ice-blocks was the small quantity of water in the river, but owing to the change of weather, the Loire is swelling rapidly. One of the peculiarities of the Saumur ice-blocks is the difference of colour exhibited. Some of them, impregnated with a minute sand, and produced in the bottom of the stream, are coloured yellow, others are perfectly transparent; a large number formed in the Vienne are magnificently coloured azure blue, and many are white and opaline, owing to a large number of air bulbs which obscure the transparency.

A very favourable report was presented at the annual meeting, yesterday, of the Royal Microscopical Society. The total number of Fellows is now 575; improvements have been made in the library, several additions have been made to the collection of instruments and objects, and it was proposed to enlarge the journal of the Society.

The report read at the recent annual meeting of the Birmingham Natural History and Microscopical Society showed that although the number attending the meetings during the past year had, from various causes, been somewhat smaller than usual, the work of the Society had been, on the whole, very satisfactory, resulting in the discovery of many rare animals and plants, and of four species of animals new to Great Britain. The finances of the Society were in a flourishing condition. It was announced that about 700*l.* had been expended on the library and apparatus since the establishment of the Society in 1858. We believe a special meeting of this Society will shortly be held to consider the propriety of creating a new class of Members, to be called Associates, consisting of intelligent youths of from fifteeen to twenty one years of age, who are interested in natural history. This is a step quite to be commended. Prof. Huxley has accepted the office of honorary vice-president of this Society.

A splendid stalactite cavern has just been discovered in the Adams Valley (Moravia), which is celebrated for its numerous natural beauties. A peasant from the village of Sloup had the courage to penetrate into one of the numerous creeks which are found in the caves near Sloup. When he had reached the end of the creek he lit a candle, and to his astonishment found himself in a picturesque stalactite cavern measuring some 40 metres in width and length and some 25 metres in height. Stalactites of 1 or 2 metres in length descended from the ceiling, and mighty stalagmites arose from the ground like a forest of stone fir trees. The peasant announced his discovery to the Mayor of Proskowitz (the district town), who also visited the cavern and gave orders for enlarging the entrance and providing it with a gate, &c.

A letter from South Africa states that companies have been formed in Griqualand West and Natal to prospect for gold in Sikukuni's country, where it is known to exist.

The additions to the Zoological Society's Gardens during the past week include two Thars (*Capra jemlaica*), six Impeyan Pheasants (*Lophophorus impeyanus*) from the Himalayas, three Horned Tragopans (*Ceriornis satyra*) from the South-East

Himalayas, a Temminck's Tragopan (*Ceriornis temmincki*) from China, a Spotted Turtle Dove (*Turtur suratensis*) from India, presented by H.R.H. the Prince of Wales, K.G.; two Black Lemurs (*Lemur macaco*) from Madagascar, presented by the Rev. G. P. Badger, D.C.L., F.Z.S.; a Sykes's Monkey (*Cercopithecus albogularis*) from East Africa, presented by Miss Mabel Beale; a Sambur Deer (*Cervus aristotelis*) from Malacca, presented by Mr. W. H. Stevenson; a Stanley Crane (*Tetrapteryx paradisea*) from South Africa, presented by Capt. Edward Jones, R.M.SS. *Conway Castle*; a Wood Owl (*Syrnium aluco*), European, presented by Mr. W. Addison; a Kittiwake Gull (*Rissa tetradactyla*), European, presented by Mr. H. R. Bower; a Hairy-nosed Wombat (*Phascolomys latifrons*) from South Australia, deposited.

OUR ASTRONOMICAL COLUMN

THE HARVARD COLLEGE OBSERVATORY.—We have received the Thirty-fourth Annual Report of the Director of this Observatory, presented to the Visiting Committee on December 5. Prof. Pickering notifies that the subscription of 5,000 dollars a year for five years, suggested in his previous Report, for relieving the immediate needs of the Observatory, more especially with regard to the publication of accumulated work, has been completed through the liberality of some seventy ladies and gentlemen, who have thus shown their interest in the establishment, an example of scientific zeal, we may say, by no means unique in the United States, nor indeed in the history of the Harvard Observatory; it may be remembered that the beautiful plates illustrating Mr. G. P. Bond's great work upon Donati's comet (Harvard *Annals*, vol. iii) were contributed by a few citizens of Boston and vicinity. The success attending the subscription has enabled both the equatorial and the meridian circle to be actively used during the year, the former frequently through the night. Photometry is still made the prominent feature in the work; vol. xi. of the *Annals* will contain the results of over 25,000 photometric observations, principally made with the large equatorial; amongst them are measurements of the outer satellite of Saturn, *Japetus*, on 101 nights in the autumn and winter of 1878-79, which, with similar observations on twenty-eight nights in the previous year, will furnish a determination of the law followed by this satellite in its changes of brightness. Another work of some extent, in the same direction, was commenced in 1879, viz., a determination of the light of all stars visible in the latitude of Harvard College; a preliminary catalogue has been formed containing all the stars in the Uranometries of Argelander and Heis, and in Behrmann's Atlas, with the stars of the *Durchmusterung* to the sixth magnitude inclusive. Most of the stars being inconspicuous objects, Prof. Pickering remarks, there would be much loss of time in identifying them in the field of a photometer mounted on an ordinary stand. This he avoids by observing them in the meridian as with a transit-instrument. "The photometer consists of a horizontal telescope pointing to the west, and having two objectives. By means of two prisms mounted in front of the telescope the pole-star is reflected into one object-glass, and the star to be measured into the other. The cones of light are made to coincide by a double-image prism, the extra images being cut off by an eye-stop. The star to be measured is thus seen in the same field with the pole star, with the same aperture and magnifying power." Errors to be apprehended in the use of the Zollner photometer and other instruments, when the comparison is made with an artificial star are by this means eliminated. Of the work with the meridian circle, the observation of eight thousand stars in the zone + 50° to + 55° undertaken by the Observatory, and which has occupied Prof. Rogers during the greater part of eight years, was completed on January 26, 1879, and is mentioned as one of the largest astronomical undertakings which have been carried to completion in the United States; some years, it is added, will still be required to finish the reductions and publication of this work. The General Catalogue, 1874-75 (in vol. xii.) will be issued shortly, over two hundred pages being in type. Vol. xi., to which we have alluded, will be distributed in the course of the present year.

It will be seen from this summary of the contents of Prof. Pickering's Report that the Harvard College Observatory is fully maintaining the high reputation it acquired under the management of his predecessors, and the discrimination with which the subjects to which attention is directed are chosen, so as to avoid unnecessary or useless duplication of work, is not the least important point to be remarked. If this should hardly appear to apply to the proposed determination of the light of naked-eye stars, it must be remembered that the previous determinations of Argelander, Heis, &c., were made from eye-estimation, not by photometric instruments.

THE MINOR PLANETS IN 1880.—The specialty of the *Berliner astronomisches Jahrbuch* is well known to be the ephemerides of the small planets, which at the expense of a great amount of labour Prof. Tietjen has for many years kept up so nearly to our knowledge of these bodies. In anticipation of the appearance of the volume for 1882, these ephemerides applying to the year 1880 have just been circulated amongst observers. In addition to fifty-nine accurately computed ephemerides about the times of opposition of as many planets, there are approximate places for every twentieth day of the first one hundred and ninety-nine of this numerous group, excepting only *Dike* and *Scylla*, for which adequate material for calculation does not exist. Only two out of the number approach the earth during the year, within the distance 1·0, viz., *Ariadne*, in the middle of May, distance 0·923, and *Procne*, in the middle of August, distance 0·996.

That *Dike*, No. 99, should be still adrift, notwithstanding it was discovered as far back as May, 1868, is not perhaps a matter for surprise, considering that M. Borrelly, when he detected it, did not estimate its magnitude over 13·14, though it was within ten degrees from the perihelion. *Scylla* was observed for a fortnight in November, 1875, and may have been in opposition during the last autumn, though not found: from the elements in the *Annuaire* for 1879, it would not appear to be identical with No. 206, discovered by Prof. Peters at Clinton, N.Y., on October 13, 1879, and only observed for three or four days.

A GREAT COMET.—Dr. Gould, in charge of the Argentine National Observatory at Cordoba, telegraphs thus from Buenos Ayres to Prof. Peters, the editor of the *Astronomische Nachrichten*:—"Great comet passing sun northwards;" the telegram was received at Kiel on the 5th inst. The ocean cables may in future prevent such a surprise as was experienced in these latitudes on the sudden appearance of the huge comet of June, 1861, which, rising rapidly in declination and passing the sun, as Dr. Gould describes the new one, was observed simultaneously or nearly so, throughout Europe, with a tail upwards of 100° in length. The astronomical phenomena of the present year which admit of prediction, do not offer any feature of special interest, and a large comet will therefore come the more opportunely.

PHYSICAL NOTES

TWO researches on singing condensers, such as that employed in Varley's telephone, have lately been published. M. R. Chavannes, in the first of these, maintains that undulatory currents produce no sounds in such condensers; that intermittent currents are absolutely necessary. M. Trève has shown, in the second, that a pressure exerted upon the leaves of the condenser sufficient to drive out the air from between them will destroy the production of the tones; and that if the condenser is placed in an exhausted chamber it ceases to emit sounds.

IT will be remembered that in 1876 Prof. Rowland discovered the magnetic effects of electric convection. M. Lippmann has discussed, in a recent number of the *Comptes Rendus*, the converse case of the ponderomotive force exercised upon material bodies charged with electricity by the relative motion of a magnet.

CAST-IRON MAGNETS are now being made of a superior quality by M. Carré, who publishes in the *Revue Industrielle* an account of his process. A soft and very slightly carburetted metal is melted in earthen crucibles. Just previous to running into the moulds 10 to 15 per cent. of steel filings are added. In order to produce a metal which will stand tempering at a cherry-red heat, there is added either 1 to 1·5 per cent. of nickel, with 0·25 per cent. of copper, or 2·0 per cent. of tin and 0.5 per cent. of copper.

AN "acoustico-electrical kaleidoscope," the invention of M. Michelangiolo Monti, is mentioned in *Les Mondes*. It consists of a microphone used in conjunction with an induction-coil and a Geissler tube, and is, like Edmunds's phonoscope, which it resembles, intended for the optical study of sounds. A complete description of the instrument is not, however, given.

According to Herr H. Schwarz, an admirable cement for glass, and one which completely resists the solvent action of water, may be prepared by the following process: From 5 to 10 parts of pure, dry gelatin are dissolved in 100 parts of water. To the solution about 10 per cent. of a concentrated solution of bichromate of potash is added, and the liquid is kept in the dark. When articles joined by means of this cement are exposed to the light the gelatine film is acted upon by the chemical rays, the chromate being partially reduced, and the film of cement becomes extremely tough and durable.

The "meter" devised by Edison for his system of domestic electric lighting depends upon the electro-deposition of copper upon an electrode in a branch circuit whose resistance bears a known ratio to that of the circuit of the user, the movable copper electrode being weighed at stated intervals in order to gauge the consumption. There is also in the "meter" a most ingenious contrivance whereby if any consumer draw too largely on the supply the armature of an electromagnet in the circuit is attracted and "cuts out" the transgressing consumer, actually fusing up the only remaining metallic connection!

Lippmann's principle that if by mechanical means we deform a mercury surface, an electrical liberation is produced which tends to arrest the movement of the mercury, has led M. Debrun to contrive an apparatus (*Jour. de Phys.*, January) in which mercury is admitted in drops, with acidulated water between, down a conical tube, into a vessel arranged as a Florentine receiver (giving separate outflow to the two liquids). The upper and lower masses of mercury are connected with platinum wires, which take their polarity, and a current is found to proceed in the direction of the globules. With a tube 0·30 m. long, 2·5 mm. diameter at top, and 1 mm. at the lower part, and containing at least twenty mercury globules, and not more than thirty-five, the electromotive force is about 1·4 volts, giving decomposition of water with Wollaston points. Only 2 kg. of mercury are expended in the hour. Letting the mercury flow twenty-four hours, M. Debrun was able to silver strongly a five-centimes piece. Several experiments may be made with the apparatus; thus if the poles are disconnected the mercury flows slowly and difficultly, but when they are connected it flows very rapidly.

A new galvanic battery with circulating liquid, described by Signor Ponci in *Natura* (3, p. 402, 1879), has the following form:—Rectangular lead channels, beak-shaped at one end, are so placed over one another in slanting position that the beak of the first is over the broad end of the second, and so on. In each channel is an amalgamated zinc plate, and above this a carbon plate insulated from it by two rings of caoutchouc; the carbon plate is perforated under the beak of the lead channel above. The lead channels have wires, and the carbon plates, at their upper ends, binding screws, with which they are alternately connected. By means of a caoutchouc siphon a solution of chromate of potash is conducted through the system (200 gr. $K_2Cr_2O_7$, 21 water, 11 commercial muriatic acid; for long use 3 to 6 litres water and 100 to 150 ccm. muriatic acid may be added to each litre of the solution). A battery of 99 such elements gives a light-arc equal to that of a battery of 60 Bunsens, and is constant in duration.

The following reaction, proposed by M. Jorissen, for discovering very weak traces of morphine, is reported by M. Donny (*Bulletin* of Belgian Academy) to be very sensitive. The morphine is treated first with sulphuric acid, then with ferrous sulphate; a nearly colourless liquid is thus obtained, but on letting it fall drop by drop into concentrated ammonia, a very intense blue-purple coloration is immediately produced.

GEOGRAPHICAL NOTES

At the meeting of the Geographical Society on Monday evening, the Earl of Northbrook announced, amidst great applause, that Colonel Gordon had been elected an Honorary Corresponding Member, and at the same time passed a high eulogium on his character and his services in Egypt and elsewhere. Major-Gen. Sir M. A. S. Biddulph, K.C.B., who commanded a column in the last Afghan campaign, afterwards read a paper on the eastern border of Pishin and the basin of the Loras. The country dealt with had never previously been examined by Europeans, all our information having been derived from native sources, and consequently the particulars so laboriously collected by Sir M. Biddulph, with the aid of the survey officers acting under him, will prove of the utmost value to cartographers. He mentioned several instances in which our present maps are entirely wrong, specifying one in which the position of a place would have to be shifted fifty miles. A peculiar characteristic of the country examined was the existence of long plains in the valleys, which rendered movement comparatively easy, another being the great number of water-partings. The basin of the Loras,—a name given to all streams in that region,—consists, in fact, of a curiously involved system of mountain ridges, about which Sir M. Biddulph furnished much valuable topographical information.

At a committee meeting of the German African Society at Berlin, at which Dr. Gerhard Rohlfs was present, it was resolved to recommend Dr. Stecker to continue the expedition to Wadai, by way of Mursuk, Bornu, and Adamauk, as on this route he will travel under the protection of the Khedive of Egypt. According to the opinion of Dr. Rohlfs it is beyond all doubt that the Turkish government will fully compensate the Society for the loss sustained through the attack upon the expedition.

The *Vega* left Port Said on the 6th inst., and may be expected to reach Naples to-day.

The new number of the *Annales de l'Extrême Orient* contains, among other matter, a paper on the languages and literature of Java, by Prof. P. J. Veth, President of the Dutch Geographical Society, notes on recent Dutch explorations in New Guinea, and some remarks on Lieut. Delaporte's work, entitled "Voyage au Cambodge."

Mr. Alexander Forrest contributes to the December number of the *Victorian Review*, published at Melbourne, a very interesting, though somewhat brief account of his explorations during his recent journey from Perth, West Australia, to Port Darwin, in the Northern Territory. We believe that Mr. Forrest is very sanguine that large tracts of the fertile country which he has discovered will shortly be taken up and occupied by settlers.

The last number of the *Proceedings* of the Asiatic Society of Bengal contains a paper on the exploration of the Great Sanpo River of Tibet, by Major-General J. T. Walker, which is illustrated by a map. Capt. W. E. Gowan also furnishes a translation from the Russian of the geographical information regarding the Kirghiz Steppes and country of Turkistan, afforded by the Book of the Great Survey.

Writing to *Les Missions Catholiques* from Landana, in Congo, Père Carrie supplies a few particulars respecting Mr. H. M. Stanley's expedition from the west coast, about which the International African Association has been remarkably silent. Mr. Stanley, it appears, has with him fourteen white men, one Arab, two natives of Sierra Leone, and sixty-one men from Zauzibar, whence a large additional number are shortly expected to arrive in charge of a European. Père Carrie adds that Mr. Stanley has already established a station at Noki, some miles above Mboma. He has with him a number of wooden houses all ready for erection at various points as he advances into the interior.

As the result of fifteen years' research into the archæological riches of Hainault, M. Théodore Bernier has just published (Mons: H. Maneraux) a volume entitled "Dictionnaire Géographique, Historique, Archéologique, Biographique, et Bibliographique du Hainault."

In connection with Mr. G. J. Morrison's paper on the Grand Canal, read before the Geographical Society on January 12, much interest attaches to a letter in the *North China Herald*, from its Tientsin correspondent, whose experiences are about eighteen months later. Being desirous of going to Tê-chow, in Shantung, he made the journey by the Grand Canal The water in the Pei-ho at the time was higher than it had been for nearly ten years, but the Canal had risen but slightly, the water coming mainly from the streams to the south-west. On the second day, however, a sudden rise was apparent, the water wanting but an inch or two of overflowing. Still little effort was made to guard against danger; a few weeds or *kao-liang* (millet) stalks covered with earth, or simply a few shovels-full of earth in many cases, were the only defence against the rising water. To the west of the Canal was a vast expanse of flooded country, stretching for 100 miles or more. At one place where the bank was weak, piles were being driven and an embankment of earth and weeds was being made, while at another point, much exposed to the force of the wind and water, a number of old grain junks had been drawn up in line against the bank to break the force of the waves.

THE just published *Bulletin* of the Société Normande de Géographie contains a note of some interest on Algeria, by M. E. Masqueray, whose address on the same subject is promised in the next number.

THE United States Government are about to despatch a party of military and naval engineers to examine the various routes proposed for an inter-oceanic ship-canal across the Isthmus of Panama.

THE February number of *Petermann's Mittheilungen* contains two important papers on South American travel. Herr Fr. von Schenck describes a journey he made in 1878 in Antióquia, in the United States of Columbia, and another long paper gives an account of the travels of Messrs. Rogers and Ibar in South-West Patagonia in 1877, to which are added the journals of A. de Vicuna, in 1782, and J. H. Gardiner in 1867.

WE have to record the death of M. Capitaine, the editor of *L'Exploration*, at the early age of forty. M. Capitaine had been in former years a surgeon in the national navy, and has written numerous papers on subjects of geographical interest.

ON A NEW ACTION OF THE MAGNET ON ELECTRIC CURRENTS[1]

THE statement that "the mechanical force which urges a conductor carrying a current across the lines of magnetic force, acts, not on the electric current, but on the conductor which carries it," has often been a puzzle to students of electricity. Experiments have been made at various times to prove that the statement is not correct, but have hitherto uniformly resulted in failure. Mr. E. H. Hall working under the direction of Prof. Rowland believes himself to have been more fortunate than his predecessors, and describes an experiment which apparently proves a permanent effect of a magnet on the distribution of currents in a system of wires. As Mr. Hall promises a more extended investigation we shall describe his experiment as much as possible in his own words without comment or criticism.

The following experiment had apparently been formerly tried by Prof. Rowland, but without success:—

"A disk or strip of metal, forming part of an electric current, was placed between the poles of an electro-magnet, the disk cutting across the lines of force. The two poles of a sensitive galvanometer were then placed in connection with different parts of the disk, through which an electric current was passing until two nearly equipotential points were found. The magnet current was then turned on and the galvanometer was observed, in order to detect any indication of a change in the relative potential of the two poles."

No such change could be observed and Mr. Hall now repeated the same experiment substituting a piece of gold leaf, mounted on glass to the metal strip. Experimenting as above he obtained on October 28 a decided deflection of the galvanometer needle.

"This deflection was much too large to be attributed to the direct action of the magnet on the galvanometer needle, or to any similar cause. It was moreover a permanent deflection and therefore not to be accounted for by induction."

Some rough quantitative experiments were tried with the result "that with a given form and arrangement of apparatus the action on the Thomson galvanometer is proportional to the product of the magnetic force by the current through the gold leaf. This is not the same as saying that the effect on the Thomson galvanometer is under all circumstances proportional to the current which is passing between the poles of the magnet. If a strip of copper of the same length and breadth as the gold leaf but ⅛ mm. in thickness is substituted for the latter the galvanometer fails to detect any current arising from the action of the magnet, except an induction current at the moment of making or breaking the magnet circuit." A. S.

[1] By E. H Hall, Fellow of the Johns Hopkins University (*American Journal of Mathematics*, vol. ii. p. 287).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THERE will be an examination for at least one open scholarship in Queen's College, Oxford, on April 6 and following days. Papers will be set in Physics, Chemistry, and Biology (Comparative Anatomy and Physiology, the study of the Animal Kindom). No candidate will be expected to offer more than two of these subjects. There will also be a practical examination in one or more of the above subjects, if the examiners think it expedient. Candidates are requested to signify by letter to the Provost, *not later than March* 1, their intention of standing, and to state at the same time the subjects they propose to offer.

M. JULES FERRY has published a report stating that the development of primary instruction in France has progressed in proportion to the subsidies made by the public treasury for this purpose, and which we noticed in one of our previous numbers. In the fifty years from 1827 to 1877 the number of public schools has been increased in the proportion of 100 to 175, and the number of pupils from 100 to 182.

SCIENTIFIC SERIALS

American Journal of Science and Arts, January.—Prof. Stockwell here gives a detailed account of the principal periodic inequalities in the motions of the moon arising from the oblateness of the earth.—Prof. Leconte contributes further ideas on the glycogenic function of the liver. He represents that waste tissue is not burned or changed into final products at once, but circulates as incombustible matter dissolved in the blood, is carried to the liver, and there prepared for final combustion and elimination. Only thereafter does it unite with O to form CO_2 and H_2O.—Dr. Nichols proposes an optical method for measurement of high temperatures; it corresponds to one of three methods proposed by M. Crova, who, however, ignored the serious practical difficulties, especially in the varying values of the emissive and absorptive capacity of different bodies.—The first results from a new diffraction-ruling engine (which appears to be a very perfect piece of work) are given by Mr. Rogers.—Mr. Hill's electrodynamometer for measuring large currents has been noticed in our columns, also Mr. Todd's observations on solar parallax from the velocity of light.—Mr. Levison describes certain curious electrolytic phenomena capable of exhibition to an audience.—Prof. Marsh describes new characters of Mosasauroid reptiles, Mr. Whitfield new fossil crustaceans from the upper Devonian rocks of Ohio, and there are also geological papers on the Henry Mountains and the Wappinger Valley lime-tone.

Annalen der Physik und Chemie, No. 1.—Among the original matter in this number we note a chemical monograph of the mica-group, by Herr Rammelsberg; accounts of a new condensation or absorption-hygrometer, by Herr Matern, of some phenomena of phosphorescent light produced by electric discharges, by Herr E. Wiedemann, and of the phenomena, in polarised light, of a plate of magnesium platinum cyanide, cut at right angles to the optic axis, by Herr Lommel; a paper by Herr Korteweg, proving that, by the theory of dielectric polarisation, volume-changes of a dielectric body under the action of an electric force may be anticipated and calculated; one by Herr Edlund, controverting Helmholtz's views as to the cause of electric currents produced in flow of liquids through tubes; and one by Herr Herwig, defending his conclusions regarding the electric conductivity of mercury vapour. We also note valuable papers (communicated to Academies) on the conductivity of iron for heat, by Herr G. Kirchhoff and Herr Hansemann; on the differences of the two electric states, by Herr Mach and Herr Doubrava; and on a direct measurement of the work of induction, and a determination therefrom of the mechanical equivalent of heat, by Herr von Waltenhofen.

THE *Journal of Anatomy and Physiology, Normal and Pathological*, vol. xiv., part 2., January.—Dr. A. H. Young, the intrinsic muscles of the marsupial hand (pl. 7), and on the myology of *Viverra civetta*.—Mr. W. R. Williams, the anatomy of the knee-joint.—Dr. D J. Hamilton, development of fibrous tissue from the hepatic parenchyma in cirrhosis of the liver (pl. 8).—Dr. P. McBride, contributions to the pathology of the internal ear (pl. 9).—S. G. Shattock, a new bone in human anatomy, together with an investigation into the morphological significance of the so-called internal lateral ligament of the human lower jaw.—Dr. G. T. Beatson, the disease called sturdy in sheep, in its relation to cerebral localisation.—Dr. J. Carmichael, two cases of lesions of the temporo-sphenoidal lobe of the brain, with pathological examination by Dr. D. J. Hamilton (pl. 10).—Dr. Osler, two cases of striated myo-sarcoma of the kidney.—Dr. G. A. Gibson, the sequence and duration of the cardiac movements (pl. 11).—Prof. Turner, the fœtal membranes of *Oreas canna* and notes on the dissection of a second negro.—Dr. Anderson, a new abnormality in connection with the vetebral artery.—Dr. J. G. Garson, case of the development of wool on the cornea of a sheep.—Notices of books.—List of grants in aid of scientific investigation made by the British Medical Association.

THE *Archives des Sciences Physiques et Naturelles* (November and December, 1879).—These parts contain the following papers:—Meteorological recapitulation of the whole year 1878 for Geneva and the Great St. Bernard, by Prof. Plantamour.—Analysis of some recent works relating to the topography and the constitution of the moon (second part), by M. Rapin.—On the periodic movements of the soil as indicated by air-bubble levels, by Prof. Plantamour.—Essay on chemical mechanics, founded upon thermochemistry, by M. Berthelot.—Account of the sixty-second meeting (at St. Gallen) of the Swiss Society of Naturalists, on August 10-12, 1879.—On a portable and registering limnimeter, and observations made with it at the Peilz tower near Vevey, by M. E. Sarasin.—On the theory of joints in botany, by M. Clos.—Note on *Capsella rubella*, Reut., by M. Vetter.—Tables of meteorological observations made at Geneva observatory and on the Great St. Bernard during October and November last, by Prof. Plantamour.—Note on the "Elementary Treatise of the Qualitative Analysis of Mineral Matter," by Albert Ditti.—On the health of the pupils at the Lyons Lyceum, by Dr. H. Dor.—New researches on the quantitative determination of chromatic vision, by Drs. Dor and Favre—On the historical evolution of the colour sense, by Dr. Dor.—Researches on the action of low temperatures on the germinative faculties of seed-grains, by C. de Candolle and Raoul Pictet.

THE *Verhandlungen der k.k. geologischen Reichsanstalt zu Wien* (Nos. 13 and 14, 1879).—From these parts we note the following papers:—On the flora of the clay of Preschen, by H. Engelhardt.—On the living analogies of the late-tertiary marsh-strata and of the melanopsis-marl of south-eastern Europe, by Th. Fuchs.—On the environs of the Adamello mountains and on the development of the Perm formation between Val buona Giudicaria and Val Camonica, by G. Stache.—Report of a geological excursion to the Herzegowina, by A. Bittner.—Numerous book-notices.—On the slate of Velhota, by J. Kusta.—On the Strypa river district in Galicia, by Dr. E. von Dunikowski.—On the plants of the Cipris-slate of northern Bohemia, by H. Engelhardt.—On the strata penetrated by the main shaft of the Société de Carbonages de Bohême between Königswerth and Grasseth, near Falkenau on the Eger, by the same.—On the eruptive formations and the relief of the district of Christiania, by Dr. E. Reyer.—On the Wieliczka mine, by C. M. Paul.—On the brachipoda fauna of the oolites of Balin near Cracow, by L. Szajnocha.

Bulletin de l'Académie Royale des Sciences de Belgique, No. 11, 1879.—On a convenient means of distinguishing artificial from natural butter, by M. Donny.—On elimination (third and fourth note), by M. Mansion.—Theory *à posteriori* of elimination between two algebraic equations, by the same.—New reactions enabling to characterise very small quantities of morphine, by M. Jorissen.—On certain combinants of binary algebraic forms, by M. Le Paige.

THE *Revue Internationale des Sciences* (October, 1879), contains the following papers:—On the fauna of the depths of the sea, by Prof. A. Pagenstecher.—On lichens, by Prof. Reess.—On the adaptation and the mimetism in Turbellariæ, by Paul Hallez.—On the development of parrots, by Max Braun.—The part further contains the usual reviews, book notices, and scientific news.

THE *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfalens* (36ter Jahrg. i., 1879), contain but few papers of importance:—On the theory of the double refraction of light, by E. Ketteler.—Materials for an arachnida fauna of Japan, by F. Karsch.—On the occurrence of fossil bones near the Unkelstein on the Rhine, by G. Schwarze.—On the chemical cause of the poisonous action of arsenic, by Herr Binz.—On hannayite, newberyite and sillimanite, by Prof. vom Rath.—Several geological papers and reports of minor interest, by the same.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 5.—"On the Epipubis in the Dog and Fox." By T. H. Huxley, Sec.R.S.

In 1871[1] I gave a brief description of a structure which I had observed in the dog, in the following terms:—

"In the myology of the dog, the insertion of the tendon of the external oblique muscle of the abdomen presents some interesting peculiarities. The outer and posterior fibres of this muscle end in a fascia, which is partly continued over the thigh as *fascia lata*, and partly forms an arch (Poupart's ligament) over the femoral vessels; by its inner end it is inserted into the outer side of a triangular fibro-cartilage, the broad base of which is attached to the anterior margin of the pubis, between its spine and the symphysis, while its apex lies in the abdominal parietes. The internal tendon of the external oblique unites with the tendon of the internal oblique to form the inner pillar of the abdominal ring, and is inserted into the inner side of the triangular fibro-cartilage. The *pectineus* is attached to the ventral face of the cartilage; the outer part of the tendon of the rectus into its dorsal face; but the chief part of that tendon is inserted into the pubis behind it. This fibro-cartilage appears to represent the marsupial bone, or cartilage, of the Monotremes and Marsupials."

The only reference to this statement which I have met with is by Prof. Macalister, in his "Introduction to the Systematic Zoology and the Morphology of Vertebrate Animals" (1878), p. 265:—

"Prof. Huxley describes a fibro-cartilaginous 'marsupial' above the pubis, from whose anterior surface the pectineus arises. I have failed to satisfy myself of its existence as a constant structure in many dogs, in the common and Bengal foxes, in the dingo, jackal, *Canis pallipes*, and wolf."

The wording of this passage does not make it quite clear whether the writer has not found the structure in any case, but does not mean to deny that it may occur occasionally in the various *Canidæ* he mentions; or whether he has found it occasionally, but not constantly, in all or some of them.

Under these circumstances it may be desirable to publish the fact that, having recently dissected, for purposes of comparison, a male and female fox and a male and female dog, I have not had the slightest difficulty in demonstrating the existence of the structure which I described in 1871, in all four. And the only phrase which appears to require modification in that description is the use of the term fibro-cartilage. I do not remember whether, formerly, I submitted the structure to microscopic examination or not; but in the specimens lately examined, notwithstanding the firmness and density of the triangular plate, it contains no true cartilage cells, but is entirely composed of fibrous tissues which lie parallel with one another in the middle of the plate, while, at the thickened edges, they become closely interwoven.

A comparison of this triangular fibrous plate in the fox, with the "marsupial" bones of *Phalangista vulpina*, shows that the fibrous plate in the former animal exactly answers to the basal part of the "marsupial" bone in the latter. It may properly, therefore, be termed the *epipubic ligament*, and must be regarded as a structure of the same order as the rudimentary clavicle and the rudimentary hallux of the *Canidæ*; that is to say, as the remains of an organ which was fully developed in the ancestral forms of that group.

It is interesting to remark, in connection with this interpretation of the facts, that, in the existing *Thylacinus*, which presents so many curious points of resemblance to the dogs, the epipubis is not ossified. As, however, the *Canidæ* have certainly existed since the eocene epoch, there is no likelihood of the existence of any direct genetic connection between the dogs and the Thylacines. The existing carnivorous *Marsupialia* have evidently all proceeded from ancestral forms, characterised by the possession of a thumb-like hallux, a peculiarity which is presented neither by the dogs, when they possess a hallux, nor by any other carnivora with pentadactyle hind feet. Moreover, the early birth of the young and the development of a marsupium in the female, are evidences of the departure of the existing Marsupialia from the direct line by which the Mammalia have advanced from the ornithodelphous type. That the ancestors of all mammals possessed bony or cartilaginous epipubes is, I think, highly probable, but it does not follow that they had the marsupial method of bearing and nourishing their young.

[1] "Manual of the Anatomy of Vertebrated Animals," p. 417.

Chemical Society, February 5.—Mr. Warren De la Rue, president, in the chair.—It was announced that a ballot for the election of Fellows would be held at the next meeting of the Society (February 19).—The following papers were read:—Note on the assumed formation of ozone by the atmospheric oxidation of phosphorus, by C. T. Kingzett. The author criticises a paper recently read on the above subject by H. McLeod, and contends that his arguments fall to the ground because he has made a mistake in calculating the results of his experiments.—Contributions from the laboratory of Tôkiô, Japan, by R. W. Atkinson; II. On persulphocyanate of silver. When this yellow salt is boiled with water it turns black; a mixture of sulphide and undecomposed persulphocyanate being formed in proportions which vary with time, temperature, and the quantity of free acid present, at the same time cyanogen disulphide is probably formed.—On methylated dioxethylenamines, by H. F. Morley. The author has prepared, by the action of mono and dimethylamines on glycollic chlorhydrin, mono- and di-methyldioxethylenamine, and analysed their platinum salts.—Note on igasurin, by W. A. Shenstone. The author has prepared this substance, obtained by Desnoix, and finds it to be a mixture of brucine and strychnine.—On some reactions of tertiary isobutylic iodide, by L. Dobbin. By prolonged shaking with a 12 per cent. solution of hydrocyanic acid or water at the ordinary temperature, trimethyl carbinol was obtained; by the action of zinc oxide at 15° isotributylene was formed; no isodibutylene could be separated. The author has also studied the action of sodium on tertiary isobutylic iodide. Isobutylene, isotributylene, and hydrogen were formed with small quantities of a hydrocarbon not absorbed by fuming sulphuric acid.

Zoological Society, February 3.—Prof. Flower, F.R.S., president, in the chair.—Capt. W. Vincent Legge, R.A., exhibited and made remarks upon some specimens of the Little Ringed Plovers of India and Ceylon.—A communication was read from Dr. G. Hartlaub, F.M.Z.S., containing the description of a new species of Heron, obtained in Mohambo in Northern Madagascar, which he proposed to name *Ardea rutenbergi*.—Mr. Oldfield Thomas read a note on a specimen of *Myoxus elegans*, Temminck, which had been obtained by Mr. H. Pryer, near Yokohama, Japan.—A communication was read from Mr. H. N. Moseley, F.R.S., containing the description of a new species of Simple Coral, which he proposed to call *Desmophyllum lamprosteichus*.—Prof. F. Jeffrey Bell gave an account of *Palæolampas*, a new species of irregular Echinoidea, which presented, among others, the following archaic points:—(1) The rows of pores were completely parallel, and extended regularly to the ambitus; (2) some of the pores exhibited an elongation indicating the appearance of the connecting grove; (3) the outer row of each pore-series was continued uninterruptedly to the actinistome; and (4) two of the ocular pores retained indications of their primitively double character.—Messrs. C. J. Danford and E. R. Alston read a paper on the mammals of Asia Minor, Part II., in which they added certain species to their former list, and described a new species of Vole, under the name of *Arvicola guentheri*.—Mr. Sclater exhibited and made remarks on a fifth collection of birds from Duke of York Island and its vicinity, which he had received from the Rev. George Brown, C.M.Z.S. Four species were described as new, and proposed to be called *Megalurus interscapularis*, *Pœcilodryas æthiops*, *Munia melæna*, and *Rallus insignis*.

Physical Society, February 7.—Annual *conversazione*.—The museum of King George III., the Wheatstone Laboratory, and other halls of King's College were occupied by a fine display of physical apparatus and artistic furniture, including numerous relics of Sir Charles Wheatstone. There was a large number of ladies and gentlemen present, and during the evening selections of music were played by the Musical Association of the Royal School of Mines. The apparatus was peculiar to the whole range of physical science, and was furnished in part by the college and in part by the various instrument-makers and electric engineers of the Metropolis. The Telephone Company and the British Electric Light Company contributed telephones and electric lamps, and Herr Faber exhibited his ingenious speaking-machine.

Meteorological Society, January 21.—Mr. C. Greaves, president, in the chair.—Dr. Tripe read the Report of the Council for the year 1879, which showed that the Society was in a very satisfactory condition. Eighty-four new Fellows have been elected, and the total number at the end of the year was 473. The great local differences in temperature and humidity require to be more accurately ascertained than they are at present, and this remark applies not only to sea-side places, but also to inland districts in their relation to hills and valleys. It is with a view to obtaining better knowledge on this subject that the Council have instituted a new class of stations of a third order, to be termed "Climatological," at which observations of temperature, humidity, cloud, and rainfall are taken daily at 9 A.M. only, with certified instruments, the thermometers being in Stevenson screens, so that the observations of temperature at the different stations may be strictly comparable. The total receipts for the year were 799*l*. 6*s*. 9*d*., and the expenditure 621*l*. 19*s*. 5*d*., leaving a balance in favour of the Society of 177*l*. 7*s*. 4*d*.—The President then delivered his address, in which he advocated a more attentive inquiry by the students of meteorology into the subject of hygrometry. The appearance and disappearance of moisture, its diffusion, its origin in and withdrawal from the vaporous form, were matters which could now be readily defined through the increased supply of good observations, especially those so widely circulated by the Meteorological Office, and those recorded by the observers of the Meteorological Society. In furtherance of this object he produced a digest of all the observations published by the Meteorological Office for the year 1879, a year of abundant moisture, and one which could hardly fail to afford traces of the constancy or inconstancy of beds of moisture, if they were permanent anywhere, or of their coming and going viewed substantially as to their own existence, rather than as borne by the force of the wind, or acted on by the power of the air in its baric relations. The preparation of this digest from the hygrometric elements for 1879 proved such a laborious work that, being still incomplete and wanting the customary corrections for the various observations, he refrained from comments and deductions and gave the digest itself for the use of any students who might desire to work at the subject. The tables contained the calculated dewpoint, vapour-tension, relative humidity, and thermometric dryness throughout. These various and full data exhausted all the aspects of humidity in its vaporous state, and would supply means for a thorough study of the British climate in a year of maximum humidity.—The following gentlemen were elected the Officers and Council for the ensuing year:—President: George James Symons, F.R.S. Vice-Presidents: Edward Ernest Dymond, Charles Greaves, F.G.S., Rev. William Clement Ley, M.A., Capt. Henry Toynbee, F.R.A.S. Treasurer: Henry Perigal, F.R.A.S. Trustees: Sir Antonio Brady, F.G.S., Stephen William Silver, F.R.G.S. Secretaries: Robert Henry Scott, F.R.S., John William Tripe, M.D. Foreign Secretary: John Knox Laughton, F.R.A.S. Council: Arthur Brewin, F.R.A.S., William Ellis, F.R.A.S., Rogers Field, B.A., Frederic Gaster, Joseph Henry Gilbert, F.R.S., William John Harris, M.R.C.S., Baldwin Latham, F.G.S., Robert John Lecky, F.R.A.S., Hon. Francis Albert Rollo Russell, Richard Strachan, Henry Samuel Tabor, George Mathews Whipple, F.R.A.S.

Anthropological Institute, January 27. — Anniversary Meeting.—Mr. Edward B. Tylor, D.C.L., F.R.S., president, in the chair.—The following gentlemen were elected to serve as Officers and Council for the year 1880:—President: E. B. Tylor, F.R.S. Vice-Presidents: Hyde Clarke, John Evans, F.R.S., Prof. W. H. Flower, F.R.S., Major-Gen. A. Lane Fox, F.R.S., Francis Galton, F.R.S., Dr. Allen Thomson, F.R.S. Directors and Honorary Secretaries: E. W. Brabrook, F.S.A., W. L. Distant, J. E. Price, F.S.A. Treasurer: F. G. H. Price, F.G.S. Council: Lt.-Col. Godwin Austen, J. Beddoe, F.R.S., Prof. George Busk, F.R.S. C. H. E. Carmichael, M.A., W. Boyd Dawkins, F.R.S., Sebastian Evans, LL.D., A. W. Franks, F.R.S., Prof. Huxley, F.R.S., A. H. Keane, B.A., A. L. Lewis, Sir J. Lubbock, Bart., M.P., R. Biddulph Martin, The Earl of Northesk, F.S.A., Prof. Rolleston, F.R.S., F. W. Rudler, F.G.S., Lord Arthur Russell, M.P., Rev. Prof. Sayce, M.R.A.S., Alfred Tylor, C. Staniland Wake, M. J. Walhouse, F.R.A.S.—The President delivered his annual address, in which he gave an outline of the progress of anthropological science during the last forty years, with special reference to the work now being done in Germany.

Entomological Society, anniversary meeting, January 21.—J. W. Dunning, M.A., F.L.S., vice-president, in the chair.—The following gentlemen were elected as officers and council for the ensuing year:—President, Sir John Lubbock, Bart., M.P., F.R.S.; Treasurer, E. Saunders, F.L.S.; Librarian, F. Grut, F.L.S.: Secretaries, R. Meldola and W. L. Distant; other Members of Council: H. W. Bates, F.L.S., W. Cole, J. W. Dunning, M.A., F.L.S., F. du Cane Godman, F.L.S., O. Salvin, F.R.S., H. T. Stainton, F.R.S., S. Stevens, F.L.S., and J. J. Weir, F.L.S. In the absence of the president, an address was read by J. W. Dunning, vice-president, and the meeting terminated with the usual vote of thanks to the officers.

Photographic Society, January 13.—J. Glaisher, F.R.S., president, in the chair.—Mr. Leon Warnerke having at the previous meeting described all actinometers hitherto used, now read a paper on a new actinometer, designed by himself; it is based upon the retention of light by a phosphorescent substance. In this case calcium sulphide being the medium chosen, an ingenious apparatus has been constructed, in which is a disk of this phosphorescent material, hermetically sealed between glasses, and revolving over this is another disk containing a series of small holes where increasing layers of coloured gelatine, with figures upon them, produce increasing opacity, and the last number seen before the figures become invisible, indicates the intensity of light at the moment. A contrivance is also introduced by which, after using, any remaining luminosity is extinguished by letting red or green light pass on to the disk containing the phosphorescent material. This actinometer is found to perfectly register the value of candle, gas, or any other light possessing actinic power, however small.

Victoria (Philosophical) Institute, February 2.—A paper on recent Assyrian and Babylonian research, illustrated by maps and specimens, was read by Mr. Hormuzd Rassam; in which, after sketching the route which a traveller would take from Aleppo by Diarbekir, Mosul, and Baghdad to Nineveh, he gave a full account of his exploration in Nineveh and Babylon, with a description of the different ancient sites existing there at present.

VIENNA

Imperial Academy of Sciences, December 18, 1879.—The following papers were read:—On the changes produced by chemical change of muscle-substance in polar excitation by the electric current, by Dr. Biedermann.—On the method and data of phyto phylogenetic research; on researches of the kind in the Island of Skye; and on the phylogeny of Pinus, by Prof. v. Ettinghausen.—On the action of phosphonium-iodide on sulphide of carbon, by Dr. Jahn.—On the synthesis of biguanide, by Dr. Herth.—Report on searches and excavations during the past year (in Moravia, Lower Austria, and Krain).—On a new viviparous species of *Ungalia* from Peru, by Dr. Steindachner.—Geological observations in the Island of Chios, by Herr Teller.

PARIS

Academy of Sciences, February 2.—M. Edm. Becquerel in the chair.—The following papers were read:—On some applications of elliptic functions, by M. Hermite.—On a linear differential equation of the second order, by M. Gyldén.—Complement to recent note on the deformation of substances, by M. De Saint Venant.—Experiments on the compression of gaseous mixtures, by M. Cailletet. Compressing in his apparatus 5 vol. carbonic acid and 1 vol. air he easily liquefies the former. On carrying the pressure to 150 or 200 atmospheres, the meniscus of liquefied acid, concave and quite distinct, becomes plane, loses distinctness, and is gradually effaced, till at length the liquid wholly disappears, the tube being then, apparently, filled with a homogeneous matter, which resists all further pressure, like a liquid. On diminishing the pressure the liquid suddenly appears again, at a constant pressure for determinate temperatures (132 atm. at $+5°.5$, 110 atm. at $19°$, &c.). This disappearance of liquid cannot be due to heat liberated in compression, for the tube was immersed in water keeping a constant temperature, and the compression was slow. It seems that at a certain pressure the liquid and gas are dissolved in each other. M. Cailletet tried to test this by colouring the CO_2 with iodine, but this, attacking the mercury, masked the phenomenon. (The supposition that the disappearance of liquid is only apparent, he disproves.)—Evolution of inflorescence in Gramineæ (2nd part); types of structure of the primary rachis; order of appearance of the first vessels, by M. Trécul.—M. Gaudin submitted a method of dividing masses of ice, viz., placing on them a flexible tube of lead or alloy of tin and antimony, of small calibre, connected with a steam boiler, and open at the end to let the water of condensation out. It penetrates into the ice by its weight and heat. The trenches thus made are kept from closing by means of boards, and charges of dynamite may be put into them.—On the theory of linear differential equations, by M. Mittag-Leffler.—Remarks on the new metals of gadolinite and samarskite, by M. Delafontaine. He regards *ytterbium*, *decipium*, and *philippium* as definitively acquired for science; *scandium* he cannot speak of; *mosandrum* should be eliminated; *samarium* requires more proof; the characters of the yellow oxide, *philippine*, are those of M. Soret's earth X and the *holmine* of M. Cleve; the latter name, therefore, should not be retained.—Artificial reproduction of scorodite, by MM. Verneuil and Bourgeois. Iron wire is treated with a concentrated solution of arsenic acid in a sealed tube, heated to 140°–150°; it gets covered with grey gelatinous matter (a mixture of amorphous arseniate of sesquioxide of iron and arsenious acid in small crystals); this matter gradually disappears, being transformed into scorodite. The authors hope to get erythrine, annabergite, and some other hydrated arseniates thus.—On the anatomical characters of blood peculiar to intense and extreme anæmia, by M. Huyem. In what he calls *aglobulie intense* (the globular richness varying from 2,000,000 to 800,000), he notes that crystals form in the dried blood, like those of dried lymph; and in the fresh blood he finds white globules with coloured contents, and still retaining amœboid contractility (such are also found in lymph). In *aglobulie extrême* (800,000 to 450,000 globules) there are elements like the red nucleated globules of oviparous animals. In all cases the white globules are much more numerous and smaller than in normal blood. In anæmia, then, the blood becomes in some sort lymphatic, *i.e.*, it is formed of a mixture of blood properly so called and lymph.—Researches on the movements of the uterus, by M. Polaillon. A registering apparatus and manometer were connected with the enlarging instrument sometimes introduced into that organ. The author calculated the specific force of the uterus to be about 178, and therefore very much below the force of striated muscles in man, which is about 1087. Uterine contraction produces a regular movement without shock, and remarkable for its length, nearly two minutes (contraction and relaxation together; the former being the shorter). Violent respiratory movements raise the pressure considerably.—A note from M. Macagno treated of the composition of the air in different parts of Palermo; another, of the production of tannin in leaves of sumac; he finds leaves at the upper extremity of the stem richer in tannic acid than those at the base. The quantity of acid diminishes as the plant grows older.

CONTENTS

THURSDAY, FEBRUARY 19, 1880

MADAGASCAR

The Great African Island. Chapters on Madagascar. By the Rev. James Sibree, Jun., F.R.G.S., of the London Missionary Society. (London: Trübner and Co., 1880.)

MR. SIBREE'S book is described on the title-page as a popular account of recent researches in the physical geography, geology, and exploration of the country, and its natural history and botany; and in its origin and divisions, customs and language, superstitions, folk-lore, and religious beliefs and practices of the different tribes. Together with illustrations of scripture and early church history, from native statists and missionary experience. The book commences with an interesting summary of ancient notices and accounts of the island of Madagascar, with a continuation of the history of its discovery and exploration down to the present time. The author identifies Madagascar, as has been done by some former writers, with Menuthias of Ptolemy, but there seems little doubt that Menuthias, which is described in the "Periplus Maris Erythræi," is, as considered by Bunsen, Karl Müller, and others, the island of Zanzibar. The author admits in a note that there is some doubt about the matter. In his account of the early Arab names of the island he is not quite clear. The Arabian voyagers named the island, the home of the roc (Æpyornis), the Island of the Moon, possibly from the neighbourhood of the Mountains of the Moon. They wrote the name either Kamar or Komr, which latter name survives in the modern title of the small outlying group, the Comoro Islands, which the Arabs called Komäir or the lesser Komr. The name, as applied to the main island, survived until the arrival of the Portuguese, for on one of the oldest maps, the Charta Marina Portugalensium, of the first decade of the sixteenth century, the name Komortina occurs for the island in addition to those of Madagascar and San Lourenço.

The author attributes the discovery of the east coast of Madagascar to Don Francisco de Almeida in 1506, whereas Antão Gonçalves is given by Peschel as the discoverer and also as the giver of the name San Lourenço, which is attributed by the author to João Gomez d'Abreu. It seems, however, probable that a still earlier voyager may have discovered the east coast of the island, a certain Diogo Dias, commander of a ship of Cabral's fleet, and brother of Bartholomew Dias.

The best map of Madagascar is that published last year by the late Rev. Dr. Mullens, which is partly based on M. Grandidier's sketch-map, published in 1871. The island is nearly 1,000 miles long and 350 miles broad at its greatest extent, and being the third island in size in the world, is nearly four times as large as England and Wales. It consists of an elevated interior region from 3,000 to 5,000 feet in elevation, and a comparatively level surrounding country raised from 400 to 500 feet above sea-level, extending also over a vast area to the west and south, into which region the more elevated land does not extend. All around the coast is a belt of virgin forest with an average breadth of from fifteen to twenty miles, much of which is still unexplored. A good deal of the elevated interior is bare and somewhat dreary-looking. "The long rolling moor-like hills are only covered with a coarse grass, which becomes very brown and dry towards the end of the seven months' rainy season." The largest river is 300 miles long, and could be ascended by steamers of light draught for about ninety miles. The central plateau consists of primary and igneous rocks, and is plainly, as might have been foretold from the nature of the fauna of the island, of great antiquity. There are secondary and recent deposits on the lower region, and in the latter M. Grandidier discovered the fossil remains of a hippopotamus. With the hippopotamus occur the bones of *Æpyornis maximus*, the gigantic fossil eggs of which probably gave rise to the fabulous stories of the roc. The bones of two other species of Æpyornis have now been discovered, one was as big as a cassowary, the other only as large as a bustard.

To naturalists accustomed to think of Madagascar as full of the most interesting of animals, it seems strange to learn that "a stranger crossing the forest is always struck with the general stillness of the woods and apparent scarcity of birds seen on the route;" but after all, stillness is more or less characteristic of all forests. The lemurs, at all events, make themselves heard. "In travelling from the coast to the elevated plateaux of the interior one is sure frequently to hear their loud wailing cries, which sometimes make the woods resound for some minutes together and have a most startling effect when heard for the first time." One lemur (*L. catta*) is not arboreal like the remainder, but lives amongst the rock, having feet specially modified to suit this kind of existence. The natives have a superstitious dread of the Aye-aye (Cheiromys), believing that a person who kills one will die within a year. The hedgehogs (Centetidæ), of which there are five genera and nine species in the island, are used as food, having much the taste of pork. They seem to be very abundant in the woods, in low scattered brushwood. "We frequently met with three or four varieties whilst rambling in the outskirts of the woods." They do not roll themselves up into a ball like our hedgehogs, but put their head between their fore-paws when in attitude of defence.

We must pass over the further account of the fauna and flora, and turn to the later and more important portion of the work which treats of the ethnology of the island, and which is especially valuable. A part of it has already been published in the *Proceedings* of the Anthropological Institute and of the Folk-Lore Society, as well as in NATURE. The population of Madagascar is a very mixed one, and the exact history of its development is extremely difficult to trace. There are, possibly, traces still remaining of an aboriginal stock, that is to say, of races which existed in the island before later African colonisation and very long before the Malayan incursion. There are numerous indications of the occupation of the country now held by the Hovas, which are the race of the island which at present exhibit the purest Malay blood, by an earlier people called Vazimba. Superstition unfortunately prevents the opening of the graves of this extinct race. They are said to have been ignorant of the use of iron, and to have been of low stature. There are also vague accounts of another dwarf race with woolly hair, the Kimos; and of still another, the Béhosy. There seems to be great uncertainty as to the reality of these three races, and as to whether any of them yet exist, as they are said by some to do in the part of Madagascar as yet unexplored by Europeans. It is quite possible that some people allied to the Bushmen may have occupied the island in early times. The main mass of the population is made up of the lighter coloured more distinctly Malay races, and of a much darker skinned race with frizzly hair, and of all gradations between these two. The latter stock are regarded by most ethnologists as of African affinity, whereas the author thinks they may be Melanesians, and have reached the island from the same source as the Malays, a supposition which we can hardly regard as probable. The Rev. W. E. Cousins concludes from his researches that the Malagasy language represents an ancient stage in the Malay tongue, now so widely spread over the Indian and Pacific Oceans, and thus, as far as philology is concerned, it is probable that the emigration of the Malagasy tribes from the east took place at a remote era. The author speculates from the obscure evidence of certain lists of Hova kings as to the date at which the Hovas arrived at the island, and concludes that probably not much, if at all later than the Norman conquest, perhaps much earlier, but he seems unaware of a fact of some importance, namely, that in an Arab account of the middle of the thirteenth century, the inhabitants of Komr are spoken of as the "Brothers of the Chinese," *i.e.*, evidently Malays, whilst a town in the island is mentioned by name as "Malay" both in this later account and a century earlier by Edrisi.

But the problem of the Madagascar population is still further complicated; Arabs visited the island from very early times from the mainland, and constantly imported African slaves by hundreds in their dhows, and continued to do so until up to a very short time ago. They settled in the country and mixed with the population, and their influence is still in active operation on the north-west of the island. On the eastern coast there is a strong European mixture in the population, partly ancient, partly modern, due to Creole settlers, and planters, and sailors of all nationalities. There is, further, much Indian blood in the country, derived mostly from Bombay.

The influence of the missionaries has had the usual effect upon the Malagasy language, numerous English words connected with religious belief have been imported into it wonderfully spelled. For example, "Jesosy Kraisty." It is, perhaps, rather a pity, than a matter of congratulation, as the author considers it, that the poor Malagasys have learnt the English words "demon" and "devil," which are in the list he gives. The account of the language is full of interest. The names of villages show many parallels to English names of places. There are, for example, Oxfords, Holytowns, Kingstowns, Princetowns, and Stonebridges. Divorce is delightfully easy in Madagascar; a tired or angry husband merely sends for his wife and gives her a piece of money before witnesses saying, "I thank you, madam," and the thing is done. Divorce is hence termed "thanking a wife." Like the New Zealanders, the Malagasys are beginning to give up nose rubbing as a salutation, and are taking to our important improvement on this ancient practice, kissing. In old times they used to lick the foot of a superior as a salutation, a form which survives with us only in the case of the adoration of the pope.

The Hova girls plaster their faces with a white paste, and thus make themselves fairer when it is removed; this is a novel suggestion for possible adoption in Europe, a sort of putting the complexion in curl-papers. The girls also wear black spots on their faces, corresponding with our patches. The young men grow long nails on their little fingers with great care, thus curiously imitating the Chinese. Curiously enough, no stone implements or weapons have as yet been discovered in Madagascar. It must be almost the only inhabited place in the world where they have not been found. Probably they will yet be discovered. Their absence would be strong evidence against the former existence of the dwarf aboriginal race in the island.

In Chapter XVI., headed "New Light on Old Texts; Illustrations of Scripture from Malagasy Customs," the author draws so many parallels between Malagasy customs and those of ancient Semitic and other races as recorded in the Bible, that we feared greatly he was going to discover the lost tribes; but he is not a man to do anything so foolish. Very likely, however, some one will be found before long to do it for him with his data. Madagascar is about the only place remaining in which the discovery has not been made, now that Mr. McLeod has published his "Japan and the Lost Tribes of Israel,"[1] and identified Jin Mu Tenno's Samurai with these "wandering Jews."

In the concluding chapter of the book, on "Malagasy Church Life as Illustrative of the History of the Apostolic and Early Churches," some most interesting information is given. It appears that the Malagasy people have spontaneously developed by a process of reasoning nearly all those brilliant innovations which it is the pride of our own most advanced Ritualists to have copied from others. Thus a story is told of a terrible case of suspense in which baptism had been performed with water in a sacramental cup in lack of some other suitable vessel. What was to be done with the holy water? It would never do to throw it away; so at last a good deacon drank it. Stranger still, amongst Mr. Sibree's own people at Ambohimanga, he found a notion springing up that they ought to fast before communicating, and they appealed to him as to whether he did not do so and whether it was not improper to allow the elements to mix with common food. They also had a strong feeling that the ceremony should take place only in the forenoon and only on the first Sunday in the month. Further, some natives employed to make the bread used in the Eucharist did so in secret after various ceremonial ablutions, and explained that their reason was that "they did not want unbelievers to know how the bread was made for fear they should despise it." Any bread left over they took to the Government House, and ate there only after prayer. All these ideas have, according to Mr. Sibree, been developed quite independently of the Malagasys, though we cannot help suspecting them as due, partly at least, to French Roman Catholic influence. Only in the matter of vestments apparently do the Mala-

[1] "Japan and the Lost Tribes of Israel. Epitome of the Ancient History of Japan." By G. N. McLeod. (Rising Sun Office, Nagasaki, Japan, 1879.)

gasys seem not to have developed Ritualistic tendencies; but they have advanced notions concerning ornament, bright colours look especially well on a brown skin, and possibly before long a Malagasy bishop may appear in full Ritualistic fig, evolved out of his inner consciousness. If so, may we be there to see.

We have only been able to touch here and there on the many interesting subjects discussed by Mr. Sibree. This book is a most valuable addition to knowledge and very entertaining. It contains several full-page illustrations (not all new) and two maps.

CLAUSIUS'S "MECHANICAL THEORY OF HEAT"

The Mechanical Theory of Heat. By R. Clausius. Translated by W. R. Browne, M.A. (London: Macmillan and Co.)

THIS translation satisfies a real want of a tolerably large class of students of science. It furnishes in a volume of reasonable size a clear and readable account of a subject, an acquaintance with which has until lately been only obtainable by an English reader at the cost of a great deal of research through the transactions and memoirs of various societies. The name of its author furnishes a sufficient guarantee of the accuracy of the substance matter of the book, treating as it does of a subject specially his own. The method of treatment leaves hardly anything to be desired, even from the point of view of a student previously ignorant of the subject. The reader is nowhere perplexed by uncouth symbols or analytical operations beyond those which are familiar to all acquainted with the principles of the differential and integral calculus. At the same time, and perhaps partly in consequence of this avoidance of complicated analysis, the reader is never allowed to lose sight of the essential meaning of the symbols employed. Some of the chapters in the book will furnish a valuable exercise in the meaning and value of partial differential coefficients, even to a student who is not specially interested in the physical questions discussed. The same remark applies to some of the explanations given in the mathematical introduction, on the nature of the integral of a total differential in the case when the condition of being an exact differential is not fulfilled, explanations originally inserted, as the author tells us, in consequence of objections made to his theory by Prof. Decher.

Any one wishing to gain a general acquaintance, thorough as far as it goes, with the subject, can scarcely do so with the expenditure of less time and labour than are required for the perusal of this book. As a mathematical study the book may replace some of the luxuriant growths of modern geometry and analysis with great advantage to the brains of the student.

The translation is admirably done. It is hardly possible in reading it to recognise any traces of foreign idiom. Occasionally we find some little confusion of phraseology, probably arising from loose translation; as on page 210, where a rather curious description is given of the ordinary process of changing the independent variables from x, y, to ξ, η, and this process is apparently referred to, a little lower down, as an "artifice." It is a pity, too, and a little surprising, considering the array of scientific talent mentioned in the preface as having been applied to the correction of first proofs, that the book should be disfigured by so many misprints. Not to speak of great uncertainty as to the insertion or omission of a comma between the two variables inside a bracket after a functional symbol, and the sign $\times$ between two factors of a product, there are many serious errors. Thus, for instance, on page 69 we have "volumes" for "values:" on pages 117 and 124 we have the sign $+$ for $\times$; on page 187 we have dT for T. In equations (19) and (20) of page 190 we have $\frac{dQ}{dT}$ written instead of $\frac{dQ}{dP}$, and the error is repeated twice lower down on the same page. The figure of the steam-engine on page 237, described as an "imaginary one," certainly strikes one as decidedly imaginary. The insertion of a few valves in the figure at suitable places would render it more satisfactory, at any rate to an unimaginative reader. It may be hoped that these blemishes will be removed when a second edition is reached of what, in spite of them, is an exceedingly valuable addition to our English mathematical literature.

W. S. A.

OUR BOOK SHELF

Noxious and Beneficial Insects of the State of Illinois. Third Annual Report. By Cyrus Thomas, State Entomologist. Pp. 1–212. 8vo. (Springfield, 1879)

IF we might be permitted to propose another title for this book, we would suggest that of "An Essay towards a Monograph of North American *Aphides.*" But we fancy such a title would be too much opposed to that borne on the cover. We fear the Report is too profound to be of service to agriculturists and horticulturists, otherwise than on the same grounds that an intelligent mother of a family is enabled, from the study of a medical dictionary (intended for the use of the profesion only), to diagnose the symptoms of measles, croup, and other ills that infantine humanity is heir to. We might make the same objection to the titles of a multitude of American *scientific* publications. The axiom that "the end justifies the means" scarcely needs being called into requisition in a notice of this Report; yet some uncertainty exists in our mind as to the end aimed at. Does it consist in enabling unscientific, but intelligent, farmers and horticulturists to identify their plant-lice foes? or is it intended as a prominent contribution towards a knowledge of these insects, to be made use of by scientific workers principally? We do not attempt to solve the problem, but prefer to regard the Report more especially in the last-named light.

Looking, then, at the scientific side of the question, we see here a most valuable contribution to a natural history of American *Aphides,* and in some respects we think it would have been better had the author not been hampered with the necessity of producing a popular report at the same time. It is impossible to give an analysis of the author's views on the many vexed questions in the life-cycles of these noxious atoms. Much of the introductory remarks on habits has been of necessity (and advisedly) compiled, and the suggestions as to dimorphism (p. 31) have, we think, been somewhat fully anticipated; still there remain some very potent suggestions made by Dr. Thomas; not the least of which is in what form those species that appear habitually to attack *annual* plants only, pass the winter months?

A multitude of new species are described, and others already noticed have been more fully investigated and the details given. Naturally, many European species occur also in America. For these the author has mainly (as is acknowledged) made use of Mr. Buckton's yet incomplete monograph of the British species, adopting also the latter author's somewhat unscientific form of bibliographical and synonymic quotation. Some very glaring typographical errors are corrected, but only in the place where they first occur, although constantly recurring; others almost equally important are not noticed.

Zur Kenntniss der Fauna des untersten Lias in den Nordalpen. Von Dr. Neumayer. (Vienna, 1879.)

ENGLISH geologists who are interested in the study of the Infralias, will welcome this latest contribution to science by the indefatigable palæontologist of Vienna. The fossils described have been obtained principally from three localities — Pfonsjoch, in the Northern Tyrol, Breitenberg, in the Osterhorn group, and Zlambach in the Traunthale. Among the sixty-six forms here noticed, a large proportion are either identical with species which have been described in Western Europe or present such slight points of difference that Dr. Neumayer has not felt himself warranted in giving them distinct names. It is very interesting to find how close is the agreement in the general characters of the fossils of these Infralias beds in the Mediterranean province with the fauna of the strata on the same horizon in England, France, and Swabia. As in Western Europe, so in the Alpine province, we find the numerous varieties of *Ammonites* (*Aegoceras*) *angulatus* and *planorbis*, especially characterising the zone by their great abundance; while *Ostrea arietis*, *Lima punctata*, *L. gigantea*, *L. succincta*, *Modiola psilonoti*, *Myoconcha psilonoti*, and *Unicardium cardioides*, are associated with these ammonites in both areas. Besides these familiar forms there occur, however, some others which are quite unknown in Western Europe. Dr. Neumayer's monograph is illustrated with seven well-executed lithographic plates, and is a very valuable contribution to our knowledge of the Jurassic formation in the Alps.

J. W. J.

Africa Past and Present. By an Old Resident. (London: Hodder and Stoughton, 1879.)

IN "Africa Past and Present" the writer carries us back to the time when Herodotus, collecting material for his history, in the absence of written documents, travelled to Africa. Then follow chapters on enterprising Arabs, who penetrated into the interior of the country at a far distant period, and on the Portuguese early English and French discoveries. Accounts are given of the travellers who were sent out by the African Association to explore the interior of the country, prominent among whom were Mungo Park, "whose melancholy fate did not damp the ardent desire of the British public for further information concerning the interior of the great continent." Then follow descriptions of the more recent adventures and discoveries of Speke, Grant, Baker, Livingstone, and others, though the author makes no reference to the important work done by recent German explorers. The latter half of the book is devoted to the history and physical geography of the country, the author taking each division and giving topographical details of it, and speaking of its climate, resources, productions, and character, manners, and social condition of its inhabitants. The book is intended as a handbook for missionaries, merchants, travellers, and emigrants who wish for information about Africa. As such it will be useful. The book has many illustrations and a map of the country. It has also the advantage of being cheap and portable.

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.]

Ice-Crystals

I HAVE been prevented by other work from thanking your correspondents who offered explanations of the peculiar forms taken by ice-crystals upon rotten ligneous fibre.

Will you, however, allow me to say that the explanation offered is one respecting which I am very sceptical.

That explanation is that the long filaments, like spun glass, are merely the result of the internal freezing of the moisture in the substance of the wood and of the expansive force of that freezing pressing the ice thus formed through the pores of the wood.

My impression is that if this were the cause the expansive force would be sufficient to destroy the ligneous fibre altogether, and break it up. I question also whether there are any pores or tubes of the kind and size required by this theory running in the direction of the medullary rays. Lastly, as upright arborescent forms of ice-crystal are formed upon dry wood and upon other substances, which cannot possibly be due to any such cause, I am inclined to think that this particular form is determined by some other cause than the one suggested. The filaments are much too long and much too crystalline in structure to be the mere result of extrusion from an internal mass of ice.

Argyll Lodge, Kensington, February 14 ARGYLL

Kœnig's Collection at the Philadelphia Exhibition

MY attention has just been drawn to the fact that a report has recently been circulated in London to the effect that the splendid collection of acoustic apparatus exhibited by Kœnig, of Paris, at the Centennial Exhibition of 1876, had been retained in this country for the Stevens Institute of Technology, under promise of payment, and that nothing had been paid for it.

As regards the Stevens Institute, I have to say that the report is utterly without foundation.

We have never had one of the instruments in our charge, nor has a word ever been said about purchasing it for our use.

The collection was, in fact, removed from the Centennial building to the University of Pennsylvania at Philadelphia, which is about one hundred miles from here, where it now remains, and it has been currently reported that a gentleman in Philadelphia had presented it to the said University. As to that part of the story I know nothing, but I do know absolutely that the Stevens Institute of Technology has never had anything directly or indirectly to do with the matter.

HENRY MORTON

Stevens Institute of Technology, Hoboken, New Jersey, February 4

"Scientific Jokes"

I DO not know who your correspondent "G. H." may be, but I should surmise from the tone of his letter that he is somewhat of a beginner in science, and that he is so proud of his acquaintance with certain elementary propositions in thermodynamics, that he is on the *qui vive* to detect in others an ignorance of them. In my opinion the fair meaning of the passage objected to, when read with its context, is that the author is drawing a parallel between temperature in heat and potential in electricity (between which there are striking analogies), and that the words to which your correspondent refers are purposely employed to prevent any one imagining (as "G. H." seems to have done) that it was intended to represent the energy of heat as the *product* of heat and temperature in the same manner as that of electricity is the product of quantity and potential. Temperature is treated as inseparable from heat and nothing more, just as potential is inseparable from electricity, and this is not an unscientific view of the matter.

The latter part of the letter relating to the theory of terrestrial magnetism, propounded by Professors Ayrton and Perry, is, I think, still less creditable to the writer. Whatever be one's own views on the subject, the question of the tenability of the theory is still *sub judice*, and it is not becoming in "G.H." to speak so contemptuously of the author of the address for not taking the same view as he does of the merits of the controversy.

74, Onslow Gardens, S.W. J. FLETCHER MOULTON

On the Mode of the Transverse Propagation of Light

IN NATURE, vol. xxi. p. 301, is a letter by Mr. W. M. Hicks containing some critical remarks on a paper of mine, "On a Mode of explaining the Transverse Vibrations of Light" (NATURE, vol. xxi. p. 256), which I shall be glad to notice here.

Firstly, it is, no doubt, understood that the theory proposed by me cannot be regarded as *in opposition* to any existing theory, from the simple fact that no theory or clear conception of the constitution of the ether (in regard to the mode of propagation of the transverse vibrations of light) appears really to exist. The notion of the ether resembling a "solid" or an "infinitely thin jelly," cannot, of course, be regarded otherwise than as a resource in the face of a difficulty, which, however, we think must appear to any impartial inquirer to increase rather than diminish the difficulty; and therefore the inference would seem a not unreasonable one that any *true* theory of the constitution of the ether would be something totally different from "statical" theories of this kind. As it has been one of my objects to prove, after considerable attention given to the subject, that but *one* view of the constitution of the ether is in principle conceivable (or that one solution to the problem already exhausts the limits of the conceivable), I may therefore be excused for having some confidence in the fundamental groundwork (at least) of the view adopted, and am therefore all the more ready to reply to any criticisms on the subject, though no doubt (as in the case of any theory possessing points of novelty) difficulties may be expected at first to arise that may entail considerable thought to remove them. It need not be premised that the attainment of truth is the ultimate object of all.

In the first place, in regard to the remarkable means of correcting and adjusting their own motions that atoms moving freely among each other have been proved to possess, I may at once withdraw the expression "instantly," in regard to the rate at which this self-adjustment takes place. The expression is at best a vague one, and the idea arose from the known fact of the practically instantaneous adjustment that takes place in the case of an ordinary gas. The mean velocity of the ether atoms would, of course, be necessarily equal to that of light, and all that is essential is that the adjustment should be rapid enough to maintain adequately the equilibrium of the ether.

In regard to the second difficulty mentioned; I do not see that the fact of some of the atoms of ether moving at a greater or less velocity than the *mean* velocity (which is equal to that of light) should put a difficulty in the way of accounting for the regularity of the waves of light. For it has been proved in connection with the kinetic theory that the number of atoms whose velocities differ by any great proportion from the mean velocity is relatively very small. These atoms would no doubt distribute the energy irregularly over the beam of light, but the total effect would in this way neutralise itself. The great majority of the atoms would still be moving at the mean velocity and distributing the energy in regular waves, and producing that sequence of energy that we call light. I may note that in a paper on "The Mode of the Propagation of Sound on the Basis of the Kinetic Theory of Gases," published by me in the *Phil. Mag.* for June, 1877, and where a mathematical determination of the velocity of the wave was appended by the late Prof. Clerk Maxwell—the same considerations regarding the varying velocities of the atoms would be involved as above; and yet we know that as a fact the sequence of the waves of sound is in perfect regularity.

In reference to the third difficulty mentioned by Mr. W. M. Hicks, regarding the explanation of refraction and reflection. This leads me more strongly to return to a detail in regard to the constitution of the ether I had before adopted, but had not fully grounded, probably from the absence of the requisite encouragement to devote an adequate amount of thought to the subject. I quote the following in substance from a paper already written. I am led to regard the ether atoms as of *two* grades of dimensions. Of course there is no *à priori* reason why they should be all of one size, and the fact of their being of two sizes does not alter the principle of the theory in the least. They may therefore be assumed, if facts require it, to be of two grades of dimensions. The one set of atoms (specially concerned in the effects of gravity) are to be considered as enormously smaller than the atoms propagating light, and consequently their velocity (which will adjust itself automatically in the inverse ratio of the square root of their mass) very much greater. It might perfectly well be assumed (for example), that the mass of the atoms producing gravity is such that their velocity equals, say 10,000 times the velocity of light. I would just remark, in connection with this, that the expression "wonderful" sometimes applied to the velocity of light is, I think, to be deprecated. I would submit that there is nothing really "wonderful" in any velocity, because, however great a velocity is, it is always indefinitely small compared with that which it might be conceived to be, as one has in strict logic no power to limit arbitrarily the conceptions in this respect. If, therefore, there be reason for inferring a certain velocity to exist (no consequence what its value), it seems to me there is no ground for assuming it to be "wonderful." If a body or atom moves in free space without obstruction, there is nothing to curb its velocity, and its energy may even become immeasurably small at this velocity, provided the atom itself be small; and, in the same way, we have nothing to limit our conceptions as to the smallness of atoms. There can be no difficulty whatever in these conceptions, as mechanical principles are admittedly independent of *scale*, and therefore there is nothing mysterious whatever in the subject. The real mystery surely attaches to the spiritualistic assumptions about "forces" which spoil the interest of physical inquiries, and have involved that magnificent physical agent, the ether, in such a labyrinth of spurious mystery as to repel the inquirer. I cannot avoid the inference that any one who reflects seriously and impartially on the subject, will be disposed to admit that there really cannot be *two* methods in physical science, but only *one* method (the dynamical), the so-called "statical" speculations about "forces" leading nowhere. It has been proved again and again in connection with science that the so-called spiritualistic "method" is utterly barren, and only involves one in an inextricable maze of speculation from which there is no escape. I have thought these few remarks necessary in view of the special subject with which I am dealing.

It will be observed that the whole of the dynamical effects above referred to are automatic. The correction of the motion of the atoms so as to move in the right way to produce gravity and light is automatic; the adjustment of the relative velocities of the atoms between the two sets is automatic, or we make no arbitrary postulate at all. The effect of an adequate velocity for the smaller set of atoms would necessarily (from well-known dynamical principles) cause them to oppose no measurable resistance to the molecules of gross matter vibrating in them, and consequently they could take no measurable part in the propagation of the energy of light. They would, on the other hand, produce an enormous pressure (adequate for gravity) on the molecules of gross matter—the pressure being as the *square* of the velocity.[1]

The main reasons for assuming that the atoms producing gravity and those producing light are separate, are first the great pressure requisite for gravity, and the consequent necessity for an adequately high velocity to produce this pressure, and secondly (as Mr. W. M. Hicks points out), there would appear to be a difficulty in explaining the reflection of light from some bodies, and also the phenomena of refraction, if we assumed the atoms propagating light to pass through all bodies with perfect facility, as is necessary in the case of the atoms which produce gravity. As this letter has already grown to some length, I will at present confine myself to this inference, reserving some ideas relative to polarisation (in connection with the present theory) to a subsequent letter.

To prevent misconception, the fact may be cited that the above kinetic theory of the ether does not represent an *emission* theory of light. The motion of translation (which the ether atoms would possess if there were no light) merely serves as the carrier of the energy impressed upon them by the vibrations of the molecules of gross matter. On the other hand, the fact of the theory resembling (in the translation of the atoms) *one* of the ideas of Newton may possibly be regarded as rather a recommendation than otherwise. If, however (as I have certainly set

[1] If observation shows light to suffer no (sensible) diminution of velocity at reflection, it would follow that the luminiferous atoms do not suffer a (sensible) diminution of their translatory motion at rebound from gross matter, and consequently these particular atoms could not be appreciably concerned in the effects of gravity.

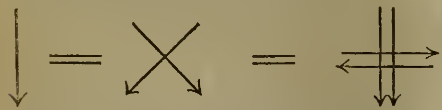
myself the task to prove) there is not really more than *one* explanation of the constitution of the ether in principle conceivable [excluding, of course, the essentially endless vagaries about "forces"], then on this ground alone the hope may be entertained by those who look to the existence of an *explanation* for every physical fact, that difficulties that may naturally present themselves at first will not prove insurmountable by a due amount of thought and careful analysis. S. TOLVER PRESTON

The Transverse Vibrations of Light

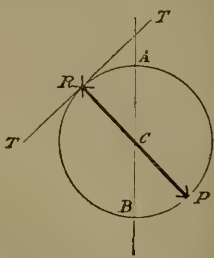
FEW are probably likely to underrate the vast benefits which have accrued to physical science since the time of Poisson, from the application of mathematical analysis to physical problems; but it seems to me we are at present rather in danger of forgetting that such mathematical reasoning can only lead to useful results when founded upon definite physical conceptions. It was upon such a basis that the triumphs of Young, Fresnel, and Airy were won; and it is for want of such a basis that I fear we shall get little aid from Mr. Tolver Preston's ingenious speculation. Mr. Hicks has taken some exceptions to them, which seem sound if he has correctly read the theory, though I am not quite sure he has, or that I should go quite with him in regard to what Mr. Preston *may* mean. But I wish to point out, with your permission, objections of a more simple and definite physical nature.

The only transverse movements capable of being communicated to an ether-molecule by transverse vibrations of matter, which do not involve translation through a measurable though minute distance in space, appear to be rotation on an axis, or (if we conceive the molecule as an annulus) alternate contraction and expansion—"vibration" Mr. Preston calls it—within its own limits. In the case of a gaseous constitution, transverse translation in space with the assumed long free path, must continue, and result in a free path different from the assumed direction of the ray. The particles of sand employed to illustrate the subject thus acquire a continuous transverse *motion* in passing through the sieve, and do not "vibrate" or come back in an orbit. Such true vibratory motion is the main characteristic of solid bodies, and is the best known reason for conceiving the ether as of a "solid" constitution.

What I wish to point out is, that large classes of phenomena appear to demand such actual transverse *motion* in orbits of the entire ether particles, and cannot at present be explained without. I confine myself to two of the simplest examples from polarisation. It is well known that the production of complementary colours from a plane polarised ray by a doubly-refracting film and analyser, may be simply represented to the eye and the mind by the following diagram equation, which shows the resolution of actual *motions*.



Similarly, the two circularly-polarised rays in quartz, and their conversion on emergence into a plane ray rotated on its axis by the angular value of the difference in velocity, may be represented thus:—



Here actual motions in the plane A B are resolved into two opposite circular motions represented by the doubly-barbed circle, which meet on their emergence at the point R, to which their respective velocities from the common departure A have brought them. There they are again resolved, the two tangential forces T R destroying each other, and the two radial forces, R C, uniting in the rotated plane wave, R P. Here again we have throughout actual motions, through definite distances. And I am at a loss to see how whole classes of phenomena of which these are typical can be explained in any other way, or by any but a true "vibration" bodily to and fro in space. If it be so, then it is not enough for some vague physico-mathematical notion to satisfy abstract mathematical conditions; we must ask for the definite physical conception which is to account for the physical phenomena. Until we have this we have made no real advance in comprehending the physics of the ether.

At the same time I cordially agree with Mr. Preston in his regret at the comparative distaste for the study of this subject; and I may, perhaps, add a suggestion on my own part, though not really new. To my own mind it seems as easy to conceive of "matter" without gravity as with it, and of infinite elasticity as of elasticity at all (which is not easy). In ponderable matter, again, the most highly elastic solid bodies are as "solid" as the least; the greater mobility of their atoms by no means interferes with that peculiarity of vibrating *in orbits* and preserving a *locus* which distinguishes solids from fluids, and which so far we have been obliged by the phenomena to attribute to the ether also. Granted that to account for elasticity we have to conceive atoms not in contact, and are confronted by the old mystery of how they can act upon each other across a vacuum. Still, does this confront us any *more* in the ether than in ponderable matter; and, so far as they do go, are not our conceptions of the one sufficient for and equally applicable to the other?

LEWIS WRIGHT

Wellfield, Ashley Road, Crouch Hill, N.

Diffusion of Copper in the Animal Kingdom

JE lis dans la NATURE, vol. xxi. p. 305, un article intitulé "Diffusion of Copper in the Animal Kingdom," se terminant par ces mots: *it is to be hoped that more extended observations will inform us of the exact nature of the rôle played by cupric compounds in the animal economy.* Je crois pouvoir satisfaire en partie au moins à ce vœu. Dans plusieurs communications insérées dans les publications des Académies des Sciences de Paris et de Bruxelles (1878 et 1879), j'ai montré que chez certains mollusques céphalopodes et gastéropodes et chez les crustacés décapodes, le cuivre joue dans le sang le même rôle physiologique que le fer dans notre sang.

Le sang veineux du poulpe (*Octopus vulgaris*), du homard (*Homarus*), etc., contient une substance albuminoïde incolore, cuprifère, à laquelle j'ai donné le nom *d'hémocyanine*, terme rappelant sa parenté avec l'hémoglobine. *L'hémocyanine* forme dans la branchie une combinaison peu stable avec l'oxygène; cette combinaison *l'oxy-hémocyanine* est d'un beau bleu. Elle se décolore en se dissociant sous l'influence du vide ou du contact avec les tissus vivants. Aussi le sang artériel du poulpe est d'un beau bleu tant que l'animal respire une eau bien aérée. Il suffit de comprimer la branchie, de gêner la respiration, pour voir le sang artériel se décolorer.

L'hémocyanine paraît avoir une constitution chimique analogue à celle de l'hémoglobine. Comme cette dernière elle est susceptible de se dédoubler en une substance albuminoïde ne contenant pas de métal et en une substance cuprifère qui paraît former des sels cristallisables analogues aux sels d'hématine.

LÉON FREDERICQ

Liége, le 11 février, rue du parc, 25

Lines of Force due to a Small Magnet

I HAVE been recommended by Sir William Thomson to send you the following construction for the lines of force due to a very small magnet.

The equation to the lines of force due to a very small magnet placed at the origin of co-ordinates and lying along the axis of x is—

$$\frac{y^2}{(x^2+y^2)^{\frac{3}{2}}} = \frac{1}{C} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

By varying C we obtain a series of similar curves.

Transforming to polar co-ordinates by putting $x = r\cos\theta$, $y = r\sin\theta$, we get for the equation (1)

$$r = C\sin^2\theta.$$

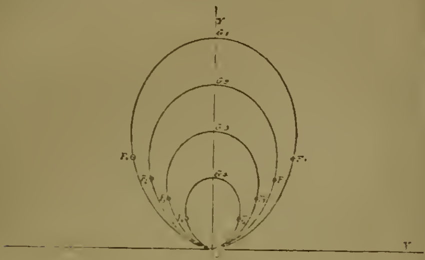
This immediately suggests the following construction:—

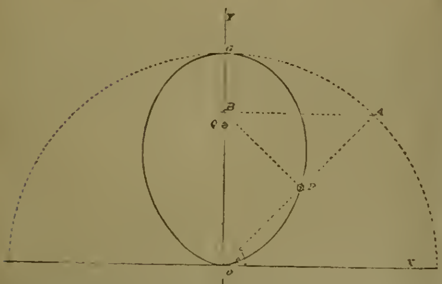
Take $OG = C$, and with this as radius, describe a semicircle. Draw any radius OA, then take AB perpendicular to OY, and BP perpendicular to OA: then P is a point on the required curve. Because

$$OB = OA.\cos OAB$$
$$= OA \sin\theta, \qquad \text{where } \theta = \text{angle } AOX.$$

Also $OP = OB \sin\theta$
$$= OA \sin^2\theta.$$

Therefore P is a point on the curve.





In a similar manner any number of points on the curve may be obtained; and by varying the length OG, we get different curves of the same class.

Near to the point G in the figure, the points on the curve cannot be constructed accurately by the method just given; but if the radius of curvature for the point ($x = 0$) be calculated, it will be found that for the point G it is $\frac{OG}{3}$. Q is the centre of curvature. And a large arc of the circle described about Q with radius QG coincides with the curve. Thus the whole curve may be constructed with great accuracy.

From equation (1) radius of curvature at any point (xy) is given by

$$\rho = \frac{C.y(4x^2 + y^2)^{\frac{3}{2}}}{3(2x^2 + y^2)(x^2 + y^2)}$$

or, with x eliminated by (1),

$$\rho = \frac{C^{\frac{1}{3}}.y^{\frac{1}{3}}.(4C^{\frac{2}{3}} - 3y^{\frac{2}{3}})^{\frac{3}{2}}}{3(2C^{\frac{2}{3}} - y^{\frac{2}{3}})}.$$

Thus $y = \cdot 432\,C$ gives the point of maximum radius of curvature.

Lines of force—

$$\frac{y^2}{(x^2 + y^2)^{\frac{3}{2}}} = \frac{1}{C}.$$

These curves may be obtained by giving to C the values

$$C = OG_1,$$
$$C = OG_2,$$
$$C = OG_3,$$
$$C = OG_4.$$

The points (F) are points of minimum curvature.

Glasgow, January 29 JOHN BUCHANAN

Prehistoric Man in Japan

IN an article on this subject (NATURE, vol. xxi. p. 350) by Mr. F. V. Dickins, there is a mistake in dates. He says: "The 'adzuma' or eastern region of the main island was probably peopled chiefly by an Aino race, up to the fourteenth or fifteenth centuries." He hesitates to assign a higher antiquity to the Omori heaps (which were discovered by Prof. Morse) than the thirteenth or fourteenth century, and yet thinks it probable that they were the works of an Aino race. But the fact is that this part of the island was already inhabited by the present race, who had expelled the Ainos long before those periods. Consequently if, as he thinks, the heaps were the remains of the thirteenth or fourteenth century, they cannot be the works of the Ainos; if, on the other hand, they were the works of the Ainos, a much higher antiquity ought to be assigned to them. Such being the case, either one of his conclusions must be incorrect.

London S. SUGIURA

Monkeys in the West Indies

IN NATURE, vol. xxi. p. 131, there is a letter from Mr. Edmund Watt, of Dominica, calling in question the correctness of Prof. Mivart's statement in his paper on "Tails," regarding the non-existence of monkeys in the West Indies.

If by this statement Prof. Mivart means that monkeys are not to be found wild at the present time in any of the West India islands, it is certainly incorrect, as they abound in St. Christopher and Nevis.

If, on the contrary, and what is much more probable, he means that monkeys are not *native* in any of these islands, then he has made no mistake, as I think I shall be able to show.

It certainly does appear remarkable that no species of monkey should exist in the wild state in any of these islands along the whole range from Grenada to Jamaica, with the exception of St. Christopher and Nevis, and the question that naturally presents itself is, Have they been introduced? I am not aware that there is any tradition to this effect in either of these colonies.

It appeared to me that the most likely mode of obtaining information on this point would be to examine all the old West India histories in my possession, as those writers who treated of the natural history of the islands could not fail to notice so singular a fact as the existence of monkeys in two neighbouring islands and in none of the others. The first history examined was that of Rochefort, "Histoire Naturelle et Morale des Antilles, 1665." He names and describes all the mammalia in the West Indies known to him, but no mention whatever is made of monkeys. The next work examined was the "Histoire Génerale des Antilles," by Père Du Tertre, 1667, a most interesting book, but little known. Du Tertre was a man of keen observation, and he has devoted a large portion of his work to natural history. He gives a very clear description of all the mammalia with which he was acquainted, but there is not a word about monkeys. This is the more notable from the fact that St. Christopher was considered the mother colony of the other French settlements, and Du Tertre lived there for several years, and visited the island frequently. From the negative evidence afforded by Rochefort and Du Tertre, it may be concluded that monkeys did not then exist in these islands, and, in consequence, must have been subsequently introduced.

On examining a third historical work on the West Indies, that of Père Labat, "Nouveau Voyage aux Antilles, 1744," conclusive evidence was discovered of the *when* and the *how* of the importation of the monkey family into St. Christopher.

Father Labat says that he paid a visit to St. Christopher in the year 1700. He describes the French quarter, the island being inhabited at the time by French and English, and gives a very amusing account of a monkey hunt (*chasse des singes*). He makes the following statement regarding the introduction of monkeys into the island, which I give in the original. "Pendant que les Anglais étoient demeurez maîtres des terres des Francois, dont la plus grande partie resterent en friche, les singes qui s'étoient échapez des maisons des Francois pendant la guerre, multiplierent tellement que quand on reprit possession de l'Isle on les voyoit par grosses troupes. Ils venoient voler jusques dans les maisons, & lorsqu'on plantoit des cannes, des patates ou autres choses, il falloit y faire sentinelle jour and nuit, si on vouloit que ces animaux n'emportassent pas tout ce qu'on avoit mis en terre."

It is thus made clear that the existence of monkeys in St.

Kitts (in the wild state) dates from about ten years previous to the visit of Labat, in 1700—so that they have been denizens of the island close upon two centuries now. The manner of their introduction may not even have been known to the English settlers of the colony.

It was on this occasion, the good Father informs us, that he first ate monkey. "It is true," he says, "I was a good deal shocked when I saw four heads in the soup, very much resembling infants' heads, but when I tasted of the dish I had no difficulty in overcoming my scruples, and continued to eat with pleasure," for, he adds, "C'est une chaire tendre, délicate, blanche, pleine d'un bon suc, & qui est également bonne à quelque sorte de sauce qu'on la mette."

The worthy Father feelingly dwells upon the admirable qualities of young monkeys in the form of soup or otherwise. The people of St. Christopher and Nevis might benefit by the experience and example of good Father Labat. Why not try young monkey as an article of diet generally? The planters would thus receive some compensation for the destruction of their canes and provisions by this pestilent mammal.

Trinidad, in a natural history point of view, may be considered more as a portion of South America than as belonging to the West India Islands proper. The two kinds of monkeys found in Trinidad are, I believe, met with in the opposite mainland. There is, therefore, no mystery as regards their existence in that island. The same remark applies to Nevis with respect to St. Christopher.

An example of almost exactly the same nature as that above related regarding the monkeys of St. Christopher has taken place in Dominica within the last half-century, and in like manner might pass out of remembrance unless placed on record.

About forty years ago a planter of this island visited his friends in Martinique: in returning from thence he brought with him two opossums, male and female. Shortly after they unfortunately escaped from their cage, and made their way into the woods. This was the current belief at the time and afterwards. The fact, however, is certain of the importation of the animal about that period. Their numbers increased rapidly, and not many years had passed when one of the results of their presence in the forests was the disappearance of the large frog, or crapaud, of the island, upon which the *Manicere* (as called by our people) preyed. The southern district of the island, where the pair escaped, was first nearly cleared of crapauds; but as the opossums multiplied they gradually extended over the whole island, with the exception of a part of the northern district, and as they spread, the frogs for most part were destroyed, and it was feared might be finally exterminated; but lately it would seem that their numbers have somewhat increased, and the opossums are probably not so numerous.

Fortunately our peasantry eat the opossum with great satisfaction, and set traps in the woods to catch them and hunt them on all occasions.

The large frog, or crapaud, of this island, *Cystignothus ocelatus*, I believe, is a part of the dietary of the people of all classes in the colony. It is very wholesome and much relished. Its extensive destruction by the mischievous opossum has been a great evil to the country, but its extermination would be a serious loss. Happily, however, it appears to be gaining ground of late, though it can never abound as formerly while the "Manicere" exists in our woods. JOHN IMRAY

Dominica, January 10

Intellect in Brutes

I SEND the following notes on the habits of the red or agricultural and the small black ant, which may be of interest to the readers of NATURE:—

I have been stationed for several years where the red or agricultural as well as the small black ant are common, and have observed with much interest their habits. The burrows of the red ant are said to be very deep, always extending to water, and it is stated that one has been followed for a depth of twenty feet.

I have never seen any evidences of the sowing of seeds, but have frequently seen them carrying leaves of grasses and grass-seeds into their burrows.

The mounds are usually from two to three feet in diameter at base and one foot in height, are made of gravel, and frequently ornamented with bits of crockery, beads, or pins, as opportunity may offer. The warriors are very bold, attacking anything which may trespass upon their grounds; I have often placed a centipede or scorpion upon the mound, and observed them attack and destroy it.

The fighting is all done by the warriors, who, on being called upon by the sentries, sally out in great numbers, and rush to the attack; some seize and hold the victim, while others attack it on every side; as soon as it ceases struggling, the warriors return to their burrows, leaving to the workers the labour of cutting up and carrying in.

Hospital-Steward Smith, U.S. Army, states that in Arizona and Idaho he has observed that these ants render much service by freeing houses of that insect pest so common in warm climates, *Cimex lectularius*.

One day last autumn, while halting for lunch on the banks of the Cinnamon River, I.T., a forager belonging to a party of black ants was observed to discover some sugar which had been dropped upon the ground; the ant immediately ran off, and soon returned, followed by a long line of its fellows. The first to arrive did not carry away any of the treasure, but seemed to resolve themselves into guides for the approaching column; they ran back upon the trail, and every now and then an ant in the advancing column seeming to be in doubt as to the correctness of its course, would run out of the line and approaching a guide, would confer a moment with him, then, reassured, would hasten back to the line and continue on its course.

Post Hospital, U.S. Army, T. E. WILCOX
Boise Barracks, Idaho Terr., Dec. 23, 1879

Stags' Horns

A FEW weeks ago I was staying with a friend in Sussex, in whose park are about sixty red deer, and upon my asking him whether he had ever picked up any cast-off antlers, he replied that he had not only picked up some that were *gnawed*, but had actually himself seen them gnawing them. He has promised to send me some specimens after this year's shedding.

G. J. R.

THE VOLCANIC ERUPTION IN DOMINICA

ON Sunday, January 4, shortly after eleven o'clock in the morning, a volcanic eruption occurred in the Grande Soufrière district of Dominica. This district is situated near to the centre of the southern third of the island; and before the late eruption its volcanic energy was manifested by the action of four solfataras and by the Boiling Lake. During the morning of January 4, the weather in the town of Roseau—the capital of the island, was cool and showery; but shortly before eleven o'clock the sky became overcast and heavy rain began to fall, accompanied with thunder and lightning. Soon afterwards the sky darkened, the rain poured in torrents; a powerful odour of sulphuretted hydrogen pervaded the atmosphere; the lightning increased in vividness; and thunder of a peculiar sound, and without the usual reverberation, crashed for several minutes with intermissions of so short a duration as to be scarcely recognisable. After the lapse of about five minutes the darkness began to lift, and it was then seen that the rain was bringing down volcanic ash of a light greyish colour and metallic lustre. The ash fell for about nine minutes, covering the ground to the extent of a quarter of an inch, and during the time everything had a dull leaden aspect, whilst the mud rolled off the houses and the leaves of the trees like big globules of partially oxidised mercury. During the time the ash was falling I noted that the barometer indicated a pressure of 30·10 inches, and a few hours afterwards the mercury fell to 29·96 inches. The Roseau River, which rises near to the volcanic district, became a raging torrent, flooding the land through which it passed and creating great destruction; its water became of an opaque white colour, and even now, more than three weeks after the eruption, the white colour remains, though in a lesser degree. It is worthy of notice that the greater body of water came from the vicinity of the eruption, for the lower tributaries of the Roseau River were very little swollen.

The scene of the eruption is about eight miles east from Roseau, and the volcanic ash was blown to the west, by the trade wind, in a narrow belt about one and a half miles wide. There is, unfortunately, no means of ascertaining the extreme limit of this belt; but a small vessel, which was about four miles out at sea at the time of the eruption, experienced a shower of ash similar in every respect to that which fell in Roseau. The area, then, over which the ash fell must have been at least twenty square miles.

On the 12th of January, I visited the Soufrière district, and found that a volcano had opened up about a mile to the south-west of the Boiling Lake. The Grande Soufrière lies in the depth of the primeval forest which covers the greater part of Dominica, so that no loss of life occurred; but for a considerable distance beyond the crater the trees have been destroyed, and the earth is covered several feet deep in some places, with volcanic *débris*. Here and there, stumps of blasted trees sticking up a few inches or a few feet from the gray ash give a striking evidence of the force of the explosion. Most of these stumps have been quite shattered by the ejecta, and in many were found embedded large pieces of trachytic rock. I did not observe any traces of fire, but on scraping away the ash from the ground at some distance from the lip of the crater, large splinters of wood and a few bleached leaves were discovered. Beyond this zone of desolation, the forest has been destroyed to a great extent by a whirlwind which appears to have occurred just before the eruption. Branches of trees, broken and twisted off from the parent stem, have fallen to the ground, and by their weight have crushed down all the forest undergrowth. In spite of the heavy rains, which had been almost continuous since the time of the eruption, I found the ash still tenaciously clinging to the leaves and the trunks and the branches of the trees. The swollen streams which run through the ravines radiating from the volcanic district, were in many places dammed up with large pieces of sulphur and pumice, and with splinters of wood. On reaching the lip of the crater, which was a work of some difficulty on account of the depth of the ash, the bottom was seen about 600 feet below. This appeared to be cooling down, for although commotions were observed in several places there was no flame or glow visible. Here and there, columns of aqueous vapour ascended and widened out into clouds before reaching the lip, so that the bottom of the crater could only be seen at intervals. The crater is ovoid, with its long axis running in a direction from west-south-west to east-north-east and the lowest part of the lip, as measured by the aneroid barometer, is 2,615 feet above the level of the sea. At the north-eastern extremity there is a break in the side of the crater, and through this a quantity of volcanic mud poured into the Point Mulatre river, which flows towards the eastern side of the island; it would appear that an enormous quantity of the gray mud was thrown out, for it is stated that at one time the bed of the river was nearly filled up, but since the eruption most of the mud has been carried out to sea.

Large masses of pumice and sulphur are seen in the vicinity of the crater; and I picked up, near to the lip, pieces of felspar and porphyry. Rocks containing augite are found in abundance, and the solid ejecta lying about in all directions are composed for the most part of grey trachyte, containing a large proportion of iron pyrites. Were these trachytic rocks pulverised they would form, with the addition of sulphur, a sand similar in appearance to that which fell in Roseau at the time of the eruption.

Strictly speaking, a new crater has not formed, for the eruption was only the breaking into activity of an old volcano. The Grande Soufrière district formerly included four solfataras and the Boiling Lake, and the most active of these solfataras was situated in the crater of the volcano which has again become active. With the exception of a part of the bottom and southern side occupied by the soufrière—as a solfatara is called in the West Indies—the crater was clothed with trees, many of which were of large size and considerable age; and a stream of strongly ferruginous water rising at its south-western extremity, ran through the ovoid basin and found an exit at the break in the north-eastern side. The path to the Boiling Lake passed through the crater, and the north bank of the chalybeate stream—which has now entirely disappeared—was the usual place selected for an encampment by those visiting the lake. No earthquake was experienced at the time of the eruption; and beyond the peculiar thunder there were no sounds, similar to the booming of cannon, which are usually mentioned as concomitants of all manifestations of volcanic energy. It is also to be noticed that there was no flow of lava, and on my visit to the volcano, I found no trace of this usual educt of an eruption. It may be that the resistance to the volcanic force, was too small to cause much tremulation except in the immediate vicinity; and the surrounding country is of so rugged and broken a nature—dislocated rocks, and sharp ridges alternating with deep ravines—that a seismic wave would be propagated with difficulty.

The ash and sand which fell in Roseau, was similar in many respects to that ejected from Tomboro in April, 1815, for on that occasion the Commander of the H.E.I.C. cruiser *Benares*, reported concerning the ash which fell at Macassar, "though an impalpable powder or dust when it fell, it was, when compressed, of considerable weight; a pint measure of it weighed twelve ounces and three-quarters, it was perfectly tasteless, and did not affect the eyes with painful sensation, had a faint burnt smell, but nothing like sulphur; when mixed with water it formed a tenacious mud, difficult to be washed off."[1] The ash which fell in Roseau was heavier, for a pint measure of it without compression weighed twenty-one ounces and fifteen drachms; this heaviness may however, be accounted for by the large proportion of iron pyrites, and the presence of this mineral was the cause of the metallic glistening first noticed when the ash fell.

M. Bert, a resident in Roseau, has made a qualitative analysis of the ash, and he informs me that he found the following bodies:—ferric sulphide, magnesia, potash, soda, silicon, sulphur, carbon, oxides of iron, lead, and alumina. M. Bert also found traces of other bodies, but their proportion was so small that he was unable to determine their exact nature with the means at his disposal.

H. A. ALFORD NICHOLLS

JUNGLE LIFE IN INDIA[2]

OF the many volumes published about the British possessions in Asia not one of them appears to us to go over the same ground as Mr. Ball's "Jungle Life in India." For nearly fifteen years the author, as one of the staff of the Geological Survey of India, was engaged in the work of the survey in parts of the Central Provinces and of Western Bengal far out of the ordinary tracks. Fond of sport, an excellent ornithologist, and a good botanist, there was much to engage his attention outside the ordinary routine of his daily duties—duties indeed which by their very nature brought him into everyday contact with all sorts of natural objects, both great and small. A specialist, it is true, has the proud satisfaction of knowing the subject he works at perhaps better than any one else, but he too often acquires the knowledge by the sacrifice, dismal to contemplate, of his love for almost all other subjects, and he can look for sympathy with his

[1] Memoir of Sir Thomas Stamford Raffles, F.R.S. London, 1830, p. 246.

[2] "Jungle Life in India; or, The Journeys and Journals of an Indian Geologist," by Valentine Ball, M.A., of the Geological Survey of India. London: Thos. De la Rue and Co., 1880.

labours to a very select few. Not so with our Indian geologist; his special work is but little touched on in this volume, though a glance at its 702nd page (Appendix G) shows the amount of that work accomplished, in the form of Memoirs, Records, and Reports published from time to time by the Geological Survey of India, to have been both important and great. One great charm of this journal lies in its many touches of nature. One feels as one reads it that for the moment they are with the journalist as he travels through some jungle, wanders along the bed of some mountain torrent, or explores some new coal-field big with promise. As a personal narrative it is full of life, and what it may want in precision is more than made up by the vivid pictures it presents.

The volume opens with an account of the Ranigunj coal-field, the largest and most important of those in which coal is worked in India:—

"The Ranigunj coal-field is the largest and most important of the areas in which coal is worked in India. Its proximity to the main line of railway, and also to the port of Calcutta, tends to give it pre-eminence over other less favourably situated localities. In the year 1774 coal was known to occur there, and so long ago as 1777 was actually worked. In 1830 several collieries of considerable extent had been opened out, and were, we have reason to believe, in a flourishing condition. The total area of coal-bearing rocks which is exposed is about 500 square miles; but it is possible that the real area may be even double that, since on the east the rocks dip under and are completely concealed by alluvium. Throughout this area a central zone includes the principal mines, and the chimneys which dot this tract constitute it the black country of India. At the present time (1879) there are about six principal European companies engaged in the extraction of coal, while many minor firms and native associations contribute to swell the total amount raised.

"Formerly a large proportion of the coal was obtained by open workings and quarries: but at the present day most of the seams which were accessible in this way have been exhausted, and regular mining is now carried on with more or less system. The miners are, however, individually, in some cases, allowed a degree of freedom, or rather licence, which would never be permitted in European mines. They chiefly belong to two races, the Bhowries and the Sontals; the former using the pick, while the latter cannot be induced to work with any other tool than a crowbar, with which they produce an altogether disproportionate amount of small coal and dust. The pillar and stall is generally practised in preference to the long wall system of 'getting' the coal. None of the mines are of great depth, and a perfect freedom from fire and choke-damp renders it possible to carry on the work without its being necessary to adopt the precautions which in England only too often fail to secure the object aimed at. Many of the seams are of considerable thickness; one which is worked contains nearly forty feet of coal. As a rule, however, the thick seams, especially those in the lower measures, do not contain the best coal. Compared with ordinary English coal, the Ranigunj coals, and Indian coals generally, are very much inferior in working power, still they are capable of generating steam in both locomotive and other engines, and for this purpose several hundred thousand tons are raised annually from Indian mines."

The many details in reference to articles of commercial value to be found scattered through this volume may be well illustrated by the following extracts, the first relating to "cutch," the second to shell-lac:—

"At this season a particular class of the natives were engaged in preparing the substance called *Koir*, which bears the commercial name of cutch, and is otherwise known as catechu. The chopped heart-wood of *Acacia catechu*, Willd., is boiled down in earthen vessels, and the resultant red liquid is subjected to further boiling, and, on arriving at a treacly consistency, is poured into clay moulds or wooden troughs. In some places I have been told that the finer qualities are improved by being buried for some months in the earth. It is an article of great value, and the right to manufacture is farmed out by the Zemindars. It is exported to Europe for dyeing and tanning, and in India it forms one of the constituents of pawn for chewing. It is also employed for various other purposes."

In these countries the consumption of cutch is very considerable; it is chiefly in use for tanning manufactured articles, such as the nets used in the herring and mackerel fisheries. Our next extract relates to an important production called shell-lac. Why is this term sometimes, and in standard works, spelled with but two l's?

"This morning, before leaving the station, we visited a shell-lac manufactory, and as the method by which that useful article of commerce is prepared, and the source from which it is derived are not generally known, I shall endeavour to convey what I know of the subject as briefly as possible.

"Lac (or as it is called in Hindustani, *lah*) is secreted by an insect (*Coccus lacca*) on the branches and twigs of certain jungle trees. The principal of these are the khusum (*Schleichera jujuga*), plas (*Butea frondosa*), and bier (*Zizyphus jujuba*). The lac from the first-mentioned, the khusum, is more highly esteemed than that from the others. To some extent the lac is found occurring, so to speak, spontaneously, and is collected by the forest tribes, and brought by them to the fairs and bazaars for sale. Where, however, there is a regular trade in stick-lac, propagation of the insect is systematically carried on by those who wish for a certain and abundant crop. This propagation is effected by tying small twigs, on which are crowded the eggs or larvæ of the insect, to the branches of the above-named species of trees. These larvæ are technically called 'seed.' The larvæ shortly after sowing spread themselves over the branches, and, taking up positions, secrete round themselves a hard crust of lac which gradually spreads till it nearly completes the circle round the twig. At the proper season the twigs are broken off, and we must suppose them to have passed through several hands, or to have been purchased directly from the collectors by the agents of the manufacturer. On arrival at the factory, they are first placed between two powerful rollers, which, by a simple arrangement, admit of any degree of approximation. The lac is then crushed off and is separated from the woody portions by screening; it is next placed in large tubs half-full of water and is washed by coolies, male or female, who, standing in the tubs, and holding a bar above with their hands, stamp and pivot about on their heels and toes until, after a succession of changes, the resulting liquor comes off clear. Of the disposal of the liquor drawn off at the successive washings I shall speak presently. The lac having been dried is placed in long cylindrical bags of cotton cloth of medium texture, and which are about ten feet long and two inches in diameter. These bags when filled have somewhat the appearance of an enormous Bologna sausage. They are taken to an apartment where there are a number of open charcoal-furnaces. Before each of these there is one principal operator and two assistants. The former grasps one end of the long sausage in his left hand, and slowly revolves it in front of the fire; at the same time one of the assistants, seated as far off as the sausage is long, twists it in the opposite direction. The roasting before the glowing charcoal, soon melts the lac in the portion of the bag nearest the operator's hand, and the twisting of the cloth causes it to exude and drop into a trough placed below. The troughs which I saw in use were simply leaves of the American aloe (*Agave americana*). When a sufficient quantity, in a molten condition, is ready in the trough, the operator takes it up in a wooden spoon and places it on a wooden cylinder some eight or ten inches in diameter, the upper half of which is covered with sheet brass. The stand which supports this cylinder gives it a sloping direction away from the operator. The other assistant, generally a woman, now steps forward holding a strip of the agave or aloe between her hands, and with a rapid and dexterous draw of this the lac is spread at once into a sheet of uniform thickness which covers the upper portion of the cylinder. The operator now cuts off the upper edge with a pair of scissors, and the sheet is then lifted up by the assistant who waves it about for a moment or two in the air till it becomes quite crisp. It is then held up to the light, and any impurities, technically 'grit,' are simply punched out of the brittle sheet by the finger. The sheets are laid upon one another and the tale, at the end of the day, is taken, and the chief operator paid accordingly,—the assistants receiving fixed wages. The sheets are placed in packing-cases, and when subjected to pressure break into numbers of fragments. In this fresh state the finest quality is a very beautiful object having a rich golden lustre. On seeing it thus, one cannot help feeling regret that it is not nice to eat—the best Everton toffee never looked more tempting. The above is the history of shell-lac, from its birth in the jungle to its appearance in the world as the commercial article. From the manufacturer it passes through the broker's hands to the merchant, and from him again to the manufacturers of varnishes, sealing-wax, and other commodities of which it is an ingredient.

"The dark red liquor resulting from the washing above described, is strained, in order to remove all portions of woody fibre and other foreign materials. It is then passed into large vats, where it is allowed to settle; the sediment is subjected to various washings, and at last allowed to settle finally, the supernatant liquor being drawn off. The sediment, when it is of the proper consistency, is placed in presses, from which it is taken out in the form of hard dark purple cakes, with the manufacturer's trade-mark impressed upon them. This constitutes what is known as lac-dye. By the addition of mordants, this dark purple substance yields the most brilliant scarlet dyes, which are not inferior, I believe, to those produced by cochineal. The dye which is thus separated from the lac by washing is said to be the body of the insect, not a separate secretion."

One more extract we venture to make, which gives a description of the uses made of the flowers of the *Bassia latifolia*, Roxb. Not only are the fruits of this tree used as an article of food, but "the fleshy deciduous corollas are likewise largely employed for the same purpose, and, in point of fact, constitute a staple and sometimes almost the only article of diet available to the poorer classes during several months of each year. Towards the end of February or the beginning of March, as the crop of mhowa flowers approaches ripeness, the corollas, becoming fleshy and turgid with secreted juices, gradually loosen their adhesion to the calyx, and fall to the ground in a snowy shower. The duty of collecting the fallen blossoms is chiefly performed by women and children; at dawn they may be seen leaving their villages with baskets and a supply of water for the day's use. Before the crop has begun to fall they take the precaution to burn away the grass and leaves at the foot of the trees, so that none of the blossoms may be hidden when they fall. The gleaners generally remain under the trees all day, alternately sleeping and collecting the crop, and the male members of the family visit the trees once or twice during the day, in order to carry away what has been collected. At night bears, deer, and other animals visit the trees to take their share of the crop. In the early mornings, and late in the evenings, the less frequented trees, on the borders of the jungles, attract numbers of jungle and pea fowl. Cattle also are very fond of the flowers, and cow's milk has in consequence, at this season, a strong flavour of mhowa.

"It often happens that the people who collect come from a considerable distance, in which case they erect with the branches of the sál a temporary encampment of huts, in which they live until the crop is all gathered in. In front of each of these huts a piece of ground is made quite smooth and hard, for the purpose of spreading out the flowers to dry in the sun. When perfectly dry they have a reddish-brown colour, and in size they have lost three-fourths of their original dimensions, and about half their original weight. It is the custom with some of the natives, before spreading them out to dry, to pull off the ring of minute foliaceous lobes which crowns the fleshy corolla. It is very difficult to obtain any trustworthy statements as to the yield of the mhowa trees. A first-class tree, I have been told, will continue to shed its blossoms for fifteen days, at the rate of 120 pounds a day; but this estimate is, I believe, at least double what it ought to be. The rent of the trees varies with the abundance of them in the district, the quality of the previous rice harvest, and various other circumstances affecting the demand and supply. Twopence to four shillings were the extremes of prices which, in various places, had, I ascertained, been actually paid for permission to collect. As does the rent of the trees, so the saved crop varies much in price—the limits being from 120 to 480 pounds for the rupee or two shillings, but when, as is most frequently the case, the exchange is in kind, the merchants only give a small quantity of salt and six or eight pounds of rice for a maund (80 lbs.) of mhowa. During the famine in Manbhum the price of mhowa averaged about 24 lbs. for the rupee.

"Two maunds of mhowa are stated by some to furnish a month's food to a family consisting of a father, mother, and three children. It is, however, seldom eaten alone, being mixed with the seeds of the sál, or with the leaves of jungle plants; sometimes a small quantity of rice is added. It is the custom to cook but once a day, and each member of the family helps himself whenever he feels hungry.

"When fresh the mhowa has a sweet taste, with an odour somewhat suggestive of mice; when dried it presents some resemblance to the inferior kinds of figs. Cooking renders it vapid, and utterly devoid of flavour. On distillation the newly dried flowers yield a highly intoxicating spirit called *daru*; this is generally diluted with from five to ten times its bulk of water, and is then sold at about the rate of a penny for a quart. Its odour is most offensive to Europeans, but British soldiers have been known to secure for themselves the pleasures of intoxication by drinking it with held noses, as a child takes a nauseous draught. By careful distillation it is possible to get rid of the essential oil which causes the unpleasant flavour. From the seeds a sort of oil is expressed, which is used for cooking purposes and to adulterate ghi. Although the natives protect such mhowa trees as exist I am not aware that they do anything to increase the number.

Some of the most interesting parts of the work are those describing two trips made in 1869 and 1873 to the Andaman and Nicobar Islands. These trips served the purpose of bracing up our author for a renewed jungle life. As an example of the excellent illustrations, we give one showing a group of Nicobarese at Nankowri Island. The origin of these people "is still shrouded in much obscurity. According to themselves they all came from the Great Nicobar. They are said to possess two traditions as to their primary origin: the first being that they are sprung from ants, and the second that they are descended from a man and a dog, the sole survivors of a great inundation. This latter, however, may very possibly be a comparatively modern idea, derived from some jumbled account of the Noachian deluge taught them by the earliest missionaries. To what I have already said as to the probable affinities of the Nicobarese with the Malays and Burmese, I would here add that I have noticed among them certain traits which seem to me to point to an affinity between them and two tribes of Dravidians, with whom I have some acquaintance; these are the Malés, or Rajmehal Paharias, and the Sowras, or Savaras, of the tributary states of Orissa. The grounds for this identification are not, it is true, very definite; but when visiting the villages of the Malés, many little things, such as the erection of ornamental bamboos to ward off evil spirits, and the store-houses raised on posts, recalled to my mind similar objects in the Nicobars. In order to test this supposition I have compared lists of Nicobarese and Dravidian words, and the result is that some few have proved to be identical, or nearly so."

The following curious phenomenon is worthy of being noted. Presumably the lime must be taken up in solution by the roots in large quantities, and then deposited in the manner described.

"Some white marks on the cut stump of an Asan tree (*Terminalia tomentosa*, W. and A.) caught my eye, and these on examination proved to be the sections of laminæ of calcareous matter, which alternated with the ordinary rings of woody growth. How this calcareous matter found its way into such a position it is difficult to say, but its occurrence is perhaps not more singular than that of silica in the joints of bamboos, where, as is well known, it sometimes forms what is called 'tabasheer.' The rocks about were gneisses and schists, and I could discover nothing in the soil to account for the peculiarity.

"About a year previously, or in April, 1870, the fact of the occurrence of calcareous masses in timber had been brought to the notice of the Asiatic Society of Bengal by Mr. R. V. Stoney, who stated that many trees in the Orissa Tributary Mehals have pieces of limestone (or calcareous tufa) in fissures in them, but principally Asan

Group of Nicobarese, Nankowri Island.

(*Terminalia tomentosa*, W. and A.), Swarm (*Zizyphus rugosa*, Lam. ?), Sissu (*Dalbergia sissu*, Roxb.), and Abnus (*Diospyros melanoxylon*, Roxb.). In some cases, irregular-shaped pieces, seven inches long by two inches thick, were met with in the trunks at a height of about six feet from the ground. By the natives the lime is burnt, and used for chewing with pawn. On examination it was found that there was no structure in these masses which would justify a conclusion that they had been formed by insects. Some included portions of decayed wood seemed to be cemented together by the lime. Though I have not had an opportunity of consulting many botanists on the subject, I believe it to be the case that the occurrence of deposits of carbonate of lime in timber has not been met with elsewhere. Oxalate of lime is sometimes met with in vegetable tissues, but in the form of carbonate, I am informed, however, that there is no recorded case of lime having been found, and such also appears to have been the opinion of the late Dr. Kurz."

We had marked for further extracts some passages from the author's account of his second trip to the Andamans and Nicobars, made in 1873, and from his account of the district about Orissa, and of his visit to Afghanistan, but for these and many other such we must refer the reader to the volume, feeling assured it will be found very pleasant reading. In it there is much about the economic resources of a great country, and very many interesting details of several of the native races.

The Survey is happy in having on its staff one who by this volume has proved the good use he has made of his small amount of leisure time. We wish we could add that such zeal and such knowledge had met with or were sure to meet with a proper reward from those in whose hands the destinies of India now lie.

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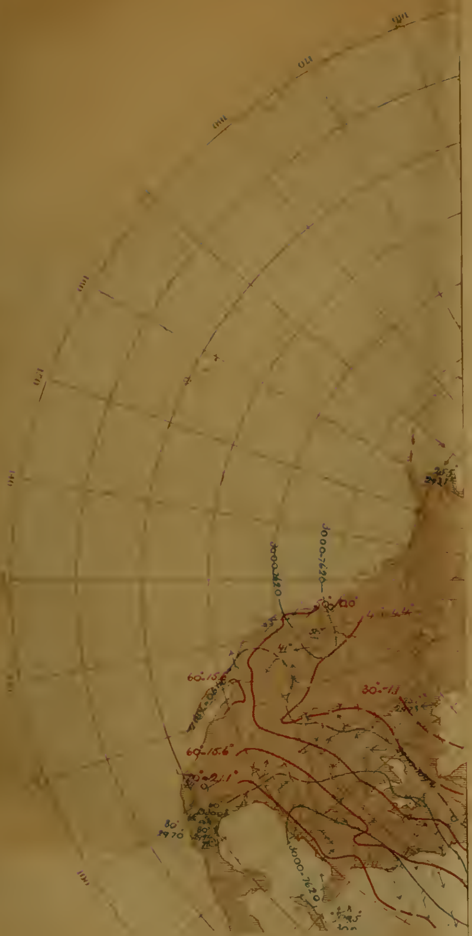
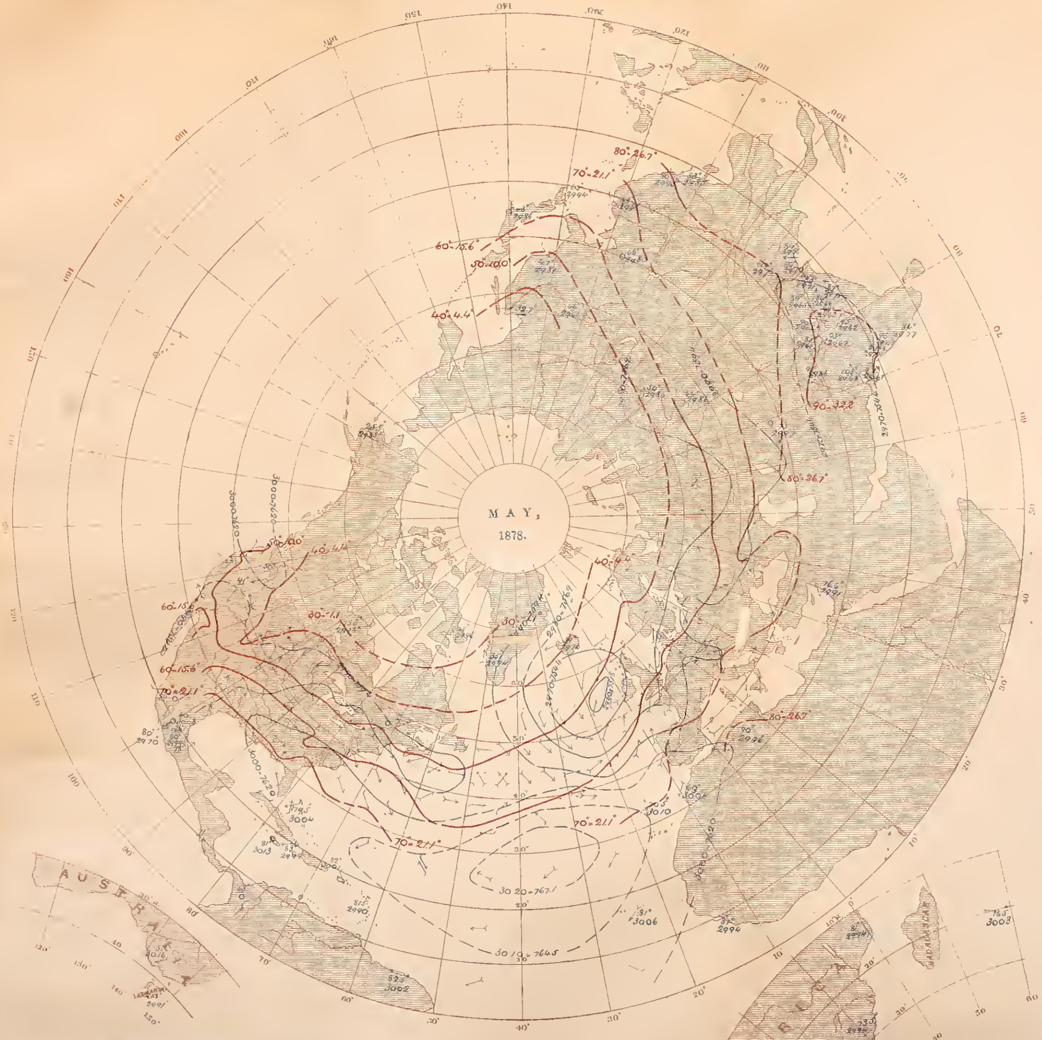
Charted from Actual Observ



Office of the Chief Signal Officer,

UNITED STATES ARMY.

Charted from Actual Observations taken Simultaneously. Series commencing October, 1877.



PREVAILING WINDS.

Arrows shows the direction of, and fly with, the wind.
Force is shown as follows:

Symbols.	Force.	Velocity.	
		Miles per hour.	Metres per second.
⟶	1, 2	0 to 9	0 to 4.0
⟶	3, 4	9.1 to 22.5	4.1 to 10.1
⟶	5, 6	22.6 to 40.5	10.1 to 18.1
⟶	7, 8	40.6 to 67.5	18.1 to 30.2
⟶	9, 10	67.6 up	30.2 & over.

PUBLISHED BY ORDER OF THE SECRETARY OF WAR

Albert J. Myer

BRIG. GEN. (BVT. ASSG'D) CHIEF SIGNAL OFFICER U. S. A.

ISOBARS AND ISOTHERMS.

Isobars in *blue*; detached barometer means in English inches.

Isotherms in *red*; detached temperature means in degrees Fahrenheit.

INTERNATIONAL MONTHLY CHART.

Showing mean pressure, mean temperature, mean force and prevailing direction of winds at 7:35 A. M., Washington mean time, for the month of May, 1878, based on the daily charts of the International Bulletin.

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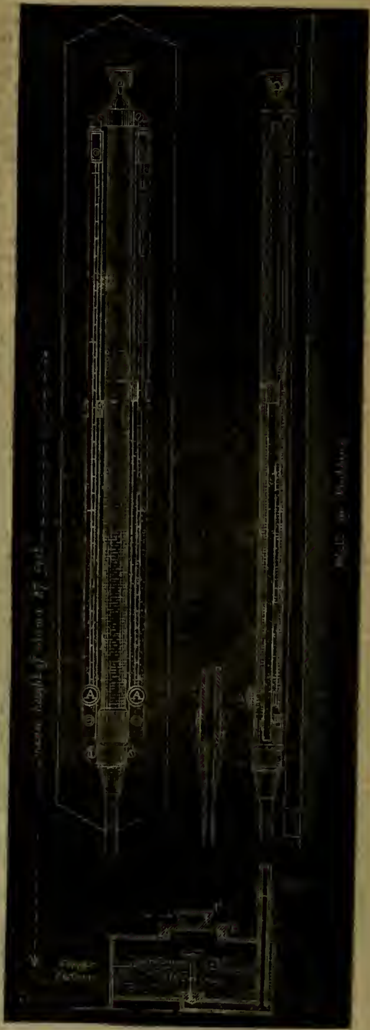
ON THE CONSTRUCTION OF A NEW GLYCERINE BAROMETER

THE direct influence of changes of atmospheric pressure on the occurrence of many of our colliery accidents, so clearly demonstrated by the investigations of Messrs. Scott and Galloway, has naturally led to the consideration of barometers affording a wide range of movement, thereby rendering small atmospheric changes at once apparent, and clearly noticeable to the uneducated eyes of those engaged in such situations as collieries, storm stations, and other places where it is important to note rapid movements without the careful observation which is requisite for the correct reading of an ordinary mercurial barometer.

Among the various attempts which have been made from time to time to construct long range barometers, may be mentioned the celebrated water barometer, constructed at great cost for the Royal Society in 1830, by Prof. Daniel, but a water column is found to be unreliable in its action, the effects of pressure being so often masked by variations due to changes of temperature on the aqueous vapour existing in the Torricellian vacuum. Mr. Jas. B. Jordan, of the *Mining Record Office*, has for some years been devoting much attention to this subject, believing that if precise instruments of this class could be made, they would prove of scientific value in showing the character of the more minute vibrations of pressure, and of practical use for the purpose above referred to. The fluid which has shown the most successful results appears to be glycerine—and a glycerine barometer was constructed by Mr. Jordan in the year 1870, which is still in operation. The purest glycerine, as manufactured by Messrs. Price and Co., has a specific gravity of 1·26; from its high boiling-point, 440° Fah., it has a very low tension of vapour at the ordinary temperatures of the atmosphere, and a very low temperature is required to freeze it. The mean height of a column of glycerine is 27 feet, and a variation of one-tenth of an inch, in the height of a mercurial column is shown by a change of more than an inch in the glycerine column. The glycerine absorbs moisture freely when exposed to the atmosphere, but this is prevented by covering the exposed surface of the liquid in the cistern with a layer of heavy petroleum oil prepared especially for the purpose. Barometers of this character have also been constructed by Mr. Jordan at the South Kensington and Jermyn Street Museums with good results. Still further to test the scientific value of the new instrument, application was made to the Government Grant Committe of the Royal Society for a small grant of money to construct an experimental barometer, and an instrument was erected therewith at the Kew Observatory, by the permission of the Kew Committee.

A detailed description of the instrument has recently been read at the Royal Society by the inventor. The accompanying figure explains its construction: the cistern is a cylindrical vessel of copper tinned inside, 5 inches deep and 10 inches diameter, fitted with a screwed cover, B, the air having access through a small hole in the cap, C, attached to the cover, which has a recess, holding cotton wool for filtering out the dust. The main tube is connected with the cistern by attachment (with a soldered joint) to a projecting piece of tube D, which enters the cistern through the bottom, and is fitted at its opening with a screwed plug, E. The tube is an ordinary composition metal gas-pipe, five-eighths of an inch in diameter, furnished at the top with a gun-metal socket, into which is cemented a glass tube 4 feet in length, with an inside diameter of 1 inch, terminating in an open cup, and fitted with an india-rubber stopper.

The fluctuations of the level of the column of glycerine are observed and read off on brass scales placed on either side of the tube, fitted with indices and verniers, moved by milled heads, A A, at the bottom of the scales. The right-hand scale gives inches and tenths of absolute measure from the level of the liquid in the cistern; the left-hand scale the equivalent value in a column of mercury, divided into tenths and hundredths, the hundredth division being equal to about one-tenth of an actual inch.



The observing part of the barometer is attached to an oak back fixed to the wall of an upper room in the Observatory, the main tube being carried down through the entrance hall to the barograph room below, a distance of 27 feet, where the cistern is placed on a bracket on the north wall, the distance being accurately measured with a tape, the error of which was found by comparison with the standard yard preserved in the Observatory.

The cistern was filled with three-fourths of a gallon of glycerine, coloured red by aniline, first heated to a temperature of 100° F. to render it more limpid, so as to disengage the air more freely; the plug, E, was then removed, and the air extracted out of the tube by means of an air-pump connected at the top of the glass tube, when the pressure of the atmosphere forced the liquid up to a height of 323·571 inches, being equivalent to 30 inches of mercury, the Kew standard at the time reading 30·3 inches. The plug was then screwed in to support the column, air admitted at the top, the air-pump connections removed, and the tube filled up to the top with glycerine, and the india-rubber stopper inserted. The screw plug being removed for a few seconds to allow the column to fall an inch or two, was then replaced, and the instrument left, until the liquid was completely exhausted of air, which slowly rose to the surface, into the vacuum above; the india-rubber stopper was again withdrawn, the tube filled up, the stopper replaced, and the cistern plug finally removed, when the column gradually fell until balanced by the weight of the atmosphere, leaving a small quantity of glycerine in the cup above the stopper, over which a plate-glass cover was placed to keep out the dust.

Daily observations of this instrument are now being regularly taken at Kew Observatory, under the superintendence of Mr. Whipple, the Director, which will decisively prove whether the instrument is to be regarded as one of scientific precision, but in any case the inventor is to be congratulated on having reduced to a simple construction an instrument forming a large scale weather-glass, suitable for ordinary observation, which cannot fail to be of interest and value at our museums and other public institutions.

C. E. R.

THE HISTORY OF WRITING[1]

I HAVE promised to speak to you to-night on a large subject, one which, to be treated adequately, would require, not a single lecture or a single hour, but many lectures and many days. The history of writing is in great measure the history of the human mind; just as anything like real abstract thought is impossible without language of some kind, so, too, without writing it is difficult to conceive of a progressive civilisation or a developed culture. The trained memory is no doubt able to accomplish marvellous feats, as we may learn from the Hindus, who have preserved by means of it, through long centuries, not only poems, but even scientific works as well; nevertheless, the memory has a limit, and I think most of us would be sorry to trust to it alone for the record of our own thoughts and discoveries, much less those of others. If language gave man the power of continuous thought, writing has enabled him to develop and make use of it.

There is a striking analogy between the history of language and the history of writing. Both have sprung from a humble origin. Language began with a few sounds and cries which symbolised and expressed an equally small number of ideas; writing began with pictures of such objects as fell within the experience of the first draughtsmen. How early this was in the history of our race has recently been disclosed to us by archæological research. Like the child, primitive man amused himself by drawing pictures of the things he saw about him, and like precocious children sometimes showed remarkable talent in practising the art. The drawings of reindeer and other animals, scratched by means of rude flint implements on reindeer-horns or mammoth-tusks, which have been found in the caves of France and our own country, are frequently of high merit, and prove that considerable skill in the art of drawing may coexist with the lowest savagery in other respects. It is a lesson that we might already have learnt from the Eskimo, whose etchings on whalebone are not unworthy of European artists, or from the Bushmen of Southern Africa, who have long excelled in painting animal forms on the smooth surfaces of rocks. But these contemporaries of the reindeer and the mammoth, who belonged to what is termed the age of polished stone tools, when England and France were still enfolded for six months of the year in a garment of glaciers and solid ice, were not the first in the West who practised the art of drawing. A remarkable discovery, made during the past year in the region of the Pyrenees, has shown that long before then, in the days when the cave-bear and hyæna and other extinct monsters of the old world still existed, and when the geography of Europe differed widely from that of our own time, there were men who employed their leisure in depicting the animals about them as well as themselves. A number of teeth belonging to the cave-bear have been discovered in a cave of the palæolithic or "old-stone" period, adorned with drawings, some of which represent human beings, covered, let it be observed, with long hair like the mammoth. I have sometimes fancied that language itself may have owed its first start and progress to pictorial aid. It is said that two Chinamen, in despair of understanding each other through the help of a language which has to denote so many different ideas by the same sound, have been known to have recourse to writing; and most of us remember when our own efforts to learn to read, and in some cases to increase our acquaintance with our mother-tongue, were assisted by the use of pictures. An appeal to the eye is surer and more impressive than an appeal to the ear, and we recognise objects more readily by their pictures than by their names. After all, therefore, it may not be a paradox to imagine that the beginnings of writing may be older than the beginnings of language, that men drew pictures before they uttered articulate sounds.

However this may be, the development of writing was soon far outstripped by that of language. Language enabled man to create and record *ideas;* the pictures he made were pictures of objects only. Until he could represent to the eye ideas as well as objects, his writing was a very poor affair indeed. It is only by courtesy that it can be called writing at all. But a time came when a great step forward was made. The ideas that had to be supplied when combining the pictures of several objects into a story gradually came to be read into the pictures themselves. A pair of legs, for instance, came to signify not only a man's legs but the idea of walking as well. Writing began to pass out of its infantile stage; to cease to be merely pictorial and to become ideographic.

This is the point at which the development of writing has stopped among some races of men. Thus certain of the North American Indians have long possessed a means of communicating with one another, and of inscribing magical charms and exorcisms on rocks or the bark of trees, by means of pictures and ideographs. When these hieroglyphs, as we may term them, are painted, the system of writing is called Kekinowin, and some of the pictorial symbols employed in it are curious enough. A warrior, for example, is represented by the picture of the sun, with eyes, and nose, and two pendant lines, because he ought to be as bold and strong as the great luminary of day. A hand held upwards with the fingers extended denotes death, and a series of circles one within the other signifies time. This system of writing has been developed to such an extent among the Mikmaks, that a religious work has been published at Vienna entirely written in it, and containing no less than 5,701 different signs.

As soon as writing advances to the ideographic stage, the exact delineation of outward objects naturally ceases to be necessary. When once it has been determined that

[1] Lecture at the London Institution, February 12, by Prof. A. H. Sayce.

a pair of legs should express the idea of walking, the accurate drawing of the legs is no longer a matter of consequence. The two lines of an angle could represent the idea just as effectually as a carefully drawn pair of legs. The memory and intelligence have been appealed to as well as the eye, and we can as easily remember that the idea of walking is denoted by two lines as by two legs. Consequently we shall find that as soon as the ideographic stage of writing is reached, the forms of its symbols begin to degenerate. Just as the sounds of which words are composed are worn away in time by phonetic decay without any necessary impairment of their meaning, so, too, the forms of characters grow changed and modified without injury to their significance. It takes less trouble to represent the human figure by a couple of crossed lines than by an elaborate picture, and if the symbol remains intelligible, the less troublesome representation inevitably supersedes the older one. Pictures pass into ideographs not only as regards their inner sense, but also in their outward form.

The great discovery has thus been made. Ideas can be rendered intelligible to the eye not by calling up pictures of objects but by arbitrarily determining that a particular sign shall stand for a particular idea. The pictures of primitive man have become characters. It is no longer the outward senses but the memory that is appealed to. In short, a system of writing has been invented which can be learned like a language. All that now remains is to perfect the invention, to discover how the whole realm of human ideas can be expressed by the fewest and simplest signs.

But the development and perfecting of the invention was a slow and gradual process. When we look back upon past ages it seems strange to us that the characters were not at once reduced to an alphabet, the letters of which denoted mere sounds. We may ask why it was that men were so long in finding out that it is quite as easy to symbolise sounds as to symbolise what is still more impalpable, namely, ideas. What seems obvious to us, however, was by no means obvious before the knowledge and experience which we inherit was slowly and laboriously acquired. No great discovery is ever made at once, by a leap as it were. It must be prepared for and led up to; the time, as we say, must be ripe for it. And the history of writing is the same as that of all other great discoveries. It was a long time before men began to realise that our system of writing may be intelligible to others even if we do not try to represent ideas at all. As ideas multiplied it was found impossible to find separate characters for each of them, much less to remember them all. At first the difficulty was evaded by combining two or more ideographs together in order to express a new idea, which was analysed into others already known and represented in writing.

Thus the ancient Babylonians had separate characters to denote "water" and "eye;" by combining these they succeeded in suggesting to the mind of the reader the notion of a "tear." So, again, as the sun was symbolised by a circle, a month was readily represented by writing within the circle the numeral thirty, which signified the 30 days of the lunar month.

This mode of expressing ideas may be termed classificatory. Ideas were arranged in classes, one under the other, and just as we define an idea by making it a species of some other or more comprehensive idea, new ideographs were formed by setting two or more side by side, one to denote the genus, the other the species. Thus, as Dr. Legge has shown, "a wife" is represented in the ancient Chinese writing by the two ideographs of "woman" and "broom," the Chinese conception of a careful housewife being that of one who keeps the house clean by constant sweeping. So, too, in the hieroglyphic system out of which the cuneiform characters of Babylonia and Assyria sprang, the ideographs of "great" and "man" stood for "a king," who was regarded as a special member of the genus "man." The idea of "father," again, was picturesquely expressed as "the maker of the nest," and that of "prison" as "house of darkness."

But after all there was a limit to the number of ideas which could be represented ideographically. As civilisation and culture progressed, pictorial writing found it difficult to keep pace with the new ideas which were being continually called into existence. And even if means were discovered for representing them all, the burden upon the memory became excessive and intolerable, a lifetime was required to learn a system of writing which attempted to denote by separate pictures or groups of pictures the manifold conceptions of civilised life. A civilised people, moreover, is necessarily brought into contact with its neighbours. It may try to shut itself up in silent isolation, like the Egyptians of the Old Empire or the Japanese of a more modern day, but sooner or later the nations which surround it will force themselves upon its attention, if not in the way of peace, at all events by war. Then comes the question, how to express in writing foreign proper names which have no meaning in the language of those who would record them? There is only one answer to the question, only one solution of the difficulty. We must cease trying to represent objects and ideas, and must represent words, that is, sounds instead. The day on which this fact dawned upon the human intelligence was one of the most important in the history of our race. An alphabet became possible, and with it the almost unlimited power of expressing the thoughts and needs of mankind.

But it took some time yet before the possibility was realised. Great discoveries, as I have before said, are not made all at once; simple as they seem when once made, they must be led up to slowly and step by step. An alphabet was preceded by a syllabary, that is, by a system of characters each of which denoted not a single sound but a syllable. It was almost inevitable that it should have been so. We do not naturally divide our words into individual sounds but into syllables, and a syllable often stands for a word. This was especially the case with the languages of the three leading inventors of writing, the Chinese, the Egyptians, and the Accadian population of primitive Chaldea. Many of the ideographs, therefore, used by these nations represented not only ideas but also single syllables, and it was obvious that they might be employed to express both. In Accadian, for instance, the word *bat* signified "to die," and was represented by a picture of a corpse; but *bat* also meant "fortress," and so what was originally the picture of a corpse came to be inserted in the picture of "an enclosure" when the latter was intended to denote a fortress or citadel.

As soon as the fashion had been set of assigning to characters as phonetic values their pronunciation as ideographs, it rapidly spread until every character came to have a purely phonetic value attached to it, as well as an ideographic one. The process was, no doubt, much aided by the decay and decomposition of the old pictures; it was easier to treat a character which had lost its original pictorial form as a mere representative of a syllable than one which still remained a faithful image of some natural object. But the process was attended by one great drawback. Ideographs, as we have seen, might stand for more than one idea, or the same idea might be known under different names; when, therefore, the old system of ideographs was changed into a syllabary, each ideograph represented more than one syllable. The polyphony or power possessed by each character of denoting several phonetic values, which resulted from this, has been a great stumbling-block to the decipherers of the inscriptions of Egypt and Assyria, and has only gradually been removed. It was also a stumbling-block to the Egyptians and Assyrians themselves, and various devices were adopted for avoiding it. Why it was never determined to take it out of the way altogether by restricting each character to the expression of a single syllable, was probably due to the same cause as that which makes ourselves cling so tenaciously to our own polyphonous alphabet, the innate conservatism, I mean, of the human mind. At any rate, it was left to a later age and to the foreign borrowers of the Assyrian syllabary to make an improvement which seems to us at once so obvious and so necessary. Up to the last, therefore, an Assyrian character could not only be used ideographically, but also as the representative of several distinct and different sounds. Take, for instance, the character which, as we have seen, meant originally a corpse. As the usual word in Accadian for "a corpse" was *bat*, *bat* remained the usual phonetic value of the character, but besides denoting *bat* it also denoted the syllables *til*, *mit*, and *be*, and might be used to express any one of these sounds whenever the writer willed.

In the eighth century before our era, the Assyrian mode of writing was adopted by the tribes which at that time occupied Armenia on the north, and Media on the east, and the first great reform was introduced into it by restricting each character to the expression of a single syllable. In order to express syllables, however, a good many characters were required; by the side of *ba*, for example, it was necessary to have a *bi*, a *be*, and a *bu*, and accordingly, every one who wished to learn to read and write was obliged to have a good memory. It was reserved for the Persians to make the last improvement in the cuneiform system of writing by ingeniously extracting an alphabet out of it. And the way in which they went to work was this. A certain number of characters was taken, their signification as ideographs translated into Persian, and the particular sound with which each of these Persian words began was assigned to the character as its alphabetic value.

What it required the combined labours of several different races and nations to effect in the case of the cuneiform characters of Assyria and Babylonia was effected unaided and alone by the wonderful people of ancient Egypt. The Ashmolean Museum at Oxford contains one of the oldest monuments of civilisation in the world, if indeed it is not the very oldest. This is the lintel-stone of a tomb which formed the last resting-place of an official who lived in the time of King Sent, of the second dynasty, whose date is placed by M. Mariette more than 6,000 years ago. The stone is covered with that delicate and finished sculpture which distinguished the earliest period of Egyptian history, and was immeasurably superior to the stiff and conventional art of the later ages of Egypt which we are accustomed to see in our European museums. But it is also covered with something more precious still than sculpture, with hieroglyphics which show that even at that remote epoch Egyptian writing was a complete and finished art, with long ages of previous development lying behind it. The hieroglyphic characters are already used not only pictorially and ideographically, but also to express syllables and alphabetic letters, the name of the king, for instance, being spelled alphabetically. In the hands of the Egyptian scribes, however, Egyptian writing never made any further progress. With the fall of what is called the Old Empire (about B.C. 3500) the freshness and expansive force of the people passed away. Egyptian life and thought became fossilised, and through the long series of centuries that followed, Egypt resembled one of its own mummies, faithfully preserving the form and features of a past age and of a life which had ceased to beat in its veins. Until the introduction of Christianity the only change undergone by Egyptian writing was the invention of a running-hand, which in its earlier and simpler form is called hieratic, and in its later form demotic.

But what the Egyptians themselves failed to do was done by a body of enterprising and inquisitive strangers. For some centuries after the fall of the Old Empire Egypt was given over to decay and intestine troubles, and when it again emerges into the light of history it is under the princes of hundred-gated Thebes in the period known as that of the Middle Empire. It was while these princes were adorning Thebes with temples and granite colossi, and excavating tombs for themselves in the rocks of Beni-Hassan, that a small party of immigrants, only thirty-seven in all, arrived in the Delta about 2,700 years before the Christian era. They were shepherds and cowherds from the coast of Phœnicia or Palestine, and as it were with an instinctive realisation of the great part their kinsfolk were afterwards to play in the history of Egypt, their arrival was commemorated in painting and hieroglyphics on the walls of one of the tombs at Beni-Hassan. There we may still see them pourtrayed in vermilion and ochre, and trace in their hooked noses and black hair the features of the shepherd-kings who subsequently held Northern Egypt under their sway for 600 years, as well as of the Children of Israel and the later population of the Delta. For a time came when the Egyptians were driven out of the rich and fertile lands of the Delta, the first seat of their power and civilisation, and their places taken by the traders of Tyre and Sidon and the agricultural tribes of Southern Canaan. Henceforward the Delta received a new name among the subjects of the Pharaohs; it was called Caphtor or "Greater Phœnicia," since here the Phœnician Semites found a richer territory and broader lands in which to expand than in their own narrow coast-line at home.

It is to these Phœnician settlers that we owe our present alphabet. They were, as I have said, an enterprising people, and their commercial business soon taught them the value of the writing of which their Egyptian neighbours were possessed. But as became men of business they were a practical people as well as an enterprising one; they felt none of that conservative reverence for the past which prevented change and innovation among the Egyptians, and so when they went to school in Egyptian learning they carried back with them not the whole cumbrous hieroglyphic system with its ideographs, its syllabic values, and its polyphony, but its alphabet only. All else was discarded; they found twenty-two characters sufficient to express all their thoughts and speech, and twenty-two characters only they accordingly kept. These twenty-two characters constitute the so-called Phœnician alphabet, which was handed on by the Phœnicians on the one side to the Hebrews, and on the other side to the Greeks, from whom it has descended through the Romans to ourselves. The Egyptian characters were borrowed by the Phœnicians of the Delta, not in their hieroglyphic but in their hieratic forms, as two or three examples will make self-evident.

(*To be continued.*)

RECENT PROGRESS IN ANTHROPOLOGY

AT the annual meeting of the Anthropological Institute on January 27, the president, Dr. E. B. Tylor, delivered the anniversary address. He compared the present state of the science with that of a generation ago, as shown in the addresses of 1847-8 delivered by Dr. Prichard to the newly-formed Ethnological Society. In those days it was still commonly believed that the broad-skulled tribes, whose remains are found in our early stone-age burial-mounds, were of the Keltic race; in fact, the so-called Ancient Britons. How backward comparative philology then was is shown by the fact that so eminent a scholar as Colebrooke fancied that Tamil and other Dravidian languages of South India were mere degraded dialects of Sanskrit. Prichard was the founder of English anthropology, but between his time and ours lie two events which have transformed it, namely, the development-theory, which has rationalised the study of the races of mankind, and the discovery of quaternary man, which has extended human antiquity to a period long enough for the development-theory to work in. Dr. Tylor next proceeded to give an account of the Anthropological Society of Berlin, which, founded ten years ago, has, under the presidencies of Professors Virchow and Bastian, steadily risen to over 400 members, and has done admirable work. Its financial arrangements differ much from those of the English Society, it being housed by the State, and receiving an annual grant from the Minister of Public Worship, through which aid the members receive publications exceeding in value their moderate subscription. Among the contents of its publications for the last few years, special mention was made of the accounts of anthropoid apes in the Zoological Gardens of Germany. The life of Mafuka, who lived some time at Dresden, is among the most instructive of ape-biographies, as illustrating the approach of the anthropoid to the human mind. Knowing how to unlock her cage with the key, she stole and hid it for future use; she took the carpenter's bradawl and bored holes with it through her own table; when pouring drink from a jug into her cup, she would carefully stop short of overfilling it. Her death had an almost human pathos: she threw her arms round the neck of the director, Herr Schöpf, kissed him, and then putting her hand in his, lay down and died. Mention was made of Dr. Kulischer's paper on sexual selection in primitive times, which collects more fully than has been done by previous writers, the evidence that a pairing-time like that of the lower animals prevailed in rude human society, taking effect especially in festivals held in spring and autumn, as the times of returning warmth and plenty. On these occasions the great feature is the courting-dance, the often-unrestrained proceedings of which are not to be looked on as abnormal orgies, but as simply and undisguisedly natural, forming, indeed, part and parcel of the marriage-system of rude communal society. The courting-dance, though becoming more decorous with advancing culture, has held on with extraordinary tenacity through the history of society. In the middle ages it fully kept its connection with the season-festivals to which it especially belonged, curious relics of which still remain in European villages, for instance, the Ascension-Day festival near Gotha, where the dance under the linden-tree still marks the union of the peasant couples. Dr. Tylor added that the dances of the modern ball-room, however refined and ceremonious, show clear traces of descent from these ruder performances, not only in form, but in actual purpose.

Among matters of pre-historic archæology which of late have attracted attention in Germany are the "high-fields," or "heathen-fields," where the marks of ancient tillage are traced on ground now waste or forest-grown. These resemble the well-known "elf-furrows" of Scotland, but in neither country has the old agricultural race been identified. It is much the same with the "vitrified forts" once supposed to be peculiar to Scotland, but which are now found to be common in Central Europe. In a concluding general survey of the past year's work of the Anthropological Institute itself, particular stress was laid by Dr. Tylor on the contribution of new evidence for the Asiatic origin of the Polynesians, by Mr. Keane and Col. Yule; the minute examination of the Andaman islanders by Prof. Flower tending to prove them representatives of the primitive negro type; the Rev. J. Sibree's account of Malagasy relationships, where the indefinite use of such terms as father and mother points to an early stage of the idea of kinship; Dr. Tuke's investigation of De Rochas' theory that the Cagots of France and Spain owe their exclusion from society, not to being descendants of heretics, but of lepers, real or supposed; and Mr. Worthington Smith's collections increasing the area in England over which palæolithic man is now proved to have lived.

NOTES

We are again enabled, by the courtesy of General Myer, to present our readers with one of those monthly weather maps for the northern hemisphere, of the value of which we have spoken on several occasions. The present map is for May, 1878, representing the mean pressure, mean temperature, mean force, and prevailing direction of wind, for that month. Our readers will find it both instructive and interesting, as is indicated in our Meteorological Notes this week, to compare it with the corresponding map for April of the same year, which we published in our number for January 29.

An extraordinary prize of 3,000 francs has been awarded by the French Academy of Sciences to Mr. Crookes, F.R.S., in recognition of his recent discoveries in Molecular Physics and Radiant Matter.

We are glad to learn that it is intended to commemorate, by a permanent memorial, the distinguished services rendered to science and education by Dr. Thomas Andrews, during the thirty years that he was occupant of the Chair of Chemistry in the Queen's College, Belfast. At a meeting of a highly distinguished character which was held in the Queen's College, it was resolved that the memorial should consist—"Firstly, of a portrait or bust to be placed in the College, and of a replica to be presented to Dr. Andrews's family. Secondly, of a prize or scholarship to be founded in the Queen's College, Belfast, and awarded for high attainment in those sciences in which Dr. Andrews has achieved his distinction." We think that the form which the proposed memorial is to take will commend itself not only to Dr. Andrews's personal friends, but to the wider circle who appreciate his scientific work, and who desire to encourage the studies to which his life has been devoted. Subscriptions to the memorial are invited by the Executive Committee, and will be received by the treasurers, Mr. E. H. Clarke, Belfast Bank, and Mr. W. C. J. Allen, Ulster Bank, Belfast.

It is announced as certain that M. Krantz, the director of the 1878 Universal Exhibition, will be appointed director of the Conservatoire des Arts et Métiers, and that many improvements will take place on the occasion of his appointment.

News has reached Kew of the arrival of Prof. Bayley Balfour at Aden on January 24. In compliance with instructions from the Admiralty, Capt. Heron, of H.M.S. *Seagull*, arranged to convey Prof. Balfour to Socotra, and the latter hoped to start on February 1 or 2.

The veteran French chemist, Sainte-Claire Deville, has resigned the professorship at the École Normale of Paris, after having filled it in the most brilliant manner for twenty-nine years. Of his manifold and classical investigations during this period, the most noteworthy were those on aluminium, which, supported by Napoleon III., led to the creation of the aluminium industry; the adaptation and application of the same metallurgical processes to magnesium which created likewise the industry of this metal, and the extensive researches on platinum and its allied metals in company with Debray, in the course of which platinum was fused for the first time. Although, perhaps, of less financial value, still the results obtained by Deville in inorganic chemistry may fairly be placed at the side of the remarkable contributions of his fellow *savant* Pasteur, in the biological department of the same science. His successor is Prof. Troost, whose career as an investigator dates back some twenty-five years. He has likewise confined his attention almost exclusively to the problems of inorganic chemistry, and is best known by long-continued and exhaustive studies on the phenomena of heat connected with chemical reactions.

THE *American Naturalist* states that the report of the Curator of the Harvard University Museum of Zoology, where geology is also taught, shows that facilities are extended to those desirous of studying lithology. The instruction given by Mr. M. E. Wadsworth during the past year consisted of lectures on the macroscopic and microscopic characters of the rocks and their constituent minerals, and also of field and laboratory work. Besides the study of the laboratory collections, each student had assigned to him a separate district, which he was to map, studying the characters and relations of the rocks, and collecting the necessary specimens. Of the rocks thus collected the student was required to make thin sections and to examine them microscopically, writing a thesis upon the whole work. It was intended that the course should be sufficiently thorough to fit the student for practical field and laboratory research.

THE prospectus is issued of a proposed *Botanisches Centralblatt*, to be published weekly by Fischer, of Cassel, under the editorship of Dr. O. Uhlworm, of Leipzig. The object of the publication is to supply brief abstracts (without criticism) weekly of every important new independent publication or paper in a scientific journal, in all the various branches of botanical science; a complete index to titles of recent botanical literature in all countries; short original communications; reports of museums, gardens, botanical explorations, &c.; personal news, &c., &c. The editor has secured the co-operation for this purpose of correspondents in the various towns of Germany and France, England, Switzerland, Sweden, Servia, Denmark, Greece, Russia, Belgium, Holland, &c., &c. All communications should be addressed to Dr. O. Uhlworm, Südstrasse, 82, Leipzig, who invites the assistance of botanists in all countries to render the publication as complete and useful as possible.

A FEW alterations have been made in this year's curriculum of the École d'Anthropologie at Paris, which is now divided into a winter and summer session. Dr. Paul Broca is delivering a course of comparative anatomy, while Dr. Paul Topinard is conducting the biological section of the class for anthropology, and M. Gabriel de Mortillet that of human palæontology. The summer session will begin in April, with lectures on ethnology by Dr. Dally, on language in relation to anthropology by Dr. Hovelacque, and on demography by Dr. Bertillon.

HERR LISSAUER, in exploring the so-called "Reihengräber" near Culm, on the Weser, has found about seventy graves, not previously opened. In these the bodies were found lying in rows on the bare ground, and besides bronze and iron knives, amber, agate, and other beads, rings of an oval form, varying in diameter from 30 to 80 millim., were discovered on either side of each skull. These singular objects, to which the name of "Hackenringe" has been given from their hooked form, have never before been found at any but a purely Slave-station. In Poland there is evidence that their use was continued till the middle of the eleventh century, but hitherto no light has been thrown on the purpose for which they were intended. The crania found in these graves differed from the brachiocephalic type of the Slaves, and approached more closely to that of the mesaticephalic ancient inhabitants of Western Prussia.

A SMALL crater is stated to have appeared near Paterno, on the west side of Etna, and the other craters are again issuing a saltish oily fluid, which has formed a small lake and is injuring the neighbouring fields. Numerous slight shocks of earthquake have also been felt to the north-north-east and south-south-west of Etna; jets of steam have issued from the new craters, and steam, mixed with ashes, from the central one.

THE principles of sanitary science appear to have received but small attention in the Riviera, for, according to the sanitary commissioner of the *Morning Post*, who has just concluded a series of articles on the result of his examination of the condition of the part between Cannes and San Remo, they are everywhere disregarded. The more important facts he gives are these: As there are nowhere any sewers, the cesspool system is all but universal, and cesspools are often under the houses and have faulty ventilating pipes. There are but few public water supplies, and even where these are available they are not always used, wells, even in suspicious positions being used instead. There are two distinct sets of dangers which must be regarded quite apart. There are the dangers to villas and hotels, wherever situated, from defective cesspools, internal arrangements, and wells, and there are especial dangers in towns from the *égouts*. The dangers of villas and hotels are not under inspection, and people occupying them have no other assurance of safety than having them examined for themselves. The examination should be extended to the overflows from buildings on higher ground, which it appears the law does not prohibit. Many even of the best hotels are in a very unsatisfactory state. The ventilating pipes of cesspools frequently end by bed-room windows; wells are situated in places liable to pollution, while internal arrangements are dangerously faulty. The greatest dangers of all, however, are the *égouts* in towns. Originally intended only as drains for rain-water and waste house-water, they in reality receive the overflows of cesspools, and as they are never flushed and have but a very slight gradient, the matter hangs about in them and ferments, thus becoming a source of grave danger, as the air from the *égouts* rises into the streets through untrapped openings. The commissioner states that he has arrived at the real facts regarding the *égouts*, in spite of much official misinformation, and that he was three times laid up from working out the facts for himself. Although told at official bureaux that overflows did not exist because they were forbidden by law, he had some cesspool covers opened, saw the overflows, and then, from extended inquiries, found that the law was habitually disregarded, as the fine for an overflow was never enforced. English visitors thus know for the first time that *égouts* are not mere drains, as officially stated, but are worse than sewers. The beaches and promenades near the sea are especially dangerous, as the sands are becoming sodden with sewage matter, and the almost tideless bays are getting choked up with it. There are numberless private *égouts*, while the larger public *égouts* open on to the shores without any flaps or doors to them, so that the fouled air is wafted back to the public gardens and the favourite shore promenades. The one piece of advice offered to visitors is that they should select hotels or villas away from the shore and away from *égouts*.

AN International Meteorological Conference has been held in Sydney, at which it has been arranged to establish a uniform system of weather telegraphy for the different Australian colonies.

PROF. MILNE, of Tokio, Japan, has devised an ingenious method of detecting the least seismic trembling. In an article in the *Japan Gazette* for December 13, 1879, he thus describes his method:—"Besides endeavouring to obtain the true motion of any earth particle, I have, for special reasons, been endeavouring to obtain records of the smaller shakings. By the use of a special form of microphone when it is properly placed it is not difficult to detect any movement, however slight, of the earth's crust. My microphones are buried in pits round about the house. Precautions have been taken to keep out insects, otherwise the tramping of a beetle would register as an earthquake. The pits must also be dug at a distance from a roadway or path, otherwise every step of persons passing, even if six yards distant, will be indicated to the recorder. Excluding beetles, thieves, and unexpected visitors, it would seem that for some time before the occurrence of a 'shock' the telephone gives signs that the earth is crackling as if under an increasing strain; these indications continue for uncertain periods, but they have been distinctly noticeable before the last few earthquakes. It would seem that the power of resistance of the earth before any surface movement is felt is very great, but, at last, like a bending stick, it suddenly breaks, and the jar gives the vibrations which we call an earthquake. If these 'crackles' can be detected we shall then have the means of approximately foretelling when the consequent crash is at hand. The observations of these 'crackles' which, so far as I am aware, have hitherto been studiously avoided or else unfortunately neglected, would also tell us something definite about periodicity. From my observations I feel certain that there are many small earthquakes which ordinary instruments pass by unnoticed. The consequence is that, when we attempt to correlate earth motions with those of, say, for instance, the moon, we do not find the accordance we should expect; the attraction of the moon has not been sufficiently great to overcome the elasticity of the earth's crust, and to cause shocks great enough to be recorded upon the usual instruments. If, however, instruments still more delicate are used, we shall find little earthquakes, or what I prefer to call earth tremors recorded in those places where we have been unsuccessfully looking for big ones. We shall, in fact, detect the little straws which are being piled up in regular order and which will eventually break the camel's back."

In his just published report H.M.'s Consul at Yokohama states that the experiment made during the two previous years of manufacturing black teas for the English market has been attended with such disappointing results to all concerned that the industry is not likely to be persevered in for the future.

The Birmingham Philosophical Society, at a meeting on February 12, did themselves the honour of electing Mr. Charles Darwin an honorary member and presenting him with an address on the occasion of his seventy-first birthday, the day of meeting.

Capt. Oliver desires us to state that in his letter in Nature, vol. xxi. p. 348, he wrote by mistake, in referring to Halley's work, *official* for *optical*.

We have on our table the following books:—"A Rule of Proportion," Dr. John Marshall (Smith, Elder); "Anatomy for Artists," Dr. John Marshall (Smith, Elder); "Der Realismus der modernen Naturwissenschaft," Dr. Anton von Leclair (Williams and Norgate); "Wave and Vortex Motion," Thomas Craig (van Nostrand); "Scotch Live Stock," James Bruce, (Edmonston and Co.); "Géologie Expérimentale," A. Daubrée; "Primer of the Industrial Geography of Great Britain and Ireland," G. P. Bevan (Sonnenschein and Allen); "Nile Gleanings," Villiers Stuart (John Murray); "Memoirs of Dr. P. P. Carpenter," Russell L. Carpenter (C. Kegan Paul); "Rural Bird Life," Charles Dixon (Longmans); "Hot Air," Richard Metcalf; "Ceylon Coffee Planters' Association," John Hughes; "Lethæa Geognostica," F. Roemer (E. Koch); "Biological Atlas," D. and A. N. M'Alpine (W. and A. K. Johnston); "Physical Geography," E. W. Lewis (Moffatt and Paige); "The Unity of Matter," A. S. Wilson (Samuel Highley); "The Art of Perfumery," G. W. S. Piesse (Longmans); "Who are the Irish?" James Bonwick (Bogue); "Das Protoplasma," Dr. Johannes v. Haustein (Carl Winter); "The Spectroscope in Medicine," C. A. McMunn (Churchill); "Zoology," A. S. Packard (H. Holt and Co.); "The Comstock Lode, its Formation and History," J. A. Church (J. Wiley and Son); "Handbuch der Botanik," Dr. N. J. C. Müller (Carl Winter); "River of Golden Sand," 2 vols., Capt. Gill (John Murray); "Chapters from the Physical History of the Earth," A. Nicols (Kegan Paul); "Medicinal Plants," parts 38, 39, 40, and 41, Robert Bentley and H. Trimen (Churchill); "Lange's History of Materialism," vol. 2, E. C. Thomas (Trübner); "Linkages," J. D. C. de Roos (van Nostrand); "Theory of Solid and Braced Elastic Arches," William Cain (van Nostrand); "On the Motion of Solid in a Fluid," Thomas Craig (van Nostrand); "Lucernariæ and their Allies," H. J. Clark (Washington).

The additions to the Zoological Society's Gardens during the past week include a White-fronted Lemur (*Lemur albifrons*) from Madagascar, presented by Mr. W. C. Gordon; a Macaque Monkey (*Macacus cynomolgus*), a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. J. Snowden Henry, F.Z.S.; two Hawk-headed Caiques (*Deroptyus accipitrinus*) from Brazil, presented by Mr. Chas. Frieke; a Spur-winged Goose (*Plectropterus gambensis*) from West Africa, presented by Mr. R. B. Dobree; a Peregrine Falcon (*Falco peregrinus*) from Newfoundland, presented by Mr. F. R. Haynes; a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by Mr. W. Porter; a Bewick's Swan (*Cygnus bewicki*), North European, two Sharp-nosed Crocodiles (*Crocodilus acutus*) from Jamaica, deposited; a Serval (*Felis serval*) from West Africa, purchased.

OUR ASTRONOMICAL COLUMN

The Comet of 1577.—For more reasons than one the comet which was observed at the end of 1577 and beginning of 1578 deserves prominent mention in the history of these bodies. It must have been the brightest comet of the sixteenth century, visible even in full sunshine, as we know from the testimony of Tycho Brahe, and it was from his careful observations of it, made at a critical time in the discussion as to the nature and distance of comets, that he proved it to have a much smaller parallax than the moon, and hence to be situated far beyond our satellite. Tycho's observations formed part of a work which, though it appears to have been completed so far as it referred to the comet in 1588, and copies distributed by Tycho to his friends in that year, was not published in the full sense of the term until 1603, when it was brought out at Prague after his death, under the care of his son-in-law. The work is entitled "Tychonis Brahe, Dani, De mundi ætheri recentioribus phænomenis liber secundus, qui est de illustri stella caudatâ anno 1577 conspectâ." In 1648 it was reprinted at Frankfort in the collective edition of Tycho's works. Pingré refers to the inaccuracy with which the observations of the comet were given in this edition, which served him for his *Cometographie*, but he thought he had discovered and corrected all the errors in his transcript of the observations for that work (vol. i. pp. 513–16).

The comet was seen in Peru as early as November 1, according to an historical work composed in 1589 by the Jesuit Joseph de Acosta, and about the same time, perhaps a day later, in Japan, as we learn from Kaempfer. It was seen in various parts of Europe on November 10, 11, and 12, and on November 13 Tycho observed it for the first time at Uraniburg, his observatory in the island of Huen. His experiences with regard to the comet are detailed in the work we have referred to. He thus describes his discovery of it: "Having gone out some time before sun-set, and while waiting supper, to amuse myself with witnessing the taking of fish from one of my ponds, I occupied myself while the net was being drawn, in surveying the western part of the sky, to see if the purity of the air promised for that night my usual pleasure of observing the stars. As I was least expecting it, I perceived in that direction a certain bright star, which appeared as distinct as Venus, when near to the earth and when seen before sunset or after sunrise. For the rays or *chevelure* of the star could not yet be perceived, the sun, still above the horizon, entirely obliterating the feeble brightness of its rays." Tycho then describes how he was astonished at the visibility of an unknown object of such brightness as to strike the eye while it was yet daylight; he was sure that there was no planet in that quarter of the sky excepting Saturn, which could not be seen in sunshine, and as to the fixed stars, he knew they were none of them visible under such circumstances. He asked those about him whether they saw an object in the direction he pointed out, and they replied it was perfectly distinct, and must be Venus because no other planet could be so conspicuous in daylight. Tycho, however, assured his friends that Venus was not in that part of the sky, and said it would be found as it grew darker that "aliquid insoliti admirandique" was there shining. Accordingly, as soon as it was dusk, the star-like object was seen to be accompanied by a great train of light turned towards the east, and estimated by Tycho to be 22° in length; the head of the comet he judged to be 7′ in diameter. Generally he describes the head as round, bright, and of a yellowish light; the tail appeared to be burning or formed of red rays, brighter and more deeply coloured near the head; it was also curved, the convexity on the side of the zenith. Tycho's observations with instruments terminated on January 12, 1578, but he saw the comet for the last time on January 26, and estimated its place with respect to neighbouring stars.

The orbit of the comet of 1577 was calculated by Halley, but in 1844 a new reduction of Tycho's observations with modern star-positions was made by Dr. Woldstedt, who investigated the most probable resulting elements, in an inaugural dissertation at the University of Helsingfors.

The definitive orbit is as follows:—

Perihelion passage 1577, October 26·9476 G.M.T.

Longitude of perihelion	129° 42′·0	} 1578·0
,, ascending node	25 20·4	}
Inclination	75 9·7	
Perihelion distance	0·1775	

Motion—retrograde.

On November 1 when the comet was first seen in Peru, its right ascension would be 230°, with 29° south declination, distance from the earth 0·75, and from the sun 0·28, so that the intensity of light, as represented by the usual formula, would be 21·8. On the first day of observation in Europe, November 10, at 6h. G.M.T., its R.A. was 266° 19′, Decl. − 19° 39′, distance from the earth 0·63, and from the sun 0·53, and hence the intensity of light was 9·1. On November 13, when Tycho detected the comet, the sun set at Uraniburg at 3h. 41m. mean time, and calculating for this time from the above elements, we find the R.A. was 276° 55′, Decl. − 14° 19′; the comet was distant from the earth 0·647, and from the sun 0·604, and the corresponding intensity of light 6·6, or only one-third of that when it was discovered in Peru, but it was then within 15° from the sun. Saturn was in about R.A. 281°, with 23° south declination. At the time of Tycho's last observation, or 7h. 30m. P.M. at Uraniburg, the comet was distant from the earth 2·65, and from the sun 2·07, the intensity of light, therefore, only 0·03. A consideration of these figures will amply bear out what we have stated, as to the conspicuous place which the comet of 1577 must claim.

THE SOUTHERN COMET.—A second telegram from Dr. Gould, received by Prof. C. A. F. Peters at Kiel the day after the first one, assigns a *southerly* motion to the great comet, or contrary to that mentioned in the previous one. Both statements may possibly be correct for the times to which they refer, as the case may be similar to that of the great comet of 1843, which sweeping round the sun with a velocity of 350 miles in a second, and almost grazing his surface, passed from ascending to descending node in two and a quarter hours.

METEOROLOGICAL NOTES

IN a "Brief Sketch of the Meteorology of the Bombay Presidency in 1878," Mr. F. Chambers opens a discussion of no little importance regarding certain relations subsisting among the meteorological phenomena of India. In that year the rainfall nearly everywhere throughout the Presidency was in excess of the normal quantity, and remarkably well distributed. No long-continued period of unusually dry weather was experienced in any district from the beginning of July to the end of the monsoon, the year being in this respect strikingly different from 1877 with its drought and terrible famine which followed in its footsteps. From a comparison of the weather phenomena of these two years, it is shown that the abnormal change of barometric pressure in July, 1878, as contrasted with July, 1877, was a fall of 0·068 inch, and the rainfall was 107 per cent. of the average fall greater in the latter than in the former month; in other words, the proportionate increase of rainfall corresponding to a fall in the pressure of 0·100 inch, was nearly 16 per cent. of the average fall. It is evident that if the extension of this inquiry to past and future years and to the whole of India, should confirm this important relation between the atmospheric pressure and the rainfall over their extensive region, or establish similar relations, the discovery will be of the utmost value in assisting towards the formation of forecasts of the probable character of coming monsoons.

IN the same report, Mr. Chambers extends this discussion over a much wider area than that of India, and from a comparison of the atmospheric pressure and rainfall of the Presidency with those at Zi-ka-wei, Manila, Batavia, and Mauritius, arrives at results which, though necessarily provisional in their character, are of the highest importance in the investigation of the great movements of the atmosphere. The general conclusion is that the special function performed by the central area of low barometric pressure in Asia during the summer months is merely that of a distributor of the monsoon vapour by the production of the successive "bursts" and "breaks" of the rainy season; but that the copiousness or scantiness of the vapour, and consequently of the rainfall, depends chiefly on the meteorological conditions previously existing in the Indian Ocean, the source whence the moisture and rainfall are drawn. The supreme value to meteorologists, in conducting such cosmopolitan inquiries, which attaches to the weather maps of the War Department of the United States, embracing the whole of the Northern Hemisphere, which we are now publishing, is very obvious. Their wide and deep significance will begin to be better seen on comparing the maps for May, 1878, about to appear in an early number of NATURE, with those for April, which have already appeared (NATURE, vol. xxi. p. 304). The shifting positions of the areas of high and low atmospheric pressure, with the consequent or accompanying changes of temperature, will throw much light on the changes of weather which occurred in the different regions of the Northern Hemisphere, and their rainfall; and the maps of subsequent months will go far in the elucidation of such large questions as the rainfall of India during the monsoon season of 1878, and the exceptional weather we have had in these islands for the past fifteen months.

ONE of the most conspicuous services that could be made to science by a simple catalogue of phenomena has just been rendered by Dr. Rubenson, director of the Central Meteorological Institute of Sweden. The work, which appears in the *Transactions* of the Royal Academy of Sciences of Sweden, is the first part of a catalogue of all the auroras observed in Sweden down to 1877. This part includes those which were observed and recorded from 1536 to 1799. The more special value of the catalogue, in addition to the length of time over which it spreads, consists in the circumstance that it is restricted to a well-defined portion of the earth's surface but of sufficient extent to afford results showing a generally close correspondence to the number of auroras which actually occurred over that part of the globe. The observations in the earlier years are fragmentary and scanty, but from 1722 the catalogue may be regarded as tolerably complete. From 1722 to 1799 auroras are recorded as having been seen on 4,245 nights. These years embrace fully seven sun-spot periods. Arranging the number of days each year on which the aurora was noted, according to the sun-spot periods, we obtain the following highly important results for the eleven years period of sun-spots: 30, 54, 63, 68, 78, 67, 62, 56, 55, 50, and 42. Hence the maximum occurred on the fifth year, there being thus three years from the minimum to the maximum, but six years from the maximum to the minimum. The following figures distribute these 4,245 auroras, in percentages, through the months of the year:—January, 9·7; February, 11·2; March, 13·8; April, 8·7; May, 1·8; June, 0·1; July, 0·5; August, 5·5; September, 13·7; October, 14·6; November, 10·4; and December, 10·0. The most rapid increase takes place on August 28, and the most rapid decrease on April 20.

MR. WILLIAM MARRIOTT examines in the *Journal of the Meteorological Society*, for October, two series of thermometric observations made for the twelve months ending with March, 1879, the one series being taken with a Stevenson's screen properly exposed on a grass-plot 17 feet square, and the other series with a pair of wall-screens fastened to the brick wall of an outhouse with a northern aspect. The results show that the mean of the daily maxima for the year was 1°·0 lower in the wall-screen than in Stevenson's screen, but the mean of the daily minima was 0°·5 higher. The mean temperature by the wall-screen being thus only a quarter of a degree less than that by Stevenson's screen, it is concluded that the mean temperature may be roughly ascertained from thermometers shaded by a wall with a northern aspect. It is to be noted, however, that while Stevenson's screens placed over grass plots well exposed to the sun give results comparable with each other, wall-screens give results which are not comparable, *inter se*, it being perhaps impossible to find two wall-screens in positions tolerably comparable. But it is in investigating the daily range and sudden changes of temperature, the humidity of the air, and others of the prime factors of climate that wall-screens as instruments of observation totally break down.

A PAPER of researches on the rainfall of Austria-Hungary has been recently presented to the Vienna Academy by Dr. Hann. His object is, while showing the main features of distribution of rain in the country, to establish a rational method of deduction of results from measurements of rainfall during short intervals of time. In the greater part of Austria-Hungary, he shows that June is the most rainy month; it is so in the whole of Bohemia and Hungary, with Siebenbürgen, in the eastern part of Galicia, and in Bukowina. In Moravia and Silesia nearly the same rain falls in June and August, with an intermediate decrease in July. West Galicia and the Tatra-region show a preponderance of July rain. Southwards from the Upper Dranthal a maximum in October becomes predominant. From about 45° lat. southwards more rain falls in the three winter than in the three summer months. The further south the more pronounced is the distinction of a dry from a wet period. The dryest months in the whole of Austria-Hungary down to 45° (where July is the driest month) are January and February; and especially notable is the little rainfall of February at the southern base of the central chain of the Alps.

PHYSICAL NOTES

MEASUREMENTS of the heat conductivity of iron hitherto have given rather discordant results. This must be due, according to Herr G. Kirchhoff and Herr Hansemann, to the fact that in most of them the quantities of heat given out or received from without by the body examined have not been sufficiently taken into account. These physicists have recently described to the Berlin Academy experiments by a method in which a cubical iron mass, after being left to itself a long time, had a strong water-spray directed against one of its side surfaces, the water being some degrees hotter (or colder) than the place of observation. At several points back from the heated surface vertical passages were made, each to receive one junction of a thermopile of thin German silver and copper wire, the other junction being at constant temperature. An observer, with the aid of a chronograph, marked the point of time at which certain divisions of the scale of the (mirror) galvanometer passed the vertical wire of the telescope, at the same time dictating their number to an assistant. Referring to the memoir for further details, we note the conclusion arrived at, viz., that the heat-conductivity of iron divided by the product of its specific heat and its density, at the temperature $\theta = 16{\cdot}94 - 0{\cdot}034\ (\theta - 15)$, when the temperature is measured in centigrade degrees, and the units of time and length are seconds and millimetres. With this result, that of H. Weber agrees best; he obtained the number 16·97 for 39° C. The results of F. Neumann, Ångström, and Forbes, on the other hand, are more divergent. (The substance used in the experiments here described was Dortmund puddled steel, containing 0·129 per cent. carbon and 0·080 silicium.)

HERR E. WIEDEMANN has recently made further experiments on the phosphorescent or fluorescent light produced by electric discharges (*Wied. Ann.*, No. 1). Nearly all platino-cyanide double salts show fluorescence under the discharge; but, so long as they were undecomposed, no double fluorescence was observed. When platino-barium cyanide had been traversed by a single discharge, the strong green fluorescent light showed no dichroism, but, after a series of discharges, dichroism appeared. It also occurred when the crystals of that or other platino-cyanide double salts were left a long time *in vacuo* (without electric discharge), whereby they lost water; and the more rapid appearance of dichroism under the electric discharges is attributed to heating of the crystals. Herr Wiedemann opposes Mr. Crookes's view, offering the following proof of its incorrectness:—If the positive current of a Holtz machine be sent through a very thick-walled discharge-tube, and the discharges be made to follow one another in such a rhythm that they are deflected from their course in the tube by the finger, only a weak phosphorescent light appears on the inner side of the tube, but a very bright green light appears on the *outer* side. The non-observation of this before is probably due to the thinness of the tubes commonly used. In narrow, and especially capillary tubes, too, only the inner wall becomes luminous.

WE take the following from the *New York Nation*:—"It is impossible for the unaided ear to determine with certainty the direction of a distant sound, especially when the atmosphere is foggy; hence the great utility to navigators of the instrument which its inventor, Prof. Alfred M. Mayer, of the Stevens Institute, has felicitously named the 'topophone,' or sound-placer. It consists of 'a vertical rod passing through the roof of the deck-cabin,' and bearing on the upper end 'a horizontal bar carrying two adjustable resonators,' below which a pointer is set at right angles with the bar. Rubber tubes from the resonators pass through the roof of the cabin and unite in a single pipe connected with a pair of ear-tubes. The vertical rod is turned by means of a handle in any direction. The first step is to tune the resonators accurately to the pitch of the sound under observation, and fix them 'at a distance from each other somewhat less than the length of the wave of that sound;' the next, by turning the handle, to bring them simultaneously on the wave-surface, when, as 'they both receive, at the same instant, the same phase of vibration on the planes of their mouths,' it will result that if the connecting tubes be of the same length, the sound-pulses, acting together, will be reinforced to the ear, but if the tubes differ in length by one-half the wave-length of the sound, the pulses will oppose and neutralise each other, and thus tend to produce silence. At this moment the horizontal bar is a chord in the spherical wave-surface of which say the fog-horn is the centre; and the pointer represents a radius, 'or, in other words, coincides in alignment with a line drawn from the place where the sound is produced through the place of observation.' By sailing the ship a measured distance 'at an observed angle from the radius line thus found, a second radius line may in like manner be found,' and 'the distance between the two points of observation is the base-line of a triangle, of which the two convergent radii are the sides.' From these data the distance of the fog-horn is readily computed."

GEOGRAPHICAL NOTES

THE *Vega* reached Naples at 1.30 P.M. on Saturday, the 14th. Prof. Nordenskjöld and his staff received a warm reception from representatives of the Italian and Swedish Governments. Prof. Nordenskjöld has been made Grand Officer, and Lieut. Palander Commander of the Order of the Crown of Italy. On Monday the explorers were entertained at a grand banquet. The French Institute will hold its annual meeting on March 1, under the presidency of M. Daubrée, who will deliver an inaugural address, the subject being Prof. Nordenskjöld's expedition. It is expected that the professor will land in France on that day. He will stop at Marseilles and Lyons, where he will be received by the local geographical societies and authorities. The Paris Geographical Society will send a delegation to Marseilles. Prof. Nordenskjöld will receive the gold medal of the Society at Paris, in the large hall of the Sorbonne. The several learned societies of Paris will send delegations to witness this ceremony, which will be followed by a grand banquet on the succeeding day. It is expected that Prof. Nordenskjöld will reach London in about a month's time, but his present intention is not to give a public address. He does not feel himself sufficiently master of English for this purpose, and, moreover, as might he surmised, he has an aversion to "starring." The botanists and zoologists of the expedition will go overland, visiting all the museums with Arctic collections, and will rejoin the *Vega* at Copenhagen.

AT the last promotion of the Legion of Honour M. Levasseur, vice-president of the Paris Geographical Society, was appointed to the grade of officer for his geographical and statistical works. M. Levasseur is the editor of the statistical department of the *Annuaire* of the Bureau des Longitudes, which has been so much enlarged recently.

THE French Chambers, at the instigation of M. de Freycinet, have voted a sum of 600,000 fr. for the cost of sending exploring missions into the remoter parts of Algiers and Senegal, and penetrating into the Sahara of the Western Soudan. Their immediate object is to trace the lines of future railways, but the indirect influence on the extension of our geographical knowledge is most important. Three scientific expeditions are being organised in Algiers; one is to operate in the Algerian Sahara, and will not pass El Golea; a second, comprising a corps of engineers and an escort of natives, will advance southward from the Wargla, and, after passing the summer at the Jebel Ahaggar, will proceed by the Houssa to Sokoto, and ascending the Niger to Timbuctu, will return by way of Senegal. The Anthropological Society of Paris has availed itself of the permission granted it of sending out observers competent to undertake the ethnological study of the races with which the expeditions will come in contact, and has entrusted to Dr. Guyard the superintendence of the scientific staff which will accompany the Government explorers.

PROF. WALDHAUER, of Dorpat, has visited the northern boundaries of Courland, near the Riff of Domesnæs, in the Gulf of Riga, with a view of studying the condition of the small remnant of people living there, who are the sole representatives of the ancient races of Courland and Livonia. These persons, about 2,400 in number, occupy a limited area of about a verst in width between Mellesilla and Lyserort, and are separated from the Letts in the interior by a tract of morasses. They exhibit great national pride, deny their affinity with the Esthonians, are ignorant of the term Livonian, and call themselves "randalist," inhabitants of coast-lands, or "kalamied," fishermen. They are hardy sailors and skilful pilots. Several families occupy one long hut in common, and their villages resemble those of the Esthonians. They are usually fair-skinned, with chestnut or dark-brown hair; the beard, which is generally very abundant in middle life is seldom seen in young men before the age of twenty-five. Prof. Waldhauer has seen no instance of a red beard among them.

THE Chilian Government has just published in English, Spanish, and French, a "Synopsis Statistical and Geographical of Chili," treating of the condition of the country from January, 1878, to September, 1879. Among other useful matter it contains a short historical sketch, besides notes on its geographical position and physical aspect, its industrial zones, geological constitution, ethnography, and medical geography.

IN the new number of the Belgian Geographical Society's *Bulletin*, M. A. J. Wauters opportunely furnishes an article on Karema, on the eastern shore of Lake Tanganyika, where M. Cambier has just commenced the establishment of the first Belgian "Station hospitalière et scientifique" in East Central Africa.

THE *Cape Argus* publishes the results of the recent attempt to relieve the Trek Boers from the West Coast. After Mr. Palgrave returned to Capetown with the information that they had temporarily settled in what is called the Kaoko Veldt, Mr. Haybittle, by dint of hard travelling and the assistance of traders whom he met, succeeded in reaching the Boers in twenty-one days from Walfisch Bay. He describes the spot where he found them as a long limestone ridge about a day's journey from end to end, and about two days' journey south of the River Cunene, the nearest point on the coast being Point Rock, a distance of thirteen days' journey. In this ridge there are a number of depressions, in some of which springs are found, whence arises the name of Six Fountains. The country is almost devoid of population.

THE original paper in last Heft of the fourteenth volume of the Berlin Geographical Society's *Zeitschrift* is on the region around Koseer on the Red Sea, by Dr. Klunzinger. This number contains the usual annual bibliographical list of publications in all departments of geography, the most exhaustive and carefully arranged list of the kind to be found anywhere. In the *Verhandlungen* for November and January are important papers on the Marquesas Islands, by Baron von Schleinitz; on the Cordillera Passes, by Baron von Theilmann; on a journey on the Ural in the summer of 1879, by Dr. Arzuni; on agriculture in Japan, and on the geological survey of that country, by Dr. E. Naumann; and on the question whether the Andes are sinking, by Herr W. Reiss. Herr Reiss, after a careful review of what we know as to the condition of the coasts of Central and South America, where, while in one or two places a sinking seems apparent, a general rising is mostly proved, comes to the conclusion that the South American Continent, including the Andes, is increasing and not diminishing in elevation.

THE well-known traveller, Herr Ernst von Hesse-Wartegg, who has been staying in London for some time, delivered an interesting lecture on Thursday last, to the members of the German Athenæum, in Mortimer Street. The subject of the lecture was the social life of the Prairie Indians of North America, and was illustrated by numerous photographs and ethnological objects.

THE German Palestine Society has recently published part 3 of the second volume of its *Proceedings*. It contains a treatise on the Sulphur of the Jordan Valley, by Dr. Fraas (Stuttgart); a communication respecting the discovery of some valuable coins near Jerusalem, by Dr. Erman (Berlin); Notes on a Journey to Moab in 1872, by Rev. Klein (Kaiserslautern); an alphabetical list of all the localities in the Pachalik of Jerusalem, by Dr. Socin (Tübingen); an article on the ruins of Askalon, by Lic. Guthe (Leipzig), and various financial and administrative reports. The Society's last general meeting was held at Treves in September last. The efforts of the Society are now directed towards establishing a fund for scientific exploring expeditions to Palestine.

AT the last meeting of the Berlin Anthropological Society the latest news received from Prof. Bastian and Dr. Finsch were communicated by the president. Dr. Bastian stayed at Batavia until October last, and then left that place; he does not mention where he intended to proceed to next, but seems to have started on a prolonged tour, as he has sent all his collections and the scientific results of his investigations to Berlin. Dr. Finsch writes from the Marshall Islands, and says that intercourse with the natives of that group of islands is very difficult and expensive. He has collected over 300 ethnological objects, most of which, however, date from the places he visited before arriving in the Marshall group.

THE German Admiralty intends to publish a work on the scientific voyage round the world, made by the German corvette *Gazelle* during the years 1874 to 1876. The work will be divided into three parts. Part I. will contain a short description of the origin of the expedition, its objects and a general account of the voyage. The second part will be devoted to the deep-sea measurements, the meteorological and magnetical observations. Part III. will treat of the marine fauna and flora. The total cost of the work is estimated at 60,000 marks (3,000*l.*), for which the Admiralty will apply to the Federal Council.

NO. III. for 1879, of the *Journal* of the Asiatic Society of Bengal, contains a valuable *résumé* of the survey work accomplished during the Afghan campaign by the surveying officers attached to the various columns.

AT the meeting of the Geographical Society on Monday next an account by Mr. Hore, of the London Missionary Society's station at Ujiji, of his recent exploration of the Lukuga outlet of Lake Tanganyika, will be read, as well as a paper by Dr. Emil Holub, on the Marutse-Mabunda Empire in South Central Africa.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Rev. J. C. Saunders, of Downing College, is announced to lecture this term on "Chemistry, Physiology, and Botany," and Messrs. Saunders and Hicks are the examiners in the coming "Special" B.A. examinations in natural science for an ordinary degreee, taking in geology and the other subjects mentioned.

NATURAL science scholarships are offered this year at Clare College (60*l.*), Caius (40*l.* or 60*l.*), King's (the Vintner of 90*l.*), Christ's, Emmanuel, and Sidney Sussex, St. John's (50*l.* for three years), Trinity and Downing (40*l.* to 70*l.*) In most colleges preference will be given to students under twenty by calling them Minor Scholars; exhibitioners, in general, may be of any age.

AT present botany and vegetable physiology appear to be getting more and more at a discount in Cambridge, notwithstanding the able teaching of Dr. Vines. He has had to close his laboratory, the room being otherwise required; and Dr. Hicks, (Sidney), sustains the burden of teaching botany during the term in both elementary and advanced lectures, in addition to the joint demonstratorship in chemistry. Several lectureships in botany are vacant in London.

AN amended series of regulations has been issued and will probably be carried, in regard to the Cambridge Natural Sciences Tripos. Twelve months' notice is to be given of the branches of science in which the practical examination is to be held. The class list in the first part of the examination is to be quite distinct from that issued after the second part. In the second part of the examination there will be two questions at least in each branch of science included in the examination in each paper.

THERE are now about ten courses of professional and inter-collegiate lectures announced at Cambridge for the benefit of the selected Indian Civil Service Candidates; so that Oxford, Cambridge, and London are fairly in the field of competition in educating men for this great field of labour.

WE notice with pleasure that the Cambridge Senate have conferred the honorary degree of Master of Arts on Mr. Pattison Muir, prælector in chemistry at Caius College.

MR. J. G. FITCH's lectures at Cambridge this term, on the practice of education, are attended by between sixty and seventy students, of whom about one-half are men. The new literary schools are soon in use. There will be an examination for teachers in June, under the Teachers' Training Syndicate, and certificates will be granted for theoretical knowledge in teaching. Mr. Oscar Browning will keep a register of all the university men who pass the examination, and will act as a means of communication between them and head-masters who require assistants. With all the more confidence we may look forward to great advantages from Mr. James Ward's lectures on the Theory of Education next term, he having given high proof of ability as a physiologist.

THE Cambridge Natural Science Board announces that Prof. Hughes's lectures this term are on the Pre-Cambrian and Carboniferous rocks, while in palæontology, Mr. Tawney will lecture on Trilobites. Mr. Walter Keeping, B.A., continues his (open) lectures at Christ's College, on Rocks and Rock Masses, their Formation and Metamorphosis.

MR. HILLHOUSE is lecturing on botany in the lectures for women, and Mr. Walter Keeping on geology supplementing Prof. Hughes's lectures.

A NEW Cambridge medical association has been formed, and has obtained permission to meet in the old anatomical schools. Every effort will be made to render this association a most valuable means of advancing the interests of medical science in the University.

PROF. STUART and Mr. Garnett are the examiners in mechanism and applied science for the year.

THE law on the constitution of the high council of education in France is progressing favourably before the Senate. No other members will be admitted than professional teachers, except delegates of the five National Academies: Sciences, Beaux Arts, Française, Sciences Morales et Politiques, Inscriptions et Belles Lettres.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 29.—"A Note on Protagon." By Arthur Gamgee, M.D., F.R.S., Brackenbury Professor of Physiology in Owens College, Manchester.

In this paper the author notices the allegations of Thudichum that protagon is an impure body containing more than 1 per cent. of inorganic matters, including no less than 0·76 per cent. of potassium.

He communicates a report from Prof. Roscoe, F.R.S., whom he requested specially to determine the mineral impurities and the amount of potassium in one of the samples of protagon, of which the analyses had formerly been communicated to the Royal Society.

By means of the spectroscope Dr. Roscoe determined the existence of a trace of potassium, which he estimated as equal to one-twentieth of a milligramme in one gramme of protagon (0·005 per cent.). Further, he found that on ignition protagon left a small quantity of fused metaphosphoric acid corresponding to 1·08 per cent. of phosphorus; the mean quantity of phosphorus deduced from the observations of Gamgee and Blankenhorn being 1·068.

"On the Physical Constants of Liquid Hydrochloric Acid." By Gerrard Ansdell, F.C.S., Chemical Assistant at the Royal Institution. Communicated by Prof. Dewar, F.R.S.

In continuation of my former experiments on the properties of liquid acetylene gas, I have recently examined the physical constants of liquid hydrochloric acid. The gas was made by the action of strong sulphuric acid on dry chloride of ammonium, being afterwards freed from sulphuric acid and dried before entering the tubes.

The Cailletet pump was used in the same way as described in my former paper, two iron reservoirs being used, one containing the air manometer, and the other the tube with the gas to be liquefied.

Apart from the mere determination of the vapour tensions, densities, &c., the ratios of the volume of saturated vapour to that of the liquid was considered of the highest importance, as from these numbers the latent heat of transformation and other important data can be easily calculated. For these reasons the gas was examined in rather a different way to the acetylene, the volume to which it had been compressed at the point of liquefaction (or the volume of the saturated vapour) at any given temperature being first accurately determined, and then the pressure increased until the condensed liquid entirely filled the upper part of the tube. The volume of this liquid column was then measured, so that a comparison between the volume of the saturated vapour and the volume of the total condensed liquid was obtained at each temperature.

The results of the whole series of experiments are recorded in a condensed form in the following table:—

A.	B.	C.	D.	E.	F.
4	137·31	$\frac{1}{38·89}$	7·55	18·18	29·8
13·8	103·50	$\frac{1}{53·19}$	8·35	12·39	37·75
22·0	81·19	$\frac{1}{70·06}$	9·10	8·92	45·75
33·4	55·75	$\frac{1}{105·98}$	10·12	5·50	58·85
44·8	36·34	$\frac{1}{168·67}$	11·96	3·03	75·20
48·0	31·33	$\frac{1}{197·60}$	12·00	2·61	80·80
50·56	25·70	—	14·30	1·79	85·33
51·00	23·96				

In this table
A = temperature of gas.
B = volume of the saturated vapour at point of liquefaction.
C = fractional volume of the gas at point of liquefaction in relation to the initial volume under one atmosphere of pressure.
D = volume of the condensed liquid.
E = ratio of volume of liquid to that of the gas.
F = pressure in atmosphere.

The critical point was found to be 51°·25 C.

It will be seen from this table that the volumes of the saturated vapours and liquid gradually approach each other as the temperature nears the critical point, and would undoubtedly become identical, if the experiments could be carried on up to the critical point.

The ratio between the volume of the saturated vapour and the volume of the liquid at different temperatures decreases very regularly until within about three degrees of the critical point, where a singular point in the curve occurs, and the ratio approaches unity with great rapidity. The volume of the liquid increases very regularly up to a temperature of about 48° C., and at 51° C., or within 0·25 of a degree of the critical point, the distinction between the saturated vapour and the liquid vanishes, as although liquid is plainly seen to condense on the surface of the mercury, on increasing the pressure the line of demarcation immediately disappears, and it is impossible to say whether the tube is filled with the saturated vapour or the liquid itself; herefore no results could be obtained nearer the critical point than about a fourth of a degree.

Avenarius, in a paper entitled "The Causes which determine the Critical Point" ("Acad. Sci. St. Petersbourg," 187?-77), made a number of experiment on ether, and came to the conclusion that the volumes of the saturated vapour and of the condensed liquid at the critical point were not identical.

My own experiments appear to confirm his results, in so far as it is evidently impossible to measure the relative volume of fluid and gas within less than a fourth of a degree of the critical point, and at this place the volumes are certainly unequal. This, however, does not disprove their identity as the critical point.

The density of the liquid at different temperatures was determined in the same way as described in my former paper, and gave the following numbers:—

Temperature.	Density.
0° C.	·908
15·85	·835
33·0	·748
47·8	·619

It has therefore not quite such a high density as liquid carbonic acid which is 0·95 at 0° C., and is about twice as high as acetylene, which is 0·450 at the same temperature. It is interesting to note that acetylene is the lightest known fluid substance. Unfortunately Faraday does not seem to have determined its density.

Mathematical Society, February 12.—C. W. Merrifield, F.R.S., president, in the chair.—Mr. D. Edwardes was elected a Member, and subsequently admitted into the Society.—The following communications were made:—Geometrical notes, by Prof. H. J. S. Smith, F.R.S.—On the reflection of vibrations at the confines of two media between which the transition is gradual; and on the stability or instability of certain fluid motions, by Lord Rayleigh, F.R.S.—The calculus of equivalent statements (further communication), by Mr. H. McColl.

Geological Society, February 4.—Henry Clifton Sorby, F.R.S., president, in the chair.—Francis Bond, Charles Herbert Cobbold, Frank Crisp, William Henry Dover, Mirza Mehdy Khan, John Notman, and John Evelyn Williams, were elected Fellows of the Society.—The President announced that, according to a circular, copies of which had been sent to the Society, certain old students of Freiberg were endeavouring to collect the means for erecting a monument in Freiberg to the memory of the late Prof. Bernhard von Cotta, and, further, of establishing a fund for the assistance of needy students at the Mining Academy of that place.—The following communications were read:—On the oligocene strata of the Hampshire Basin, by Prof. John W. Judd, F.R.S. The study of the succession of strata in the fluvio-marine series of the Isle of Wight and the New Forest is attended with considerable difficulties, partly on account of the inconstant character of the beds composing estuarine formations, and partly because of the thick superficial deposits which everywhere cover them. By Webster a lower freshwater series, a middle marine, and an upper freshwater series were recognised; but Mr. Prestwich showed, in the year 1846, that at Hamstead Cliff we have both freshwater and marine strata lying above all these; and in 1853 Edward Forbes proved that the marine and freshwater strata seen at Bembridge Ledge were not, as had previously been supposed, the equivalent of those of Headon Hill, but occupy a distinct and higher horizon. Hitherto, however (in spite of some suggestions to the contrary which were made by Dr. Wright and Prof. Hébert), the strata exposed at the base of Headon Hill have been believed to be a repetition, through an anticlinal fold, of those seen at Colwell and Totland Bays. In the memoir it is shown, both by stratigraphical and palæontological evidence, that the Colwell and Totland Bay beds are distinct from and overlie those at the base of Headon Hill. The distinctness and importance of the purely marine series exposed at Whitecliff Bay, Colwell Bay, and several localities in the New Forest is pointed out; and it is shown that, among the 200 forms of mollusca which they contain, only one-fifth are found in the Barton clay below. For this important division of the strata the name of the *Brockenhurst Series* is proposed. In consequence of the detection of an error in the accepted order of succession of the strata, a rectification of the classification of the fluvio-marine series is rendered necessary, and it is proposed to divide them as follows:—1. The Hempstead Series (marine and estuarine), 100 feet. 2. The Bembridge Group (estuarine), 300 feet. 3. The Brockenhurst Series (marine), 25 to 100 feet. 4. The Headon Group (estuarine), 400 feet. By this new grouping the strata of the Hampshire Basin are brought into exact correlation with those of France, Belgium, North Germany, and Switzerland; and the whole series of fluvio-marine beds in the Isle of Wight, which are shown to have a thickness of between 800 and 900 feet, are proved to be the representatives of the lower and middle oligocene of those countries. The use of the term oligocene in this country is advocated on the ground that by its adoption only can we avoid the inconvenient course of dividing the fluvio-marine series between the eocene and the miocene.

PARIS

Academy of Sciences, February 9.—M. Edm. Becquerel in the chair.—The death of General Morin was announced. (M. Tresca's funeral discourse appears in *Comptes Rendus*.)—On virulent maladies, and particularly on the malady commonly called the cholera of fowls, by M. Pasteur. The small organism (or *microbe*) which causes this malady can be well cultivated in bouillon of fowl's muscles neutralised by potash, and sterilised by a temperature of 110° to 115°. Inoculation of guinea pigs with it causes only abscess, but fowls inoculated with contents of the abscess die. Fowls or rabbits living in company with the guinea-pigs having abscess become ill and die. The microbe multiplies in the intestines of fowls that have taken it with food, and the infected excrement is fatal to fowls inoculated with it. Repeated culture of the microbe by transference of minute drops from liquid to liquid, does not weaken the virulence, but by a certain mode of culture M. Pasteur *can* weaken it. If twenty out of forty fowls be inoculated with the very virulent virus, they nearly all die; but if the other twenty be inoculated with the attenuated virus, they all become ill, but very few die; inoculation of those that recover with the very infectious virus does not kill them. The novelty here is the preservative effect of inoculation in a disease caused by a living organism (in the virus of small-pox, &c., no life has been proved). The cholera of fowls may be prevented from becoming fatal, and the author describes the return to health of a fowl inoculated in the large pectoral muscles. He expresses the hope of obtaining artificial cultures of all kinds of virus, and notes the encouragement obtained for the search of vaccine virus of virulent maladies.—Epidemic caused in *Diptera* of the genus Syrphus by an *Entomophthora* fungus, by MM. Brongniart and Cornu. The Secretary, referring to this vast destruction of insects, recalled M. Pasteur's suggestion to seek the destruction of phylloxera by inoculation with some microscopic fungus, and invited the attention of naturalists to the subject.—Spectrometric measurement of high temperatures, by M. Crova. He describes an apparatus called a *spectro-pyrometer*. The optic zero corresponds to about 580° C., 1,000 optic degrees, to 1,900° C. Temperatures can be measured up to nearly 2,000° C.—Statistics of solar spots of the year 1879, by M. Wolf. The Zurich observations, completed by similar series at Palermo, Rome, Athens, Madrid, &c., gave, for mean relative number for 1879, $r = 6{\cdot}0$ in place of 3·4 for 1878. Thus the epoch of minimum is distinctly passed. The series of observations of magnetic declination at Milan, Vienna, Prague, Munich, and Christiania, agree in giving 1878·5 as the epoch of minimum. Comparing with the preceding epochs of minimum and maximum, the two periods (spots and magnetic variations) are found in remarkable harmony, both as to total length, 11·7 years, and as to the two parts of the period (which is slightly longer than the average of 11¼ years).

CONTENTS

THURSDAY, FEBRUARY 26, 1880

THE SECOND YARKAND MISSION

The Scientific Results of the Second Yarkand Mission, based upon the Collections and Notes of the late Dr. F. Stoliczka. Published by Order of the Government of India. (Calcutta, 1878-79.)

BY the above publication the India Government and Dr. Stoliczka's scientific friends have raised a most enduring monument to the memory of one whose loss is still felt throughout the world of science. Born in Moravia in 1838, Ferdinand Stoliczka was destined by his father, a colonel in the Austrian army, for the Church; but, as better luck would have it, having taken his degree of Ph.D. in the University of Vienna, he at once obtained a post more in harmony with his tastes in the Vienna Geologische Reichsanstalt, where he laboured until 1862, when he was appointed by the late Prof. Oldham to the responsible position of palæontologist to the Geological Survey of India. His special work in the Survey will be to all time remembered. It forms four of the splendid volumes of the "Palæontologica Indica," all of which, with the exception of one paper by Mr. Blanford, are from the pen of Dr. Stoliczka. Although his chief fame will ever rest on his palæontological work, he was not unknown as a zoologist, and several important papers of his on living forms could be easily called to mind. Considering his age when snatched away from his work and friends, he had accomplished much, and had he lived, would surely have accomplished more. In Mr. V. Ball's recently published "Jungle Life in India" we get a glimpse of Stoliczka as the enthusiastic naturalist visiting the Nicobars. In July, 1873, a mission was sent to the Ameer of Káshghar and Yárkand, under the charge of Sir T. D. Forsyth. Starting from Murree in the Panjáb Hills on July 5, the mission to which Dr. Stoliczka was attached reached Leh, in Ladák, on August 27. After a halt of about a fortnight the journey was continued over the Sakti Pass to Lukong on the Pankong Lake. Yárkand was reached on November 8, and Káshghar on December 4. From Káshghar several excursions were made, Dr. Stoliczka visiting the Chadyr Lake just inside the Russian frontier, and proceeding at another time as far north-east as the Belowti Pass on the road to Ush Turfán.

A treaty was concluded with the Ameer on February 2, 1874, and much valuable information was collected regarding the present condition, resources, history, geography, and trade of the Yárkand and neighbouring countries. On the return Stoliczka was attached to Col. Gordon's party, which left Káshghar on March 17, 1874, reaching Yárkand after a *détour* on May 21, and leaving it on the 28th, when the mission party proceeded to recross the Kuenlun by a more western route than before over the Yangi Diwán, and then took the Kárákoram and Sháyok route to Leh. On June 16 Stoliczka complained of severe headache, with a feeling of oppression on the chest, in spite of which he the same day crossed the Kárákoram, making a collection of, and writing some notes in his diary about the Kárákoram stones. On the 17th he was no better. On the 18th, although suffering much, he climbed a hill to make some scientific exploration, and the effects of this exertion were at once visible. During the night of that day Col. Gordon ordered a halt for the next day. On the morning of the 19th he fell into a semi-comatose condition, from which he scarcely rallied, and he died a little after one o'clock on that day. Undue physical exertion at an extreme elevation and in a rarified atmosphere was the immediate cause of death. The remains were brought to Leh, where, in a corner of the compound of the British Joint Commissioner's residency they were laid with all honour on June 23, 1874. Over them, at the public expense, a suitable monument has been erected.

The scientific memoirs so far as they have reached this country, are as follows:—The Geology, by W. T. Blanford; the Mammalia, by W. T. Blanford; the Reptilia and Amphibia, by W. T. Blanford; the Pisces, by F. Day; the Hymenoptera, by Fred. Smith; the Neuroptera, by R. McLachlan; the Mollusca, by Geoffrey Nevill; the Syringosphæridæ, by Prof. Martin Duncan. Each of these forms a small folio part, beautifully printed at the Government Press, Calcutta, and excellently illustrated, often with highly-finished coloured drawings. All are based on the material collected during the expedition, and this was chiefly made by or under the direct superintendence of Stoliczka. Mr. Blanford complains that a considerable portion of the collection, including most of the finest specimens, was distributed with the consent of the Government, the greater portion becoming private property, and that the distribution was made with so little care, and with such a disregard of the interests of the Government and Dr. Stoliczka's memory, that even some specially prepared specimens were not to be found when looked for. Still withal the editors have done good and true service to Stoliczka's notes, Mr. Blanford and Mr. Day being helped thereto by their local knowledge.

Of the geological work accomplished Mr. Blanford writes that "very little indeed had been done to elucidate the geological structure of the country." But the results of Stoliczka's explorations during his first journey were very great. In the course of a single season's work in a most difficult country, amongst some of the highest mountains in the world, he clearly established the sequence of the formations, and from his extensive palæontological knowledge was able to do this with an accuracy which has stood the test of subsequent research. He, moreover, added to the list of known formations the representatives of rhætic and cretaceous rocks not previously detected, and showed that some of the other groups might be subdivided. The presence of this remarkable series of marine fossiliferous beds in the North-Western Himalayan region, a series in which all the principal European palæozoic and mesozoic groups, except the Cambrian, Devonian, Permian, and Neocomian are represented, is none the less surprising that scarcely any of the formations, except a few oolitic and cretaceous strata, are found in the peninsula of India beyond the Indus River basin. In the hills of the Panjáb some of the formations have been detected, but they were, until recently, very imperfectly known. In his second and last journey much work was also accomplished, but alas its full details will never be known. From the notes left behind him Mr. Blanford has collated what he could. "It is," he very truly says, "very difficult to do justice to a rough travelling diary such as Dr. Stoliczka kept. In such a diary first impressions are very often recorded, and subsequent observations do not always show how far the first notes require modification. To the writer this is a simple matter; his notes are memoranda serving to recall details to his mind; but to another who does not possess the clue it is often very difficult to ascertain how far the notes in the diary agree with the final conclusions of the diarist." The sections illustrative of the geology of the country are from Dr. Stoliczka's note-book.

The account of the mammals, also from Mr. Blanford's pen, we are warned must only be considered as a contribution towards the zoology of the countries traversed. It is at present simply impossible to give anything like a complete list of the mammalia inhabiting Eastern Turkestan, the Pámir, and Wakhán. Even of Ladák, which is not only easy of access but is yearly frequented by English travellers and sportsmen, although the larger animals may be known, much more information will be necessary before a complete enumeration can be made. In this valuable contribution towards such a fauna Mr. Blanford describes, among the animals collected at Ladák, a lagomys, a mouse, a vole, and a shrew, which were previously unknown. The districts traversed by the second mission lay, with the exception of Kashmir, where a mixture of Indian (Oriental) forms is found, within the limits of the Palæarctic region; but they belong to different sub-provinces, distinguished chiefly by their physical characters, and especially by their elevation. Western Tibet or Ladák, in which may be included all the area north of Kashmir drained by the Indus and its tributaries, is a part of the high barren Tibetan plateau and the fauna comprises typically Alpine forms such as wild sheep and ibex, marmots and lagomys. The fauna inhabiting the ranges commonly known as the Kuenlun, intervening between the northern water-shed of the Indus and the low plains of Turkestan, is very similar to that of Tibet proper, but several species appear different. The animals of the plains of Eastern Turkestan around Yárkand and Káshghar belong to very distinct types, and appertain to the desert fauna of Central Asia, characterised especially by the abundance of rodents such as Gerbillus, Cricetus and Dipus. The few specimens of the mammals inhabiting the Thian Shan range, Pámir, and Wakhán, contained in Dr. Stoliczka's collection, are insufficient to give much idea of the fauna, as they were collected under great difficulties, during journeys when the ground was for the most part covered with thick snow. In drawing up this account Mr. Blanford has had the assistance of Dr. Dobson for the bats. It is illustrated by fifteen plates, several of which are coloured, in which all the new species are figured, with many osteological details.

The collection of reptiles made was small, partly owing to the country traversed not being rich in such forms of animal life, but still more perhaps because of the unfavourable season at which many of the excursions were made. The Thian Shan was visited in the depth of winter and the Pámir steppes and Wakhán long before the snow had melted, and under these circumstances no snakes, lizards, or other forms of reptilian life could be found. The bulk of the collection consisted of specimens procured on the journey from India to Káshghar in the Panjáb hills beyond Mari, in Kashmir and in Ladák and those obtained on the return journey between Yárkand an the Kárákoram. Of the lizards several new species are described and figured; of the amphibia only four species in all were collected. This memoir is by Mr. Blanford.

The account of the fishes obtained during the expedition is by Mr. Day. Twenty-five species are enumerated, several of which are described as new. After examining in detail the fishes of Yárkand and those of the adjoining countries, Mr. Day concludes, amongst other things, that there is to be found a peculiar group of carps (Schizothoracinæ) which has spread almost due east and west from the cold and elevated regions of Eastern Turkestan, but of which the southern progress has been barred by the Himalayas. If we look to the south we see, as it were, that a wave of tropical forms of fishes has at a prehistoric period expanded over that portion of the globe where the Nicobars, Andamans, and the most southern portions of the continent of Asia and the islands of the Malay Archipelago now are, that this fish fauna has its northward progress arrested by some cause at or near where the Himalayas now exist, and mark the division between the fish fauna of India and that of Turkestan.

The collection of Hymenoptera is described by the late Frederick Smith, of the British Museum. It contained sixty-three species, only nine of which appear to have been previously described; five new species are enumerated of that most cosmopolitan genus, Megachile; four new species of Bombus, and four of Formica. *Vespa germanica* was found at Sanju and in its neighbourhood also in Eastern Turkestan; eleven of the new species are beautifully figured from drawings by E. A. Smith.

The Neuroptera described by Mr. McLachlan were only fifteen in number: "four were species of Odonata (dragon-flies), one of Ephemeridæ, three of Perlidæ, one of Myrmeleonidæ, three of Chrysopidæ, and three of Trichoptera. The general aspect is European. All the dragon-flies are European, and two of them occur in Britain. The ant-lion (*Myrmecœlurus punctulatus*) is a species of Eastern Europe." The three species of Trichoptera were new.

The Mollusca are described by Geoffrey Nevill. As was to be expected, "the fauna of Yárkand proves to be exceedingly poor in mollusca, and these are entirely European in their affinities. The fresh-water shells are indeed either identical with, or most closely allied to, well-known European forms." "The only striking novelty is the new *Succinea martensiana*, its thickness and opaqueness of texture, and its vivid orange-coloured aperture, make it one of the most interesting and peculiar forms of the genus." The characteristic Indo-Malayan genus, Nanina, disappears on the confines of Kashmir, but reappears in the Sarafshan Valley. About thirty species, several new, are described from Eastern Turkestan and Ladák, and twenty-five from Kashmir and the neighbourhood of Mari. The new species are all figured.

The last memoir on our list is a very interesting account of the Kárákoram stones by Prof. Martin Duncan; these are described as fossil rhizopods belonging to a new order called Syringosphærida, and containing but one family with two genera and six species. The second genus is called after Stoliczka. This memoir is accompanied by three excellent plates.

Several other memoirs are expected ere this work will be complete. When finished, it will form a worthy monument to the memory of Ferdinand Stoliczka.

CRYPTOGAMIC FLORA OF SILESIA

Kryptogamen-Flora von Schlesien. Herausgegeben von Prof. Dr. Ferdinand Cohn. Zweiter Band, Erste Haelfte: Algen. Bearbeitet von Dr. Oskar Kirchner, und Zweite Haelfte: Flechten. Bearbeitet von Berthold Stein. (Breslau: J. U. Kern, 1878 and 1879.)

THE second volume of the "Cryptogamic Flora of Silesia," edited by Prof. Ferdinand Cohn, has now been completed in two parts. The first is devoted to the algæ, and the second to the lichens, the former having been worked out by Dr. Oskar Kirchner, while the latter part, on the lichens, is from the pen of Berthold Stein. The algæ of Silesia are, of course, fresh-water forms, and include a very fair proportion of all the species recognised as natives of Germany. Thus, reckoning the German algæ-flora at 1,688 species, the Silesian flora contains 794, or 47 per cent. Some of these have not yet been found out of Silesia, Kirchner giving a list of 40 species not yet detected elsewhere, and of these a considerable proportion are new species described for the first time in the present flora. Desmideæ, Diatomaceæ, and phycochromaceous forms furnish no less than 600 out of the total of 794 species, most of the others being Protococcoideæ and Confervoideæ, these numbering 88 and 86 species respectively, while the remainder is made up by 11 Florideæ, Batrachospermum and allies, and 6 Siphoneæ. The work may therefore be said chiefly to describe the Desmideæ and other Conjugatæ, 225 in number, the Bacillariaceæ (Diatomaceæ), 195, and the 185 Phycochromaceæ. The hypsometrical distribution of the species is carefully given, according to the plan adopted in the first volume, the whole country being divided into four regions. The first includes all land below the elevation of 150 metres, the second all elevations between 150 and 500 metres, the third from 500 to 1,100 metres, and the fourth from 1,100 to 1,500 metres. No less than 63 species, or 8 per cent. of the total number are met with in all the four regions, these species, however, being usually forms widely distributed in Europe. To the fourth or highest region there belong 16 special species out of a total of 104 in the whole region. The third or second highest district includes 131 species, or 16·5 per cent. of the whole, and of these 20 are special. The great majority of the species belong to the first and second regions, a distribution very different, as we shall presently see, from that of the lichens. The first or lowest region contains 472 species, or 59·5 per cent.; the second 612 species, or 77 per cent., while of these, 116 species are only found in the first, and 219 in the second, region. Lastly, it is found that the two regions together contain no fewer than 613 species not found at all in the higher districts.

A considerable part of the introduction is filled with a history of the study of Silesian algæ and of the gradual progress made by different workers in the elucidation of the species and localities. Then follows a long and excellent account of the anatomy and reproduction of the algæ, which are here defined as chlorophyll-bearing cellular plants not differentiated into stem and leaves. The unicellular and the multicellular thallus is then described, and the various gradations noticed among the unicellular forms, from the spherical Protococcus up to the highly differentiated unicellular Caulerpa, the forms of the multicellular thallus being treated in the same way. Paragraphs are devoted to the cell, cell-wall, cell-contents, and to the different colouring matters contained in the cells of the different groups. The modes of reproduction, non-sexual and sexual, to be observed in the algæ are fully described. As might be expected in a flora, Dr. Kirchner does not employ the subdivisions of the Thallophytes as defined by Sachs, although he fully recognises and points out the affinities exhibited by many chlorophyllaceous and colourless Thallophytes. The algæ, therefore, are considered as a special class, and are subdivided for the purposes of this flora into six orders and into sixteen families. The orders are Florideæ, Confervoideæ, Siphoneæ, Protococcoideæ, Zygosporeæ, Schizosporeæ. The Protococcoideæ are made to include as families the Volvocaceæ, Protococcaceæ, and Palmellaceæ, while the Zygosporeæ include the families Conjugateæ and Bacillariaceæ. Lastly the order Schizosporeæ includes the Nostocaceæ, with five subdivisions, Rivularieæ, Scytonemeæ, &c., and the Chroococcaceæ.

Under the different families the genera and species are fully described, and apparently in a manner well calculated to render the work extremely useful to all botanical students.

The second half of the second volume contains the Lichens, by Berthold Stein. The general treatment of the subject is the same as that already mentioned in the case of the algæ. The introduction, giving an historical account of the progress of Silesian lichenology, the hypsometrical distribution of the species, and then an account of the anatomy and reproduction of lichens. Stein, as might be expected, is an opponent of Schwendener's lichen theory, and bases his objection on the ground that many observations have shown that the first gonidia of the lichen are developed by division or budding from certain side branches of the lichen hyphæ, in a manner probably somewhat similar to the formation of the new cells of Saccharomyces. This alleged fact, which he does not support by any reference to his own observations or to those of other botanists, he considers of itself renders the whole of the Schwendener-Bornet theory untenable.

The Silesian lichens include 705 species belonging to 158 genera. The main feature in regard to the genera being the reduction of Lecidea and Lecanora, to comparatively limited dimensions by the adoption of many new genera. The distribution of the Silesian lichens, according to Stein, confirms the statement that lichens are the "Children of the Air and of the Light," most of them inhabiting the higher parts of Silesia in regions three and four. Common to all the four regions are 76 species, or 11 per cent. of the total given by Stein of 678 species in the introduction, although the description gives 705 consecutive numbers. The first region contains 84 species, of which only 8 are peculiar to it. The second region contains 281 species, or about 41 per cent. of the whole, 115, or 17 per cent. being limited to it. The third region contains 405 species, or 60 per cent., and of these 82, or 12 per cent., are special. Lastly, the fourth region contains 291 species, or 42 per cent., and of these 126, or 18 per cent. are found in it only. No fewer than 18 of these are found in the basalt of the lesser Schneegrube, which Stein calls the "El Dorado of Lichenologists," as 16 of them are not met with elsewhere.

Stein defines lichens as being those thallophytes in which the thallus exhibits a union of gonidia, threads or hyphæ and chlorophyll-bearing, or phycochromaceous cells, or gonidia, the fruit-body containing the spores in asci. The structure of the thallus is described in full, as well as that of the reproductive organs, the spermogonia and apothecia. Spermogonia, now recognised as the male reproductive organs, have been met with in most lichens, but are as yet unknown in the genera Solorina, Myriangium, and Siphula. Usually spermogones and apothecia occur in the same plant, lichens being thus mostly monœcious, but occasionally the two kinds of organs are on different plants, as in *Ephebe pubescens*, which is diœcious. The origin of the apothecium from the ascogonium and carpogonium is described from the observations of Stahl, and the non-sexual reproduction by the pycnides with their stylospores or conidia, is also mentioned, while the formation of soredia is described as spontaneous division of the thallus. Most lichens produce soredia, and we may form a new plant, or several may unite together to form a single new thallus. The structure of the gymnocarpic apothecium with its four layers, the hymenium, sub-hymenium, hypothecium and excipulum, is detailed in full.

The division of the lichens into subordinate group calls for no remark, while to assist the student a very good analytical key to the genera is given, occupying no less than seven pages. In the description of the species the chemical reactions are given, but Stein seems very wisely to reject all species *only* recognisable by chemical tests, *i.e.*, without some structural character.

W. R. McNab

OUR BOOK SHELF

Blowpipe Analysis. By J. Landauer. Authorised English Edition, by James Taylor and William E. Kay. (London: Macmillan and Co., 1879.)

The writer of this treatise, as appears from his preface, has designedly restricted its scope by omitting all reactions peculiar to minerals, on the ground that most works already in existence upon the subject treat the mineralogical part in great detail, and devote comparatively little attention to its chemical aspects. This resolution is unfortunate, as the principal justification for the systematic teaching of blowpipe analysis is to be found in the facility thereby acquired in the identification of the constituents of minerals by simple means when the resources of a complete laboratory are not at hand; and by omitting all characteristic mineral reactions the interest of the work is decidedly lessened. Within these restricted limits, however, the book is a very good one and likely to be useful to students in chemical laboratories as an adjunct to the ordinary text-books on analysis, and this utility will be increased by the chapter on Bunsen's flame reactions, which have for many purposes replaced the older methods of investigation. The matter is condensed in a fashion rather unusual in works of German origin, and the arrangement is good though somewhat troublesome to use, on account of the adoption of a double system of numeration by pages and paragraphs. Neither author nor translators have, however, paid sufficient attention to the necessity, or at any rate desirability, of properly proportioning the different parts of the blowpipe. In this respect the examples figured are to be avoided, as they are far too narrow in the tube to be used with anything like comfort. We should also be disposed to give the first instead of the second place to the Plattner oil-lamp when compared with the gas-flame. The latter is undoubtedly more convenient, as saving the trouble of trimming and cleaning; but for all accurate work a good lamp or even a candle flame is generally preferable as being more readily controlled than gas. A self-acting blowpipe on the principle of the Sommellier compressor made with two bottles, a length flexible tube, and a gallon of water described on p. 5, deserves notice for its ingenuity, but such contrivances are not to be recommended in practice, for they are, to quote the words of a leading American mineralogist, "unnecessary when the student has sufficient enterprise to learn to blow the ordinary instruments, and no others will be likely to make much progress in blowpipe analysis."

The Zoological Record for 1877; *being Volume Fourteenth of the Record of Zoological Literature.* Edited by E. C. Rye, F.Z.S. (London: Van Voorst, 1879.)

It is now just fifteen years ago since the project of the *Zoological Record* was first started by Dr. Günther. The difficulties of the undertaking were many, the labour was great, the reward uncertain. It would seem a proof, however, of there being a necessity for such a publication when we find it still pursuing the even tenour of its way, under the auspices at present of an association, and favoured by considerable money grants from the Royal Society, the British Association, and the Zoological Society of London. The original staff of recorders have now all but Dr. von Martens ceased from their recording labours and a younger generation takes their place.

The pagination is now, we observe, of a new, perhaps of a more scientific, but certainly of a puzzling type, each class having a pagination to itself, so that the sequence of the classes has first to be learnt and then only can one find the object looked for; that this may be a convenience to the printer we acknowledge, but we do not think it a commendable plan. We confess too that we like the method still adopted by some of the older recorders, of giving first a list of the more important publications in a group, then an account of the works on the anatomy and embryology of the same, next the contributions to faunas, and lastly, the new forms, &c., under their orders and families. To say the least the editor would consult the convenience of the student if he would suggest an uniformity in practise in these particulars to his staff. Thus making all due allowance for the difficulties in the way of classifying the Vermes, yet the manner in which the new genera and species are recorded makes it rather difficult to find out what has been done in this group during 1877. The editor too, for he alone could do it, might have added to the last paragraph but one treating of the worms, a reference to "Moll. 55," where pretty much the same facts are stated as we find recorded in "Verm. 21." Amid such a quantity of matter it would be simply an impossibility that mistakes should not sometimes occur, and indeed on a careful survey of this volume such have very rarely turned up. In "Ech. 5" we may remark that the notes by "G. McIntosh" referred to should be credited to H. W. Mackintosh, probably not even a relation of the person named. In "Cœl. 13" is not *Cylicozoa* a misprint for Calycozoa? At "4 Spong." we read, "Gen. *Ceratella*, Gray, and *Dihitella*, Gray, are undoubtedly the same genus, *C. labyrinthica*, sp.n. (*vide infrà*)" (why is the accent always on this *a*). We have looked both below and above and yet have found nothing more about this new species. Has not H. B. Brady's paper, "On some Foraminifera from the Loochoo Islands" (*Proc.* R.I.Ac., vol. ii. n.s. p. 589) been overlooked by the recorder of the Protozoa? Perhaps Ross, F. O., "Myology of the Cheetah" (*Felis jubata*), in the same *Proceedings*, vol. iii. n.s., part 3, August, 1877, was also worthy of a reference. Other papers are quoted from these same *Proceedings*, which it is true contain little that is zoological. Without a wish to start a controversy as to the reproducing the Greek *κ* by the English *c*, we venture to think that a little discretion might be allowed to authors in this matter.

In concluding this notice we thank, in common with all zoologists, the editor for the volume he has published, and we wish a long and prosperous life to the association of which he is the officer, an association which deserves every possible assistance from those interested in the subject of zoology.

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.*]

Sunshine Cycles

PROF. PIAZZI SMYTH in his letter headed as above to NATURE (vol. xxi. p. 248) has given us the latest information regarding those variations of temperature indicated by the Edinburgh earth thermometers, commonly termed "waves of heat and cold." He has, however, cited but one case in which an extraordinary amount of sunshine was actually observed to occur simultaneously with the crest of a heat-wave, viz., in 1826.

Having lately been engaged upon a comparison of the annual and seasonal amounts of cloud in different parts of Europe, I think I can bring forward some evidence to show that these waves of heat and cold are indeed veritable cycles of sunshine and gloom.

Before proceeding to give proofs of this statement, however, it will be necessary to consider for a few moments the effects that most probably attend a prevalence of cloud or the reverse at different seasons of the year. It is, I imagine, pretty generally allowed that presence of cloud in the summer is associated with coolness and in the winter with warmth; and in like manner that clear skies which in the summer by promoting solar radiation favour the development of great heat, in the winter by giving free scope to terrestrial radiation (in the then comparatively reduced stage of solar radiation) tend to produce excessive cold.

A warm year need not therefore be a *very* cloudless year, provided the majority of its cloud occurs during the cooler months. In like manner a cold year need not be *very* cloudy, provided its clear sunshiny days occur mostly in the winter, or when the solar altitude is small.

It must, however, be noted that the effects of the presence or absence of cloud are not of equal *magnitude* at the summer and winter solstices respectively. At and near the former epoch the temperature of the extra-tropics is more dependent on the direct solar rays, and anything which intercepts these produces a more marked effect than at the latter epoch, when the prevailing direction of the wind becomes the predominating factor.

If, then, any general relation with respect to cloudiness be visible in the mean annual results, at the epochs of greatest heat and cold as given by Prof. Smyth, the results for the summer seasons alone, should exhibit the *same* relation but in a more marked degree.

The following tables have been prepared from the limited data at my disposal, with especial reference to the foregoing considerations.

They comprise the following observations:—

1. The relative monthly and annual mean cloud proportions at Greenwich from 1841 to 1876, and at Oxford from 1850 to 1875, as supplied to me by Mr. Whipple, of the Kew Observatory.

2. Do. at Munich from 1843 to 1866, as summarised by Dr. J. Lamont in the "Monatliche und jährliche Resultate der an der königlichen Sternwarte bei München von 1843 bis 1866 angestellten meteorologischen Beobachtungen."

3. Do. at Breslau, as given by Dr. J. Galle in a similar work.

4. The results of the tri-daily observations at Leipzig from 1830 to 1859, and for the summer months at Münster from 1858 to 1874 ("Ueber die Beziehungen der Sonnenfleckenperiode zu meteorologischen Erscheinungen," von Dr. F. G. Hahn. Leipzig, 1877, pp. 123-126).

5. The annual number of cloudy days (giorni nuvoli) at Bologna from 1814 to 1858 ("Notizie sul clima Bolognese, etc., nel quaranta-cinquennio 1814–1858," by Prof. L. Respighi).

6. The number of days on which Schwabe was unable to observe the sun at Dessau in each year, from 1826 to 1859.

7. The number of days on which neither Prof. Wolf nor his assistant could observe the sun at Zurich from 1859 to 1877 ("Ueber die Beziehungen der Sonnenfleckenperiode zu den met. und mag. Erscheinungen der Erde," von H. Fritz. Haarlem, 1878, p. 212).

The figures in every case denote the difference from the corresponding mean, but those for Greenwich, Oxford, Munich, and Breslau only, are intercomparable.[1]

TABLE I.—*Mean Annual Cloud.*

Piazzi Smyth's dates for the crests of heat-waves.	Years.	Greenwich.	Oxford.	Munich.	Breslau.	Bologna. (diff. from yearly mean.)	Leipzig. (diff. from yearly mean.)
1826·5	1826	—	—	—	—	− 2	—
1834·5	1834	—	—	—	—	− 38	− 78
1846·4	1846	+0·2	—	−0·43	—	+ 18	− 21
1857·9	1857	−0·1	−0·2	−0·03	−0·8	− 5	−151
1868·8	1868	−0·6	−0·2	—	−0·1	—	—
Means ...	...	−0·1	−0·2	−0·25	−0·4	− 6	− 83
Dates for the crests of cold-waves.							
1829·6	1829	—	—	—	—	+ 8	+ 45
1837·3	1837	—	—	—	—	−17	+ 37
1845·2	1845	−0·1	—	+0·10	—	+10	+ 9
1848·0	1848	+0·2	—	−0·23	—	− 8	+ 16
1855·8	1855	+0·3	+0·2	+0·50	±0·0	−13	+ 2
1860·3	1860	+0·6	+0·7	+0·70	+0·6	—	—
1866·3	1866	−0·3	±0·0	−0·10	+0·1	—	—
1870·3	1870	−0·6	−0·5	—	±0·0	—	—
1879·1	—	—	—	—	—	—	—
Means ...	...	+0·1	+0·1	+0·1	+0·1	+ 5	+ 21

TABLE II.—*Summer Cloud.*

Years.	Greenwich.	Oxford.	Munich.	Breslau.	Leipzig.	Münster.
1826	—	—	—	—	—	—
1834	—	—	—	—	−16	—
1846	−0·38	—	1·35	−0·8	−15	—
1857	−1·08	−0·75	−0·70	−0·5	−25	—
1868	−1·45	−0·95	—	—	—	−18
Means	−0·97	−0·85	−1·07	−0·6	−18	−18
1829	—	—	—	—	+21	—
1837	—	—	—	—	− 3	—
1845	−0·25	—	−0·25	—	− 3	—
1848	+0·59	—	±0·0	—	+21	—
1855	−0·28	+0·41	+0·15	+0·1	− 2	—
1860	+1·45	+1·71	+0·68	+0·9	—	+14
1866	+0·49	+0·38	+0·38	+0·8	—	+ 1
1870	−0·31	−0·62	—	+0·4	—	+ 9
Means	+0·28	+0·47	+0·29	+0·55	+ 6	+ 8

[1] Those for Munich and Breslau originally given on the scale of 0–4 have been converted to the ordinary scale of 0–10.

TABLE III.—*Winter Cloud.*

Years.	Greenwich.	Oxford.	Munich.	Breslau.	Sums.
1826	—	—	—	—	—
1834	—	—	—	—	—
1846	+0·12	—	−0·03	—	+0·09
1857	+0·12	−0·34	−0·53	−1·27	−2·02
1868	+0·17	+0·46	—	+0·45	+1·08
Means	+0·13	+0·03	−0·28	−0·41	—
1829	—	—	—	—	—
1837	—	—	—	—	—
1845	−0·05	—	+0·17	—	+0·12
1848	+0·25	—	−0·58	—	−0·33
1855	+0·52	+0·13	+0·47	−0·02	+1·10
1860	±0·0	+0·21	+0·52	+0·75	+1·48
1866	−0·25	−0·54	−0·33	+0·10	−1·02
1870	−0·28	−0·04	—	−0·17	−0·49
Means	+0·03	−0·06	+0·05	+0·14	—

TABLE IV.—*Number of Days on which Schwabe was unable to observe the Sun at Dessau.*

Years.		Days.	Years.		Days.
1826	... ...	88	1843	... ...	41
27	... ...	92	44	... ...	46
28	... ...	84	45	... ...	33
29	Cold wave	121	46	Hot wave	51
30	... ...	148	47	... ...	89
31	... ...	126	48	Cold wave	88
32	... ...	96	49	... ...	80
33	... ...	98	50	... ...	57
34	Hot wave	92	51	... ...	57
35	... ...	121	52	... ...	29
36	... ...	166	53	... ...	66
37	Cold wave	197	54	... ...	31
			55	... ...	52
38	... ...	163	56	... ...	45
39	... ...	160	57	... ...	41
40	... ...	103	58	Hot wave	30
41	... ...	82	59	... ...	22
42	... ...	58			

Days on which neither Prof. Wolf nor his Assistant could observe the Sun at Zurich.

Years.		Days.	Years.		Days.
1860	Cold wave	92	1869	... ...	101
61	... ...	81	70	Cold wave	89
62	... ...	76	71	... ...	93
63	... ...	90	72	... ...	71
64	... ...	74	73	... ...	62
65	... ...	69	74	... ...	62
66	... ...	67	75	... ...	86
67	... ...	66	76	... ...	89
68	Hot wave	92	77	... ...	58

So far as the preceding tables afford a basis for deduction, it appears that with few exceptions (1) the annual amount of cloud is *below* the mean at the epochs of the crests of the heat-waves, and *above* the same at those of the cold-waves; (2) that the relation is of the same kind, but more marked when the results for the summer season alone are compared; (3) that the results for the winter show in several cases a tendency to vary in the opposite manner.[1]

I may remark that in general the dates of the crests of the hot and cold waves, as given by Prof. Smyth, coincide with, and include, the principal critical epochs of the cloud variation.

Judging from the cloud observations *alone*, the most intense, as well as most universal waves would seem to have been the hot waves of 1857 and 1868, and the cold wave of 1860.[2]

[1] As a further addition to the evidence just given, both in favour of the secular variation and the contrary character of the two extreme seasons as to cloud, Prof. Piazzi Smyth tells me that the results of the cloud observations at Edinburgh for eighteen years show June and July, 1879 (the date of the most recent cold-wave), to have been the cloudiest months throughout the period, but December, 1879, the clearest, the year on the whole being excessively cloudy. On the other hand June and July, 1868 (a heat-wave), were the clearest ever known.

[2] It is somewhat remarkable that in Dr. Köppen's great work on the temperatures in different parts of the globe in connection with the sun-spot period, the heat-wave of 1857, as deduced from air-temperatures, appears only as a local phenomenon in the extra-tropics. The other dates, 1825·8, 1834·2, 1846·4, and 1868·7, given by Dr Köppen for the maxima of the temperature of the extra-tropics are nearly identical with those deduced from the earth-temperatures by Prof. Smyth.

It would be premature to attempt to draw any definite conclusions from the results I have exhibited, but they rather tend, I think, to dissipate the notion Prof. Smyth apparently entertains, that there is any specific difference between the waves of heat and those of cold.

It would seem indeed as though *both* were partially dependent upon watery vapour and its transformations, the heat wave being in part the *effect* of an excess of sunshine, and the cold wave of an excess of cloud.

Again, were the heat waves of more direct cosmical origin than the cold waves, they should occur more universally and more simultaneously in different parts of the world than the latter, whereas the results of most investigations into this matter point the other way. The epochs of maximum and minimum annual temperature may be respectively nearly identical for as large a district as that included by the stations employed above, but they certainly differ to some considerable extent, though at the same time in a regular and progressive manner, when the observations are made to embrace an entire hemisphere.

Thus, according to Köppen, the following are the dates of maximum and minimum air-temperature in the tropics and extra-tropics respectively:—

Köppen's epochs of maximum air-temperature. Tropics.	Extra tropics.	Piazzi Smyth's epochs of crests of heat-waves.	Wolf's dates for minimum sun-spots.
1822·5 ...	1825·8 ...	1826·5 ...	1823·3
1833·1 ...	1834·2 ...	1834·5 ...	1833·9
1842·8 ...	1846·4 ...	1846·4 ...	1843·5
1854·7 ...	— ...	1857·9 ...	1856·0
1865·1 [1] ...	(1868·7) ...	1868·8 ...	1867·2

Köppen's epochs of minimum air-temperature. Tropics.	Extra-tropics.	Piazzi Smyth's epochs of crests of cold-waves.	Wolf's dates for maximum sun-spots.
1830·1 ...	1831·9 ...	1829·6 ...	1829·9
1836·4 ...	1837·8 ...	1837·3 ...	1837·2
		1845·2	
1847·6 ...	1850·3 ...	1848·0 ...	1848·1
		1855·8	
1858·4 ...	(1861·6) ...	1860·3 ...	1860·1

From the above table it is evident that *both* the heat and cold waves are retarded in the extra-tropics behind those in the tropics, the mean lag being as much as 2·9 years in the case of the former and 2·2 years in that of the latter. There is no reason, therefore, for supposing either of these phenomena in the extra-tropics to be the *direct* effects of solar or cosmical influences; but, on the contrary, there is much to favour the notion that they are both equally the indirect consequences of the corresponding elevations[1] and depressions of temperature in the tropics.

It will be noticed that while the crests of both the hot and cold waves given by Prof. Smyth agree in the majority of cases with those given by Dr. Köppen for the extra-tropics and also with the sun-spot epochs, there are one or two cold waves, such as those of 1845, 1855, and 1866, which appear completely isolated from either of these latter, though I am not aware that they are inferior to the rest in point of magnitude. That even these waves are not of mere local occurrence, though their prototypes do not appear in the tropics, is probable, from the fact that similar ones have been noticed by Dr. F. G. Hahn to occur at Leipzig in 1845, 1855, and 1865, in the form of secondary maxima of cold corresponding to the secondary maxima in the aurora.

In the short cycle 1829-37 no secondary wave appears at Leipzig just as at Edinburgh.

Meanwhile, whatever causes be ultimately adduced to account for the appearance of these periodical waves of heat and cold, it is evident that they partially bear out the designation accorded them by Prof. Smyth, of "sunshine cycles."

February 3 E. DOUGLAS ARCHIBALD

[1] This epoch is given by Prof. S. A Hill, of Allahabad, in continuation of Dr. Köppen's work, and is deduced from observations taken in India (see "Variations of the Rainfall in Northern India," by S. A. Hill, *Indian Meteorological Memoirs*, p. 193). Great reliance cannot therefore be given to it, though at the same time it agrees very well with the result for the *sub*-tropics, as given by Dr. Köppen.

The "Gastric Mill" of the Crayfish

For demonstrating the structure and action of the elaborate gizzard of the crayfish, which I have found to be usually regarded as a hopeless puzzle, I have constructed, in Prof. Lankester's laboratory at University College, at his suggestion and for the use of his class of practical zoology, a little model, the simplicity of which enables any student to construct one for himself, and thus thoroughly to apprehend the mechanical significance of the apparatus found in the crustacean.

A description of it will be useful to some of your readers.

Out of a sheet of good cardboard cut a piece having the shape represented in Fig. 1. Along the lines marked *a b*, *c d*, *e f*, *h i*, *m n*, draw a penknife so as to slightly cut into the cardboard, and on the *opposite face* of the cardboard make similar cuts along the lines *g h*, *k l*. Now bend the outstanding pieces, 2, 2, a very little downwards, so that they stand at a slight angle to the piece 1.

Revolve the pieces 9 downwards upon the hinge lines *a b*, until each of them is brought into the same plane again as the piece 6, 5, 6. Fasten, by either gum or a knotted thread, the lower or unseen surface of the shaded bit of 9 flat against the lower face of the piece 6, 5, 6. Then bend the unshaded portion of each of the pieces 9, into a plane at right angles with the shaded portion, using the dotted line, *k l*, as hinge. These upstanding pieces 9, 9 represent the lateral teeth.

Now apply gum or a needle and thread to the shaded piece between 3 and 4, bending the whole piece 1, 3, 4, upon the hinge-line *g h*, until the shaded bit lies flat upon the surface of 4, to which it is to be securely joined. Bend back the piece 1, 3, using *e f* as hinge, until it lies in a plane at right angles to that of 4. The projecting termination of 4, as the

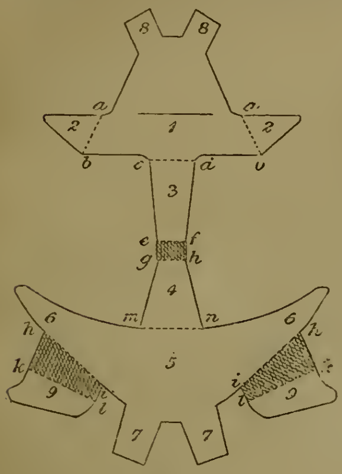


Fig. 1.

Cardboard as cut.

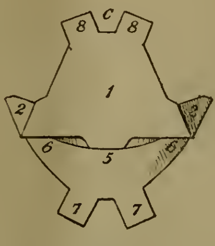


Fig. 2.

The apparatus complete: at rest.

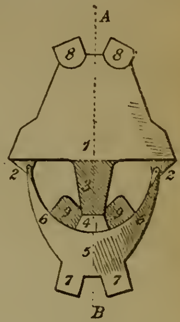


Fig. 3.

The apparatus complete: in a state of tension.

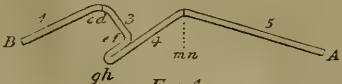


Fig. 4.

pieces are now bent and fastened, represents the central tooth of the gastric mill. Now bend 1 a little downwards upon 3, using *c d* as hinge, and bend 4 upon 5 very much, using *m n* as hinge. Finally, by means of thread or of fine wire, join the perforated corner of the pieces 6, 6, to the corresponding perforated corners of the pieces 2, 2, right to right and left to left, in such a way that the pieces 2, 2 lie outside the pieces 6, 6, and let the joint consist only of a single thread or wire, which may act as a pivot for rotation. In order to effect the joining of these pieces, the piece 6, 5, 6 will have to be bent like a bow, its right and left arms being deflected downwards and inwards.

The model is now complete. 1 represents the cardiac ossicle or sclerite; 2, 2, the two pterocardiacs; 3, the urocardiac; 4, the prepyloric; the shaded bit, together with the piece to which it has been affixed, now represents the median tooth, and projects downwards and forwards; 5, the pyloric sclerite; 6, 6, the right and left zygocardiacs; whilst 9, 9 represent the horizontally placed lateral teeth. The anterior and posterior processes, 8, 8 and 7, 7, represent respectively the anterior and posterior gastric muscles which are affixed in the position indicated and to the firm wall of the carapace. If we now pull upon these pieces so as to represent the effect of a muscular contraction, we shall find that the three teeth come together with a clash, but are again separated and the whole apparatus brought to its original condition by the elasticity of the cardboard. Again and again the clashing of the teeth can be effected by the tension applied at 8 and 9, just as it is in the living crayfish. If the parts representing the three teeth be very carefully adjusted as to size and direction, and be covered with some hard substance, such as sealing-wax (applied after solution in spirit), they may be made really to grind soft substances, such as bread, into fragments.

W. E. Roth

University College, Gower Street, February 4

Modern Chromatics

In Nature, vol. xxi. p. 78, is a review of a book of mine, "Modern Chromatics," by Silvanus P. Thompson, that contains one or two points that I ought perhaps not to allow to pass without notice. The statement is made by the reviewer that I claim as mine a certain experiment which was originally described in England by T. Rose. I find, however, on examination, that Mr. Rose read his paper on this subject before the British Association in 1861, while mine was published in September, 1860, in the *American Journal of Science and Arts*. In the same review it also stated or implied that I am in error in saying that in blue eyes there is no real blue colouring matter, but that the blue hue is due to the presence of a turbid (or opalescent) medium. Essentially the same statement with details will be found on p. 14 of Helmholtz's "Physiological Optics," also on p. 610 of Dalton's "Human Physiology." In his "Physiologie der Farben," on p. 95, Brücke remarks:—"In the most beautiful blue eye there is no trace of any blue colouring matter."

If any real blue pigment has been discovered in the iris of the human eye, it would interest me to know when and by whom.

The reviewer also intimates that I am in error in stating that the colours displayed by the photographs obtained by Becquerel and other earlier experimenters from coloured objects, were due merely to the interference of the rays of light reflected from the plates, that is, were the colours of turbid media. The conclusion reached by me was based on a repetition in 1853 of Becquerel's experiments, on a personal examination of two of the coloured photographs of Niepce, and on the results obtained by C. Schultz-Sellack, *Pogg. Ann.* for 1871, p. 449; and finally, in a more general way, on a prolonged photographic experience in which colours were not unfrequently obtained by myself that imitated those of nature, but were really due to the interference of light. OGDEN N. ROOD

New York, January

[It is a matter of regret that Prof. Rood should misunderstand the entire tone of a passage which occurs in my review of his admirable work on "Modern Chromatics." In the passage referred to I stated that there were one or two points which would be better revised whenever a second edition should be called for: these being statements set down without any qualification whatsoever, but which are not universally accepted, and which, as being still matters not removed from the field of controversy, should not be stated without reserve in a text-book where space forbids discussion or extended reference. There are physiologists who do not accept without some qualification Helmholtz's statement that the blue tint of eyes is simply due to turbidity of the medium. The most eminent authorities on the subject in this country do not accept the view that the beautiful photographs in colours obtained by Becquerel and others are *merely* due to interference of light, in fact their opinion is the very reverse. Hence, while the sentence to which I have taken exception may be regarded as Prof. Rood's *opinion*, it cannot be regarded as a universally accepted view; and that is all I have desired to intimate.

As to the experiment with the rotating disk claimed by Prof. Rood, there is no doubt whatever that he has the *priority*. It is, however, literally true that the experiment, which Prof. Rood claims (and rightly claims) as his own, was originally described in England by Mr. T. Rose in 1861. Nothing was further from the writer's intention than to charge Prof. Rood with plagiarism for describing the same experiment in America in 1860.—S. P. T.]

Etna

PROF. O. SILVESTRI writes me in a letter dated Catania, February 12:—"L'Etna dal 10 Febbrajo presenta fenomeni eruttivi dentro al cratere centrale e ci ha dato una pioggia di cenere che ha ricoperto tutta la neve sul fianco Est-Sud-Est." Some of the ash inclosed in the letter is grey in colour, exactly like pulverised basalt. Under a high power it is seen to consist of minute transparent tabular crystals (probably felspar), mixed with greenish and brownish particles. The mud craters near Paterno have lately exhibited increased activity, and slight shocks of earthquake have been felt on the north-east and south-west sides of the mountain. G. F. RODWELL

February 23

Ice-Crystals and Filaments

IF the Duke of Argyll will look again at the second of the three letters in NATURE, vol. xxi. p. 302, he will see that, although my explanation of the ice-filaments agrees on the whole with those contained in the other two, it differs in one important respect, and is not liable to the chief objection which he alleges against the theory. I suppose the crystallisation of the water to go on *pari passu* with its exudation at the surface of the rotten wood. If the wood be saturated with water the water will begin to exude by expansion as soon as its temperature falls below 4° C., that is, before it becomes frozen. Now the temperature at the surface will fall more rapidly by radiation than that within by conduction. Consequently the water will for the first time be subjected to a freezing temperature when it gets beyond the surface. There it will be solidified, and by the coating of crystals formed, help to protect the water within from freezing. It may possibly be that the slight relief from pressure which the water would experience on escaping from constraint when it arrives at the free surface would predispose it to immediate solidification.

A very similar arrangement of crystals of salts of lime may be observed occasionally to exude from plastered walls, strongly confirming the supposition that the water of which the filamentous crystals in the present case are composed comes from within and is not deposited as a form of hoar frost from without.

Harlton, Cambridge, February 20 O. FISHER

I AM astonished at the Duke of Argyll's first letter (NATURE, vol. xxi. p. 274) not having received a more adequate answer from nearer home. The explanation of the phenomenon in question is to be found in the action of capillary attraction (as stated by Mr. King, p. 302), together with the growth of crystals by absorption from surrounding media; in this case from fog and watery vapour in the air.

Comb-shaped masses of ice, of a decidedly fibrous structure, and several inches high, are to be observed here every winter, extending over wide ranges on the loose and porous soil of the wooded hills near Freiburg, especially on inclined path-borders devoid of vegetation. They are found most abundantly when fogs have prevailed for a longer period, with the temperature below freezing-point, as has been the case these last months. These filamentary masses are formed at the same times and from the same causes as the hoar frost on trees, grass, &c., but of course they are much more durable than the latter, being of a much coarser texture, and not exposed to the destructive action of the winds and of the sun's rays. They are, moreover, protected by grains and clusters of soil raised by the growth of the filaments, and sometimes forming a covering sufficient to conceal the icy masses from a superficial inspection, the structure being surprisingly revealed by a stick's stroke.

During the extraordinarily protracted frost-period of last January, a snow-sheet of a few inches only persisted round about here for several weeks. Meanwhile we have had extremely quiet air (with high barometer) and fogs of varying density, only interrupted sometimes by a few hours of sunshine about noon. Now a very remarkable consequence of this state of weather was to be observed, offering, as it were, another proof for the explanation given above. The thin snow-cover served as a soil, from which grew up everywhere the most beautiful and delicate crystalline structures, forming a superimposed stratum, in many places of much greater height than the snow-crust, on which it arose, but, of course, of a very loose cohesion. This, no doubt, is the same phenomenon as that mentioned in the beginning of the Duke of Argyll's first letter, being due, likewise, to the attraction continually exercised by crystals of ice and snow on the watery vapour of the cold air. The crystalline fern-growths in these cases, and the fibrous masses in and upon the porous soil may be considered as equivalent, the condensation of vapour being more abundant, and producing fibrous instead of more delicate crystalline structures, when taking place on and between loose earthy (or wooden) particles.

Undoubtedly such phenomena have been oftentimes observed in many countries. A careful and detailed description (with illustrations) entitled "Ueber Eiskrystalle in lockerem Schutte," has been given by Dr. G. A. Koch in the *Neues Jahrbuch für Mineralogie*, 1877, p. 449, especially considering these structures from a crystallographical point of view.

Freiburg im Breisgau, February 21 D. WETTERHAN

"Scientific Jokes"

WILL Mr. Moulton compassionate my ignorance, and explain to me (and to many others equally uninformed, and equally thirsting for information) *in what sense it is true* that "The energy of heat is made up of heat and temperature." I have been taught that heat is energy. If this be true, the energy of heat cannot depend on temperature.

I would also beg for an explanation of the statement that "Force is the power of producing energy." I have been taught that energy cannot be produced or destroyed by any natural process whatever.

As to the explanation of the earth's magnetism, I should have said that Prof. Rowland was the first to imagine it (as he was the discoverer of the beautiful result on which it is based), but he saw at once its incompatibility with known facts. His trenchant note in the *Philosophical Magazine* for last August, in which he points out "more exactly" Messrs. Ayrton and Perry's error, has not yet (to my knowledge) been answered. And no wonder; for an error of nearly *sixty thousand million per cent.* is not easily got over! G. H.

Tidal Phenomenon in Lake Constance

For the second time within 185 years the great sheet of water called the Lake of Constance, the Boden See, or the Suabian Sea, whose superficial area exceeds two hundred square miles, has been frozen over.

In connection with it a very interesting phenomenon has been noticed. At a time when the air was perfectly still and during intense frost the ice broke away in the middle of the lake and came crashing upon that nearer the shore, under which it forced itself or piled itself up in great heaps. An experienced skipper on the lake says there is no doubt that as nearly as possible every twelve hours the great fields of ice move backwards and forwards upon the lake. He adds that both in summer and winter he and his comrades have noticed during an absolute calm a powerful movement in the water, backwards and forwards, sometimes so strong as to require double force to propel the ship. Can any of your readers tell me if this is a true tidal movement?

Another fact which came under my notice to-day may interest your readers. In many places on the frozen surface of the lake and especially near the shore, there are great white spots varying from a foot to two or three yards in diameter. At these spots marsh gas has accumulated under the ice, and upon piercing them and applying a light, a flame will mount up I am told sometimes as high as six feet, though in those in which I experimented to-day it did not rise more than two feet.

Samuel James Capper

Hotel Helvetia, Kreuzlingen, Switzerland, February 17

Meteors in New Caledonia

During the last few nights we have seen numerous flights of small meteors; indeed, so frequent have they been, that they have attracted the notice of the most casual observers. I first observed them on the night of the 9th inst. No fixed direction seems to be followed; in fact, I saw one display such as I have never seen before, which will illustrate my meaning. Two fair-sized meteors proceeded severally from the neighbourhood of Castor and Pollux, and crossed mid-way between those two stars. To me it was a very interesting sight.

A neighbour (a lady) informed me she saw a very fine meteor on the 10th, which left a long trail of light, and burst into shining fragments very like, as she expressed it, "the head of a rocket." The direction pointed out was rather low down in the north-north-west. We have had an unusually long, cool season, which has been quite delightful. Now, for some days past, the heat has set in; the air is charged with electricity; heavy thunder-clouds cling round the mountains in the interior, and frequent lightning-flashes are seen, but no thunder heard. On Saturday, the 13th, heavy rain came up against the wind and drowned out a pretty children's *fête*, the distribution of prizes at the Government Schools; serious colds are prevalent in consequence, your humble servant and his family being in the full tide of fashion, a distinction we could very happily have done without.

E. L. Layard

British Consulate, Noumea, December 13, 1879

Intellect in Brutes

Mr. Thomson's communication in Nature, vol. xxi. p. 324, has reminded me of an incident which may be of interest to your readers. I have a well-bred and gentle tortoiseshell cat, a feline lady. It is her habit not to steal food from dishes which the family is using; in cold weather, if a dish is placed in the fender to keep warm, its contents are safe from pussy. She has a kitten by no means so refined as herself, one, in fact, that takes after the other parent, a half-wild cat of the gardens. One morning recently the old cat was lying at our breakfast time upon the hearthrug; the kitten was playing about. It was a very cold morning, and a plate of herrings was put into the fender to be kept warm until they were to be eaten. The kitten smelling the fish, stepped gaily forward, with tail erecting itself, towards the fender. An angry growl from the old cat attracted the notice of all in the room, and to my intense amusement and surprise, I saw her strike the kitten a violent blow in the chest, strong enough to overturn the little creature, which retired humiliated to another part of the room.

Alex. Mackennal

Bowden, February 14

A friend in a village in the south of Scotland has a she cat, a great pet in the household. One night, when the lamp was being trimmed, some paraffin was spilled on puss's back, and a short time after, going near the fire, a falling cinder set her in a blaze. In an instant she made for the door (which happened to be open) and sped up the street about 100 yards, and with a tremendous leap plunged headlong into the village watering trough, then stepped out, gave herself a shake, and trotted quietly home. The trough had eight or nine inches of water, and puss was in the habit of seeing the fire put out with water every night.

W. Brown

Greenock

THE ARTISAN REPORTS ON THE PARIS EXHIBITION OF 1878[1]

The Society of Arts deserves the thanks of all who are interested in the progress and elevation of our national industries for the manner in which it has attempted to bring home to British manufacturers and artisans the lessons of the Paris Exhibition of 1878. As in 1867, so in 1878, it took a prominent part in the movement for sending over to Paris a number of selected artisans, whose reports on the exhibits of the various departments of industry they represented the Society has now published. Thanks to the interest shown in this step by H.R.H. the Prince of Wales, and by Sir Philip Owen, the artisans sent over by this agency, some two hundred in number, were enabled to visit also a number of the workshops and factories of the French capital, to judge for themselves of the conditions under which the various industries are carried on. The thirty-nine selected Reports printed in the volume before us, form therefore, an extremely interesting and valuable contribution to our knowledge of the relative conditions of the skilled industries in the two countries. The frequent comparisons drawn from the workman's point of view not only upon the quality of workmanship but also upon the conditions and price of labour, the machinery, the tools, and the character of the workmen, are striking and instructive in the extreme.

The Reports range over a wide area of subjects. Porcelain, Earthenware and Glass, head the list with seven separate Reports. Next come Ornamental Iron-work, Wood-carving and Stone-carving. After these are Reports on Machine-Tools, Mechanical Engineering, Agricultural and Horticultural Implements, Bricklaying, Stone-work, Plaster-work, Joinery, Cabinet Making, Clock and Watchmaking, and Jewellery. Optical Instruments have a Report to themselves, followed by others on Machinery for Printing, Spinning and Weaving, on Saddlery and Harness, Shoemaking, and Caoutchouc, whilst the volume closes with a Report on Mining Appliances, and one on Iron and Steel Manufacture.

The topics incidentally touched upon by the artisan reporters are not less wide in their range; they extend from an account of the style of dancing in vogue at the Sunday evening balls in the cafés of Belleville, to a description of a harmony in gold and yellow by Mr. Whistler, which we are told "looks as though the ground had been prepared with a sticky substance, and a shower of gold leaf had been thrown from above." It would be impossible in the space of any mere Review to comment upon all the points of scientific interest raised in these multifarious Reports. To obtain from a perusal of them anything like a connected or accurate view of the relation of science to skilled labour in the systems in vogue in French workshops is almost equally hopeless, since the very different styles of writing and modes of observation of the various writers preclude strict comparisons between one department of industry and another. Nevertheless there are a number of salient features which seem to call for notice.

The Report on Optical Instruments by Mr. M. Lambert,

[1] Published for the Society of Arts, by Sampson Low and Co., London 1879.

of Dublin, speaks of the Telescopes shown by Grubb, Horne and Thornthwaite, and Dallmeyer, as unapproached by any shown by Continental opticians. Mr. Lambert regards the French instruments as a whole, as too lightly constructed to give precision or durability; and though English work errs in the opposite direction, he thinks that a judicious compromise would not only add to elegance of appearance, but would reduce the cost. He adds his opinion that much of the optical work imported into this country might be done as cheaply or more cheaply at home if employers would give the same facilities for working which French operatives have. The French avail themselves largely, it appears, of tools which are not much used for this class of work in England, small planing machines, shaping machines, and rotating cutters. The very fine quality of the brass used in the French Instruments attracted the attention of the reporter.

From Mr. Walker's Report on Machine Tools we learn that Continental engineers are still copyists, though perhaps in some ways in advance of us in the extent to which such appliances are used throughout the industries. The American Section, however, told a very different tale; for here the amount of novelty was almost inconceivable, and the designs had all the freshness of being struck from first principles. The automatic grinding machines of Messrs. Thomson, Sterne, & Co., and the hydraulic plant for boiler building of Messrs. Tweddle called for special comment amongst English exhibits. Mr. Walker points out that we have given too little attention to the necessity which is implied in the employment of machine tools, for skilled workers of a high order; and he thinks that this skill is of a kind which an English workman is better fitted to acquire than a French workman; for the latter has semi-artistic tastes that are not satisfied by machine work. "Let the Frenchman be set to carve a crockett, or to cut a glove, or to shape a meerschaum pipe, or to do any task on which he can claim the result as his own, his soul lightens up." "His own work must be made to appear conspicuously in the result, or his interest in it is gone. This personality in work is not easily attained in the manufacture of heavy machinery."

The first of the Reports on Mechanical Engineering by Mr. J. W. Phillips, speaks of the number of machine-tool makers represented in the French gallery, and of the excellence of their work. Amongst the American machines bearing the stamp of original thought commented upon in this Report, is a screw-making machine of very extraordinary precision and merit. There are a few discrepancies between the three reporters upon Mechanical Engineering, discrepancies which doubtless arise from their visits having been brief and independent. One who expected to find the French artisans deficient in energy, says that "a more earnest and thoroughgoing set of men" he never encountered in a workshop; while another says that "the energy put into their work by the mechanics was certainly much below what we are accustomed to see in England." One mentions tools of novel and superior construction; another sees "very very few tools" that he would think worth introducing into England; while the third says that in machines and tools there is so great a similarity that their nationality would be unrecognisable if it were not for the makers' names on them! One praises the get up of the iron and steel work from the Creuzot works; and while another sees nothing in it worthy of mention, the third speaks of it as a very magnificent contribution, of which any English house might have been proud. All of them comment on the Technical schools, which afford to French engineers in such abundant measure, opportunity to pursue scientific and theoretical courses of instruction. The Report of Mr. Hopps devotes no fewer than five pages to a description of the Municipal School for Apprentices in the Boulevard Villette, the pupils of which institution contributed a very admirable display of specimens of forging, turning, fitting, and carpentry, as well as several larger machine-tools made in the workshops of the school.

The two Reports on Watch and Clock-making, by Mr. Ganney and Mr. Warwick, contain a host of matters of scientific interest, and are well worthy of study. We learn also that, apart from the introduction of labour-saving machinery, the means of production of watches and the forms of the watches themselves are what they were at the beginning of the century; that the Swiss toolmakers annihilated the English watch toolmakers some years ago, and that no English watchmaker has made repeating movements for the last fifty years, the repeating train being imported and fitted to an English going train. Mr. Warwick mentions an American compensating balance in which V-shaped notches filed in a steel rim are filled in with a more expansible brass composition; a device which is probably in every way inferior to the numerous bi-metallic rim-balances with continuous laminæ that have from time to time been devised. He also speaks of certain American watch manufacturers who claim to possess the art of *conferring on springs the property of isochronism* by machines; and adds that as no idea of the machine employed for the purpose was given, "it must be left to individual credulity to form what notion it pleases of this invention." Mr. Warwick mentions with praise the exhibits of the French and Swiss Schools of Horology. Some of these, he says, contained a number of most interesting models of every form of escapement, all mounted with the escapement on the top, so as to facilitate examination; most of them were wound up and going, so that the action could be seen. They were all constructed on a large scale, the balances being four inches in diameter, so that the parts could be well observed and studied. There were working models of escapements on blackboards, with movable parts to show the action and the working angles, which were traced out on the board. "Standing before these objects," he adds, "one could not, as an Englishman, but envy them, and carry his thoughts back to his own land with regret that there are no corresponding institutions for technical education there." Mr. Ganney was even more struck by the advantages possessed by France and Switzerland over our manufacturers in possessing institutions for training workmen of the very highest skill in the theory and practice of their craft. He enters into details about the Horological School of Besançon, its system of instruction, and the extraordinary successes it has achieved. He gives a list of the work turned out by their head pupil, who after being in the school thirty-four months had completed with his own hands nearly fifty watch movements, including a fusee keyless pocket chronometer, and a keyless repeater lever finished and fully jewelled by the pupil. He adds, that as many *years* might have been deemed a reasonable time for learning so much, and that it is doubtful whether the whole English trade contains any English trained workman of experience who could do such a variety of work so well. Self-sufficiency appears to be the characteristic of the English watch trade: with the result that while we turn out less than 150,000 watches a year, America turns out nearly half a million, Switzerland and France some six millions; the French industry having risen in the last thirty years from 40,000 to over a million watches per annum. It appears that good work is as dear in America as here, though a little cheaper in France or Switzerland; but, on the other hand, the Swiss can sell a complete watch in a case, or the Americans a complete watch without a case, for very little more than is charged for an unfinished English blank movement alone; and this solely on account of the labour-saving appliances which they employ.

The other Reports, particularly those on Caoutchouc, on Ornamental Ironwork, and on the Porcelain and Glass

Manufactures, are well worthy of attention, but as they deal with the artistic rather than with the scientific aspect of those industries, we cannot dwell upon them.

Amongst the instructions handed to each artisan reporter at the outset, were suggestions to ascertain the prices and cost of production, the relative amount of machinery employed in production, the hours of labour and the manner of living of the French artisans. Much useful information has been collected on most of these heads. Almost all the reports agree that while cost of living is perhaps a little cheaper in Paris than in London, wages are on the whole much lower; so that it is only by working longer hours and by thrift and steadiness that the French workman can live. The remark is almost universally made that drunkenness is extremely rare; while the absence of almost everything that constitutes home life is equally conspicuous in the habits of the Parisian workman.

In one or two points the volume before us is, from the nature of things, strangely defective. Almost all the reporters who mention the subject at all, appear to have misapprehended the nature and status of the *Cercles ouvrières* or *Corporations ouvrières*, which are the nearest approach in France to the Trades Unions of this country, and the comparisons drawn between the two are in consequence often irrelevant or incorrect. These bodies in France cannot legally extend beyond the limits of the "commune" or parish; they are usually semi-political or socialistic in character, and while they concern themselves with the conditions of labour, are not exclusively occupied in matters of wages and hours of work, and do not, from the local restriction on their operations, exercise an influence in any measure comparable to that exercised by the English Unions over the price or conditions of labour. Again it is impossible to derive from the reports any ideas upon the relation between skilled labour and the educational systems in operation in Paris or in the provinces of France, for the simple reason that not one of the reporters appears to have been made acquainted with those educational systems as a whole. A few of the more prominent technical schools, the *École d'Apprentis*, the *Horological Schools*, and the *Typographic School* of MM. Chaix and Co., are indeed mentioned; but beyond these exceptional institutions and a chance reference to the free evening schools of drawing and modelling which are to be found in every quarter of Paris, there is no reference to the educational systems of the country or to their influence on the artisan, the foreman, and the employer. Any account of the conditions of the skilled industries in France which leaves these out of consideration must be regarded as imperfect in the extreme.

One result is however unmistakable. The artisans who drew up these reports were fully alive to all the advantages of which accrue to an industry from the extension of labour-saving appliances, and from the dissemination of higher technical knowledge. They have faithfully pointed out those departments of industry in which we excel, and those in which we are excelled. They have in most cases stated their opinions as to the causes which have brought about these results. It will be our own fault if we do not strengthen the weak points and fill the gaps now revealed to us. The strides made by some of our foreign competitors are so great as to leave us no margin for indolence or wastefulness on our part. The less favoured nation may more than make up for the material disadvantage of having to import raw products and fuel by the superior thrift and the better training of its workmen. All these things point to the need at home to lose no opportunity of pushing forward the scientific and artistic culture of the workers and of their employers, so that their training may at least be not inferior to that of their Continental rivals.

SILVANUS P. THOMPSON

HOW TO COLOUR A MAP WITH FOUR COLOURS

SINCE the publication in the *American Journal of Pure and Applied Mathematics*, vol. ii. part 3, of the solution of this problem obtained by me, and referred to in NATURE, vol. xx. p. 275, I have succeeded in obtaining the following simple solution in which mathematical formulæ are conspicuous by their absence. It may be premised that the problem is to show how the districts of a map may be coloured with four colours, so that no two districts which have a common boundary or boundaries shall be of the same colour. The object of this colouring being to make the division of the map into districts clear without reference to boundary lines, which may be confused with rivers, &c., it is obvious that nothing will be lost if districts which are remote from each other, or touch only at detached points, are coloured the same colour.

The only parts of the map that it is necessary to consider are the districts, boundaries, and points of concourse, *i.e.*, points at which boundaries terminate. Two districts may have a single common boundary, or they may have two or more such boundaries. Any two districts which have more than one common boundary, inclose one or more groups of districts; in any one of these groups two districts which have more than one common boundary inclose one or more groups of districts, and so on. Proceeding in this way, we limit the area under consideration more and more at each step, and must finally come either to a group which has no pair of districts which have more than one common boundary, or to a single district having only two boundaries, one in common with each of its two surrounding neighbours. *Thus every map must have at least one pair of adjacent districts which have only one common boundary* (β).

Every boundary is either continuous like a circle, or has two ends which lie at the same or at different points of concourse. Every point of concourse may be called *triple*, *quadruple*, &c., according to the number of *lines* radiating from it. I expressly say *lines* and not *boundaries*, because if two ends of any boundary lie at the same point of concourse two of the lines radiating from the latter will belong to only one boundary. If a boundary whose ends lie at two different points of concourse be rubbed out, the number of lines radiating from each of those points of concourse will be reduced by one, thus if the two points were each triple points, they will become double points, *i.e.*, they will no longer be points of concourse, the two remaining lines which radiate from each becoming one boundary. The result is that rubbing out a single boundary *may* reduce the number (B) of boundaries in the map by three. It can, however, never cause a greater reduction, and may cause a smaller, *e.g.*, rubbing out a continuous boundary, or one which ends in two quadruple points reduces the number of boundaries by one only.

Now the obliteration of the boundary β causes the two districts it separates to become one, thus reducing the number of districts (D) in the map by one, and the map still remains a map, and has therefore a pair of districts having only one common boundary. Obliterate this common boundary, and so on. We finally get a blank sheet, *i.e.* a single district and no boundary, and each reduction of D by one cannot involve a reduction of B by more than three; thus 3D must be greater than B, consequently 6D must be greater than 2B; but 2B is the number which would be arrived at if we counted both sides of every boundary, *i.e.*, the number which would be arrived at if we counted the number of boundaries to each district and added them all together; thus the number arrived at by the latter computation must be less than 6D, *i.e.*, it is impossible that every district can have as many as six boundaries, *i.e.*, *every map contains at least one district with less than six boundaries.*

We can therefore reduce a map to a single district by successive operations of throwing two districts into one by rubbing out the boundary or boundaries between two districts of which one has less than six boundaries. Conversely we can develop a map, starting from a single district and adding boundaries, at each stage dividing a district into two, one of which bas less than six boundaries. Suppose at any stage of its development by this process a map can be coloured with four colours [red, blue, green, and yellow]. Let these colours be indicated by coloured wafers placed on the districts. Proceed to the next operation, this divides a wafered district into two districts. Shift its wafer on to the district of these two which is not the one which has less than six boundaries: if both have less than six boundaries shift the wafer on to either. If the district (W) which is left without a wafer is only touched by three colours it can be coloured the fourth, and a wafer may be put on it representing that colour. But if it is touched by all four colours we must take another step. This can only be necessary if W has four or five adjacent districts. These may either all surround or all be surrounded by or some surround and some be surrounded by it. Take first the case in which *four* districts are adjacent, all surrounding or surrounded by W. Let *a b c d* be the districts, taking them in the order in which they stand. Let *a* be red, *b* blue, *c* green, and *d* yellow. If, starting from *a*, we can get to *c*, going only through red and green districts, and not passing through any points of concourse, we cannot, starting from *b*, get to *d*, going similarly only through blue and yellow districts, for otherwise two tracks which pass through different districts would cross. Thus *b* forms one of a group (G) of blue and yellow districts which are cut off from the rest of the map by encircling red and green ones. We can accordingly interchange the blue and yellow wafers in G without changing any others; this makes *b* yellow, and we can put a blue wafer on W. Similarly, if we cannot pass from *a* to *c*, *a* belongs to an isolated group of red and green districts. Interchanging the wafers in these, *a* becomes green, and a red wafer can be put on W. Precisely similar reasoning applies in the case of *five* surrounding or surrounded districts, viz., *e* red, *f* blue, *g* green, *h* blue (two must of course be the same colour), and *k* yellow. Here either *e* belongs to an isolated group of red and green districts, or *k* to one of yellow and green districts, or *f* to one of blue and yellow, and *h* to one of blue and red districts. In the first case, interchanging wafers as before, *e* becomes green, and a red wafer can be put on W; in the second *k* becomes green, and a yellow wafer can be put on W; in the third *f* becomes yellow, and *h* red, and a blue wafer can be put on W. In all cases before putting the wafer on W we can interchange the colours of districts, *e.g.*, we can put red wafers in the place of all the green ones and *vice versâ*. Thus we can make the three colours adjacent to W any three we please. If therefore the districts adjacent to W belong to different groups of districts surrounding and surrounded by W, and so detached from each other, we can rearrange the wafers in each group so that only three colours in all shall be adjacent to W, which can therefore have a wafer of the fourth colour placed on it. Thus in any case the district W can be wafered with a wafer of one of the four colours. Thus if the map can be coloured as developed at any stage it can be coloured at the next. Hence since it can obviously be coloured at the first stage when there is only one district, it can be coloured at the last.

Take then two copies, P and Q, of the map we wish to colour, one of which, Q, is on a slate or in pencil, so that the boundaries can easily be obliterated. Pick out a district with less than six boundaries. Rub out in Q the boundary or boundaries (if there be more than one) between this and any other district which is adjacent to it. Number with a (1) the corresponding boundary or boundaries in P. Repeat the operation, numbering the boundary or boundaries in P this time (2). Continue the process until a map is arrived at which can obviously be coloured with four colours. This will generally happen long before we reduce the number of districts to four. Put wafers on the middle of the districts of Q, representing the colours. Proceeding as before shown with the process of adding boundaries in the order indicated by the numbering of P taken backwards, and of shifting the wafers so as to be able to add a wafer to the W of each stage, we finally arrive at a stage when Q is in its original state. The map can then be coloured as indicated by the colours of the wafers.

This method applies equally to maps drawn on the surface of globes, but fails in the case of surfaces which are not necessarily divided into two parts by an endless line, these in general requiring more than four colours.

A. B. KEMPE

THE LIPARI ISLANDS

ON inquiring in Rome for the Stato Maggiore map of the Lipari Islands, I was told that it was out of print, and when afterwards I succeeded in getting one in Florence, I found that owing to the large scale, the islands from Vulcano to Stromboli, in a north-easterly direction, and from Vulcano to Alicudi, to the north-west, were given on three separate sheets, too unwieldy to use for practical purposes, except in their disconnected form. Our own Admiralty chart (scale $\frac{1}{100000}$) constructed from the maps of a French hydrographer, M. Darondeau, gives all the islands, save Ustica, at one view, accompanied by soundings, and a general diagrammatic view of the principal group. The Comitato Geologico of Rome has not yet published a geological map of the islands, and the only complete one that exists, as far as I know, is that to be found in the antiquated "Vulkanen-Atlas" of N. C. von Leonhard, which is taken from the survey of Fr. Hoffmann. In this map Alicudi, Felicudi, Salina, and the major part of Lipari are represented as composed of tuff with porphyritic lava. Panaria, with the surrounding islets Dattolo, Lisia Bianca, &c., is stated to consist entirely of trachyte. The greater part of Vulcano, and about half Stromboli are given as old felspathic lava, while the craters of Vulcano, Vulcanello, and Stromboli are described as *nochfortdauernde vulk. Bildungen*. Pumice and obsidian are shown in various parts of Lipari.

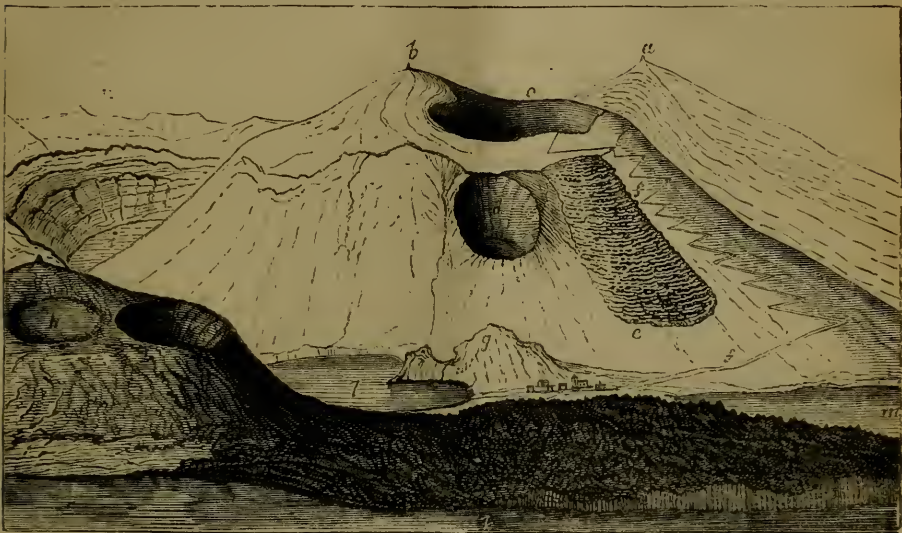
Since Admiral Smyth visited the Æolian Island in 1815, numerous observers have followed in his footsteps. He has devoted thirty pages of a quarto volume on "Sicily and its Islands" to this subject, and two of the three Admiralty charts which relate to these islands, contain engravings executed from his drawings.

In 1874 Prof. J. W. Judd visited the islands, and he has embodied the results of his observations in some valuable memoirs contributed to the *Geological Magazine*, accompanied by reproductions of drawings made on the spot. To him we are indebted for the accompanying view of Vulcano and Vulcanello.

We were surprised at the complete ignorance manifested both by the Romans and the Neapolitans, in regard to everything connected with Lipari and the members of its group. Everybody said "You must tell us all about them when you come back." In fact the islands are very little visited; communication with the mainland is at the best only twice a week; the boats are small and inconvenient, and they start at midnight; and worse than all, the most important island of the group (Lipari) is cursed by the presence of some 400 convicts, who are sent to this penal settlement, much as we sent ill-disposed persons to Botany Bay forty years ago. We left the harbour of Messina at midnight, having on board ten of these manacled *manutengoli*, guarded by carabinieri. At six the next morning we were off Lipari, and soon afterwards anchored opposite the castle. The town, although fairly clean and flourishing, affords wretched accommodation to the traveller. We lived almost entirely on hard boiled eggs and sweet *malvasia* wine; even fish, butter, and milk could only be obtained at uncertain intervals, and breakfast had to be delayed because no bread was baked. It reminded me, indeed, forcibly of some of the out-of-the-way towns on the flanks of Aetna, such as Aderno, Randazzo, and Bronte.

Lipari is about ten and a half square miles in area. The highest point is 1,978 feet above the sea. Everywhere the island betrays its volcanic origin. Tuff, pumice, liparite (quartz-trachyte), and obsidian, are constantly met with; at San Calogero a hot spring (198° F.) pours forth water charged with carbonic acid and sulphuretted hydrogen, while the Bagno Secco discharges steam, sulphurous acid, and (it is said, but I think the statement requires confirmation) hydrochloric acid. The latter is rarely evolved from fumeroles disconnected with an active volcanic vent, as in the present case.

Vulcano is undoubtedly the most interesting member of the group from a volcanic point of view. It lies between four and five miles to the south of Lipari, and contains a semi-active crater, which, as regards its usual dynamic activity, occupies a mean position between Vesuvius in its present state of action, and an actual solfatara like that of Puzzuoli. We landed at the Porto di Levante (*l*), and at once made our way to the house of the manager of the chemical works near the Faraglioni (*g*). The greater part of the island, including the crater, has lately been bought by a Scotch firm, and chemical works have been established near the base of the crater. The manager's house is the only house on the island; the workmen live in caves in the sides of the Faraglioni, and usually go to Lipari on Sundays to hear Mass and to see their friends.



Sketch of the great central cone of Vulcano, with Vulcanello in the foreground. *a a*. outer crater-rings, culminating in Monte Saraceno; *b*, highest point of central cone; *c*, great crater; *d*, small crater, called the *Fossa Antica*; *e*, obsidian lava-stream of 1775; *ff*, road leading into the crater; *g*, the Faraglioni, with the chemical works near it; *h*, Vulcanello, showing two of its craters: *i*, the Atrio between the outer crater-rings and the central cone; *k*, the lava-stream proceeding from Vulcanello; *l*, Porto di Levante; *m*, Porto di Ponente. (Taken by permission of Prof. J. W. Judd and Dr. Henry Woodward, from the *Geological Magazine*, December, vol. ii.)

Sulphur, alum, and boracic acid are the substances procured from the crater. We noticed also sublimates of sulphide of arsenic, and salts of copper were found in association with some of the aluminous incrustations; also chloride of ammonium. I have been assured by two eye-witnesses that blue and green flames sometimes issue from clefts in the bottom of the crater. The former would of course be due to burning sulphur; might not the latter owe their colour to the boracic acid?

Prof. A. Cossa (*Gazetta Chimica Italiana*, 1878, p. 235-246) has pointed out that Vulcano furnishes the richest supply known of cæsium and rubidium. The Faraglioni, also called *rocca dell' allume*, is a trachytic mass much decomposed by sulphurous and sulphuric acids; potassium-alum is found in its cavities, associated with the sulphates of aluminium and calcium, with chloride of ammonium, and with the alums of thallium, cæsium, and rubidium. Iron and copper compounds are also found in small quantities in the incrustations, also the sulphides of selenium and arsenicum, and traces of sulphate of lithium. The most complex mixture of volcanic products hitherto found was discovered by Cossa on the edges of a small fumerole at the bottom of the crater of Vulcano. It was found to consist of the sulphides of arsenic and selenium, chloride of ammonium, boracic acid, sulphate of lithium, together with cæsium- and thallium-alums, and traces of the alums of potassium and rubidium. To the south-west of the Faraglioni there is a well containing about half a metre of water through which bubbles of gas are continually and rapidly rising. C. Sainte Claire Deville calls this *la Grotta del Cane dell' isola di Vulcano*. The gas analysed by Cossa was found to consist of 80 per cent. of carbonic anhydride, 19·4 of nitrogen, and 0·6 of oxygen. The temperature of the water is 22° C.

We ascended the crater of Vulcano by the zigzag path *ff*, and on arriving at the summit we found beneath us a very regularly formed crater (*c*), which is nearly one-third of a mile in diameter, and from four to six hundred feet in depth. For many years it has ceased to emit lava, but so recently as 1874 several large fissures opened in the floor and sides, and from them stones of considerable size, ashes, and vast volumes of vapours were emitted. The descent into the crater is easily effected. We found steam issuing at high pressure from several orifices in the floor, around which crystals of sulphur and other products of sublimation had collected. On the south-west side of the crater, about twenty feet from its floor, we saw a large opening apparently going down a considerable depth into the heart of the mountain. From it loud surging noises proceeded, as if much-agitated lava existed within it, but no lava could be seen, and the air which proceeded from it was so fearfully hot that it was impossible to approach within many feet. At the orifice itself I believe it would have readily melted lead. Hot sand and blue and green flames are frequently emitted from this bocca.

A small fis erman's boat carries the letters twice a week to Stromboli, but as the weather was particularly fine, we determined not to wait for it, and started on January 5 in a small open boat, with four rowers. The distance is about twenty-three miles, and the course passes between the group of islets, eleven miles from Lipari, of which Panaria is the largest member. The sea was perfectly calm all day, and we had to row every inch of the way. A few miles from Stromboli we came upon a parrot-billed turtle asleep upon the surface of the water, and rowing gently up to it, the sailors secured it before it had time to dive. We arrived somewhat late in the evening and started for the summit (3,090 feet) the next morning at seven o'clock. The ascent is steep, and occupied us two hours. The great conical shadow of the mountain was seen stretching many leagues out to sea, and gradually approaching the base of the mountain as the sun got higher in the heavens. From the time of Pliny the inhabitants of Stromboli have asserted that the eruptive force is always weaker in calm than in stormy weather. They reiterated this again and again, and undoubtedly changes in the atmospheric pressure may effect it. Our calm day was unfortunately followed by a comparatively inactive condition of the volcano. It gave forth, indeed, enormous quantities of steam, but red-hot ashes were only ejected at long intervals of time, and never to a height exceeding 200 feet, and the sight at the summit of the mountain was altogether less interesting than that presented by Vesuvius even in its condition of *piccolo eruzione* a year ago. We descended rapidly over steep beds of fine volcanic ash, reached the base of the mountain before noon, and returned to Lipari in the afternoon. Some days later while steaming from Messina to Naples, we passed within sight of the crater of Stromboli, which was obviously in a state of increased activity.

G. F. RODWELL

SOMETHING ABOUT MILK

A SPECULATOR upon the possible fluctuations of that inscrutable phase of human attribute which we know as "fashion" or "custom" might find material for a lucubration of no small interest in a forecast of probable results, supposing the influence exercised by it on many of our largest branches of trade were to extend itself to certain others which appear thus far to have escaped it, and are therefore more or less unprepared to encounter one of its eccentric revolutions.

And yet in an age when the successive crazes for novelty are certainly as rampant as ever they were among the *haut-monde* of the ultra-æsthetic Greek metropolis, it is hardly safe to reckon upon the endurance of any purely customary feature of life merely on the strength of its universality or even its long standing. Probably not one man in a thousand takes the trouble to realise to himself the degree in which many of our most indispensable demands are really maintained by conventional habit. And in no instance is this more likely to escape appreciation than in that of the so-called "necessaries," whose "intermittent service" is as much taken for granted as the return of daylight.

The milk-supply of any large centre of population, to be anything like efficient, must rest upon a series of conditions so various, so complicated, and so linked together, that probably no one unacquainted with the details of both the material itself and the machinery of its delivery, has any idea of the extent to which the dislocation of any one of them might entangle the whole. Complex and unstable in its physical constitution to a degree far beyond any other of the "perishables" in hourly requisition, milk of every description is for this very reason in tenfold greater risk of imparting a shock to the foundations of its trade if society should happen to rush into any modification of its conventional uses. Every one is prepared to awaken in the morning to a sense that the world has decreed a new system of coiffure, or set up another Dagon of Form or Colour since last night; but should the popular vote be found to have discarded the teaspoonful of cow's milk which the habit of years has mingled with certain sups of boiling vegetable infusion, and which in fifty cases out of a hundred bears as trivial a part in the actual nutriment of the body as it does in the gratification of the palate—surely we have but a faint conception of the dismay which would greet the reduction of the milk-supply by some thousands of tons daily, from a cause so easily conceivable.

The miniature ocean of milk in consumption during every four-and-twenty hours in the United States alone has approached, if not exceeded, 200,000,000 of gallons; a quantity approximately sufficient to fill the Grand Junction Canal half way from London to Birmingham, with something to spare for locks and evaporation. We may picture to ourselves society stretching itself one dull morning and observing that after all this antiquated "fad" of mixing a driblet of milk with the infusions of tea or coffee is a very curious one—difficult to trace, and still harder to account for. Indeed our doctors and chemists are telling us that many of the choicest qualities of milk are annihilated by contact with a hot liquid, and that in the particular case of tea it is even so far decomposed, or recomposed, that it is absolutely not milk at all that reaches our digestive organs, but a mixture of semi-saponified fats with an entirely new compound of curds and tannin. As a correspondent of one of the food journals has aptly observed, "there may be nothing like leather, but a leather lining to one's stomach is hardly an illustration of the eternal fitness of things.

"The habit is really a culpable waste, and it is time we laid our heads together to blow it up." Then the dairy trade would rise to find its business cut down to one-third of what it was, the demand for milk being suddenly limited to creaming, cookery, and babies, and a vast industry would be upset, until it had perforce adjusted itself to the new requirements.

Upon some few conditions of this order, or rather upon the absence of popular appreciation of them, have grown up several of the standard prejudices on the matter of milk and its value and method of use, which it is often thought impossible to combat, and which therefore it has been the aim of dairies and milk-sellers rather to compromise than to make evident. It is true that science is still but on the threshold of the subtle changes characteristic of all compounds which originate in the action of vitality; and theories "understanded of the people," are not easy of diffusion so far as to bear the fruit of popular common-sense. Yet if it were practicable by a sort of bird's-eye view of the whole question to enforce a general apprehension of a few comparatively simple facts, there is no doubt that both the public and the trade would benefit by the disappearance of a tribe of erroneous fears, annoyances, and malpractices, which are reciprocally inflicted on both parties. And this with the result that the natural use of fresh milk would commend itself to the world in such a manner as to compensate the hypothetical disorder entailed by any such freak of fashion as above indicated.

Foremost among these easily-defined but little-known facts stands the exceedingly sensitive nature of the material itself, a clear conception of which alone would wipe out many charges against unoffending causes, and prove a natural and inevitable salve for many sore grievances. In the first place it must be distinctly realised that *nearly the whole* of the vast demand made upon milk is, in fact, outside its natural functions; and is, so to speak, *ab initio*, an unfair one. Nature never designed milk for exposure to atmospheric air or variations from its own limits of temperature, its primary purpose being to gently supplement and gradually replace that source of the earliest sustentation which commences from the fountain of life itself. It is scarcely necessary to point out that in the natural process milk is but a transition-compound, evolved directly with the blood, and passed (without delay, exposure, or appreciable change of temperature) from the body of the parent to that of the offspring, there to meet with an immediate assimilation by which the conversion into blood is completed. If practical evidence of this were needed, the chemist and comparative analyst will point with interest to the really very inconsiderable difference both in mechanical and chemical structure which subsists between the two.

Similar also is their behaviour when cooled and exposed to the air, save only that the changes occurring in blood show it to be even more susceptible of chemical alteration than milk.

Have we then much reason in our surprise or complaint when this exquisitely delicate compound occasionally resents the outrageous changes from heat to cold and back again—the hours of ruthless jolting and contact with air of every degree of impurity, which we expect it to sustain with unruffled sweetness of temper?

Rather let us marvel that a confection (for such it really is) which the tenderest care can hardly retain in its pristine perfection, should so often reach our breakfast-tables with the refinement of its true quality so little impaired.

Only of late years have even the commercial authorities practically learned the lessons of purity which some of them have so creditably endeavoured to teach us by concentrating the business within large-scale establishments when time and capital are really devoted to securing the desired care.

Now let us look more closely at one or two of the innate peculiarities of milk, in consequence of which a large amount of grumbling is almost invariably lavished upon the wrong heads. The most pregnant of all these is what we shall call its *effluvium*, that is to say, effluvium in the strict sense, to which nothing offensive *necessarily* attaches.

Every known substance is capable, in a greater or less degree, of both diffusing and imbibing effluvia or vaporous compounds which are often beyond the reach of any chemical estimation. These become known to us, *if at all*, through the sense of smell, and only subsequently by their action on surrounding matters. Probably but few persons outside the scientific world would be prepared to hear that it would be *next to impossible to devise a compound liquid more susceptible to effluvial influences than fresh milk*.

Imbued at its outset with a slight and agreeable effluvium of its own, it possesses every condition of structure favourable to the reception and retention of every volatile matter approaching it. Most persons are aware of the affinity of all oily matters for odoriferous principles of any kind, and to such as are acquainted with the composition of milk, an illustration of daily occurrence cannot seem overdrawn. A can of milk is received into the house in the evening, and according to a tradition, commendable as far as it goes, is at once poured into a clean earthenware jug; there is no cover, perhaps, but the vessel is clean. This is stood, say on a stone shelf in the larder, to keep cool and free from taint. Its companions there are a joint or two of cold meat (in its gravy), a few unfinished tarts and blanc-manges, a large bowl of scrap-bread (with incipient fungoid growth), a couple of dozen of eggs (not *all* fresh), underneath, the cheese; overhead, a jar of onions in pickle; in the near distance a few head of game in an advanced stage of—well, "keeping", and last, but not least, a closed window. Now, what is the "action" hereupon? A thousand to one, the temperature of the milk is, when received, *different* to that of the air in the larder (whether higher or lower). Immediately that it comes to rest, the surface next the air becomes warmed or cooled as the case may be, and by giving place to other portions, sets up a series of gentle currents, by means of which every part of the fluid is successively brought into contact with the air, and its countless crowds of butter-corpuscles, containing fatty matter in a high state of sub-division, are enabled to expose the greatest possible extent of surface. Now it is scarcely the fault of that milk if in ten hours' time it has failed to lay by at least a trace of every shade of effluvium which has had a chance of circulating near it. And yet when the pardonable nastiness of the milk is commented upon at breakfast, there will not be found wanting some one to exclaim, "What *can* those people feed their cows on?"

Is it necessary to follow the case further? into the nursery or sleeping-room, for example, where the half-breathed air, kept in active movement by the human lungs, and laden with suspended moisture condensing carbonic acid from every direction, heightens even further still the conditions of contamination, while the temperature is such as to place the unfortunate milk upon the very tenter-hooks of absorptiveness. Indeed, one must repeat that a plan could scarcely be devised, short of actually pouring in acetic acid, to communicate the taint of sourness with such absolute certainty and rapidity.

In every grievance, therefore, that arises on the score of *bad or tainted* milk, let us at least learn to distrust the *last* place it has been in rather than the *first*; and ask ourselves whether it is not possible that a substance which has already gone so far out of its way to serve us may not have been finally "put upon" in a manner for which our own end of the transaction is alone responsible. Let it be borne in mind that our own care of the milk we purchase is *more important* than that which precedes it, for two obvious reasons—first, that we receive it at a late period of its life, when it has already suffered from previous ill-usage, and is therefore more susceptible of injury; and secondly, that we receive it in *small quantities*, and thereby expose a proportionately larger surface to contamination.

The other chief point upon which general prejudice is still much astray is that of modern adulteration. There is no doubt that within the last ten years that which was the rule in this respect has become the exception, and it is a high satisfaction to be able to say that in London especially there is even less cause for present uneasiness on the score of tampering with milk than is popularly supposed. The system of supervision and the simplicity of tests have really driven the ancient mysteries of "Bob" and "Simpson" into a remote corner, and Annatto stands forth in the daylight with an easy conscience.

Pure milk, and not only pure but *clean* milk, can be obtained with certainty at current prices, and when this is the case it will take no long period to obliterate the common fallacy which still clings to the idea that yellow milk must be rich, white milk chalky, and blue milk watered. Annatto openly accomplishes the first, nature has no occasion to be ashamed of the second, nor an exhausted cow of the third.

There is reason to hope the time is not far off when it may be said of town milk-supplies that if we will only do our part in taking care of the pence, the pounds may safely be trusted to take care of themselves. And if we have no justification for the comparatively hard service still required of milk, we may at least allow it a precedent dating from a time even earlier than that at which any land can have "flowed with milk and honey."

ARTIFICIAL PRODUCTION OF DIAMONDS

GLASGOW seems determined to have the honour of producing the diamond artificially. In spite of Mr. Mactear's recent failure, Mr. J. B. Hannay, whose paper on the solubility of solids in gases we published not long ago, has been utilising the method indicated in that paper in experiments on the artificial production of the diamond. Mr. Hannay reads a paper on the subject at the Royal Society to-night, and any remarks on his work we shall postpone for the present. Meantime from the letters and articles that have appeared in the papers, we may form some idea of what has been done. Prof. Story Maskelyne, writing to the *Times*, says:—

"A few weeks since I had to proclaim the failure of one attempt to produce the diamond in a chemical laboratory. To-day I ask a little space in one of your columns in order to announce the entire success of such an attempt by another Glasgow gentleman. That gentleman is Mr. J. Ballantine Hannay, of Woodbourne, Helensburgh, and Sword Street, Glasgow, a Fellow of the Chemical Society of London, who has to-day sent me some small crystallised particles presenting exactly the appearance of fragments of a broken diamond. In lustre, in a certain lamellar structure on the surfaces of cleavage, in refractive power, they accorded so closely with that mineral that it seemed hardly rash to proclaim them even at first sight to be diamond. And they satisfy the characteristic tests of that substance. Like the diamond, they are nearly inert in polarised light, and their hardness is such that they easily scored deep grooves in a polished surface of sapphire, which the diamond alone can do. I was able to measure the angle between the cleavage faces of one of them, notwithstanding that the image from one face was too incomplete for a very accurate result. But the mean of the angles so measured on the goniometer was 70 deg. 29 min., the correct angle on a crystal of the diamond being 70 deg. 31·7 min. Finally one of the particles, ignited on a foil of platinum, glowed and gradually disappeared exactly as mineral diamond would do. There is no doubt whatever that Mr. Hannay has succeeded in solving this problem and removing from the science of chemistry an opprobrium so long adhering to it; for, whereas the larger part of the great volume recording the triumphs of that science is occupied by the chemistry of carbon, this element has never been crystallised by man till Mr. Hannay achieved the triumph which I have the pleasure of recording to-day. His process for effecting this transmutation, hardly less momentous to the arts than to the possessors of a wealth of jewellery, is on the eve of being announced to the Royal Society."

The *Glasgow Herald*, in referring to Mr. Hannay's discovery, states in a general way that his process "involves the simultaneous application of enormous pressure—probably many tons on the square inch of surface within the apparatus—and a very high temperature, ranging up to a dull red heat. It may be said that the process is the outcome of a thoroughly scientific investigation into the subject of solution, and not a 'happy-go-lucky' hit. We understand that hydrocarbon compounds have been used in the process, but we have some hesitation in concluding that the crystalline carbon is of necessity obtained by the dissociation of those compounds; by and by, however, that point will doubtless be satisfactorily established. So far as we can learn, Mr. Hannay's experiments were not all successful, there being, it is said, far more failures than successes; the latter, however, occurred near the end of the series, thus showing that the operator had become familiar with the conditions under which the dissociation of the carbon was effected, and its subsequent deposition in the crystalline form. It would seem that up to the present only very small crystalline particles have been obtained, and hence the process must be an exceedingly expensive one to produce a real gem; something like spending 5*l.* to get 5*s.*, to speak roughly."

Prof. Roscoe, writing to the *Times*, states that the use of his name as having accepted Mr. Hannay's discovery as an accomplished fact has not been authorised by him, and that the evidence yet submitted to him by Mr. Hannay is insufficient, in his opinion, to establish so important a conclusion.

THE HISTORY OF WRITING[1]

II.

THE new alphabet eventually made its way from the Delta to the old home of the Phœnicians on the coast of Palestine. Already in the time of David the Syrians had their historians and state annals, and Hiram of Tyre, we are told, wrote letters to King Solomon. The Phœnician alphabet, as we may now call it, was communicated to the Israelites along with other elements of culture, and the neighbouring populations of Edom, of Ammon, and of Moab received it at the same time. Names had already been given to the letters, derived from Phœnician words which began with the several letters of the alphabet, *a*, for instance, being called *aleph*, "an ox," *b*, *bêth*, "a house," and so on. In this way the meaning of each letter was the more easily impressed upon the memory of the Phœnician schoolboy, just as in our own nurseries it used to be thought that we should have less difficulty in learning our alphabet if we were taught that "A was an archer who shot at a frog," than if we were simply told that A was A. Names and letters alike were imported into the countries that adjoined Phœnicia, and in course of time inscriptions in the new characters were engraved upon stone, as well as painted on the more perishable materials of papyrus or bark. The earliest monument of the Phœnician alphabet that has come down to us is the famous Moabite Stone, discovered a few years ago on the site of Dibon, which records the conquests and buildings of King Mesha, the contemporary of Ahab. The forms assumed by the characters upon this stone must have been the same as those employed by the Jewish prophets when writing down their prophecies or recording the history of their times.

Meanwhile the northern neighbours of the Phœnicians, who lived on the shores of the Gulf of Antioch, had been venturing on trading voyages into the far west and carrying with them a knowledge of the alphabet along with the wares and pottery of the East. They had found the inhabitants of Asia Minor and the adjacent islands in possession of a syllabary, the origin of which is still a puzzle, but as they pushed further westward into the islands of the Ægean and the harbours of Greece, they discovered a people wholly illiterate and unacquainted even with the rudiments of picture-writing. Amongst this people whom we now term Greeks, they soon established colonies, the most important being at Thebes, and in the islands of Melos and Thera. The island of Thera was probably the first spot on European soil where words were translated into written symbols. The earliest Greek inscriptions, it is believed by competent authorities, belong to Thera, and

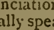
[1] Lecture at the London Institution, February 12, by Prof. A. H. Sayce. Continued from p. 380.

the alphabet of these inscriptions is the oldest alphabet of which we know. The forms of the characters in it bear so close a resemblance to those on the Moabite Stone as to justify us in concluding that the parent-alphabet from which those of Thera and of Moab were both derived, was the same, and that the date of the inscriptions of Thera was not far distant from that of the inscription of King Mesha. In this case the alphabet would have been introduced into Greece in the ninth century B.C.

The Greeks themselves believed that the old Phœnician colony in Bœotian Thebes was the source and centre from which the alphabet was spread throughout the country. Kadmus, "the Eastern," for such is the meaning of his name, was its mythical inventor, though later legends told how the crafty Palamedes and the poet Simonides subsequently added fresh letters. But these legends are all the fables of the literary age; the kernel of truth they contain is the fact that the Greek alphabet came from Phœnicia. It is a fact, indeed, to which the word *alphabet* itself still bears witness; *alphabet*, or *alpha*, *beta*, the two first letters of the alphabet, are both, as we have seen, Phœnician words.

It would be tedious and unnecessary to follow out the fortunes of the alphabet when once it had made good its settlement on European soil. The forms, and in some cases the values, of the characters gradually changed, and many of them underwent particular modifications in different parts of the Greek world. A little practice enables us at once to determine, by merely looking at the forms of the letters, to what special branch of the Greek race an inscription belongs.

Like the Phœnicians before them, the Greeks repaid the benefit they had received by handing on their alphabet to nations still further west. The Greek colonies in Sicily and Southern Italy being mostly of Doric descent, brought with them the Doric alphabet, and accordingly the natives of Southern Italy, when they first began to write, used the Doric alphabet of their Greek neighbours. Hence it is that the Latins and ourselves after them attach a tail to the letter *R*, which was wanting in the old alphabet of Phœnicia; hence, too, we have inherited from the Romans the letter Q, which had been lost in all the Greek alphabets except that of Dorian origin. On the other hand, the Etruscans, that mysterious people of Northern Italy, who exercised so profound an influence upon the infant civilisation of Rome, learnt the art of moulding and decorating vases from the potters of Athens, and since the latter were in the habit of inscribing the names of the gods and heroes they depicted above the representations of them the Etruscans learnt at the same time the Old Attic or Ionic alphabet. We need only place the alphabets of Etruria and Athens side by side to be convinced of this fact. *R*, for instance, is represented in both by the tailless P, we look in vain in both for a Q, and the two distinct symbols that once stood for the gutturals *c* and *k* are amalgamated into one. Alphabets, like words, if rightly questioned, can be made to tell their own history as well as that of the people who employed them.

The alphabets of Western Europe are the lineal descendants of that of Rome. Our capital letters are identical with those inscribed on the monuments of the Eternal City, and we can trace by the help of contemporaneous documents the successive changes which have transformed these capitals into the smaller type of the printing-press or the letters of our running-hand. Thus A became , *a* on the one side, and , a on the other, while *b* and b can be followed back to B through the intermediate stages , and *b*.

But in borrowing or deriving an alphabet from another people one great difficulty has always to be encountered. The pronunciation of no two peoples is exactly the same, nay, generally speaking, it differs very widely. Consequently the sounds attached by the one people to the letters of their alphabet will not in all cases agree with those attached to the same letters by the other. It will often happen, moreover, that sounds will be wanting in one language which are common in another. In borrowing an alphabet, therefore, it will be necessary to do more than simply transfer it; it must be adapted just as the pronunciation of French words like *Paris* or *Marseilles* has been adapted to the genius of English pronunciation. New sounds have to be given to the old letters, new letters have to be invented or formed out of old ones, while some of the old letters may be dropped altogether. It is not often, however, that an alphabet has been adopted and adapted in so scientific a manner as to make it express even approximately all the varieties of sound peculiar to the language of the borrowers. Generally speaking, the adaptation has been of a rough-and-ready kind, and those who use it have been contented if the words they utter are made fairly intelligible when written in it. Often, too, the alphabet has not been consciously and deliberately introduced among an illiterate people or a race which has hitherto employed a different mode of writing. Most of our West-European alphabets have gradually grown into what they are through the slowly-working force of time and circumstances and the successive attempts of individuals to improve them. We cannot say, for instance, with any real truth, that our English alphabet has been borrowed and adapted in the same sense in which it has itself been borrowed and adapted for representing the sounds of a Polynesian dialect. From the time that it was first introduced into these islands under the form of the so-called Anglo-Saxon alphabet it has had a continuous history, a history of slow and sometimes almost imperceptible change and development, which, if allowed to have gone on without check and hindrance, would have resulted in a tolerably serviceable instrument for representing and recording our words. But unfortunately its natural development was suddenly checked nearly 400 years ago by the invention of printing. The necessities of the printing-press stereotyped the alphabet and spelling of the time with all their imperfections, and, what is more, stereotyped the pronunciation of words which that spelling endeavoured to symbolise. It was in vain that a healthy spirit of independence long continued to prevail among that large section of educated Englishmen who were neither printers, authors, nor schoolmasters, and that as late as the end of the last century it was considered no disgrace for a cultivated member of the aristocracy to spell in any way he might think fit. We have only to examine the original manuscripts left by some of the most distinguished Englishmen of the eighteenth century to discover that they were still able to assert the liberty of private spelling against the tyranny of the printing-press.

For a language and its pronunciation must change from generation to generation in spite of all the efforts of printers and pedants to put them into a straight waistcoat. We have only to use our ears to perceive that the pronunciation of cultivated English is even at the present moment slowly but surely undergoing alteration. I wonder how many here this evening still cling like myself to the old pronunciation of *either* and *neither*, and have not yet passed over to the ever-multiplying camp of those who change the pure vowel of the first syllable into a diphthong, or agree with the poet-laurate in accenting *contemplate* and *retinue* after the fashion of our grandfathers? So long as a language lives it *must* grow and change like a living organism, and until this fact is recognised by our schoolmasters, our boys will never realise the true nature of the language they speak and the grammar they learn in childhood. The change that has passed over the pronunciation of English since the days of Shakspeare is greater than can be easily conceived. Were he to come to life again among us, the English that we speak would be almost as unintelligible to him as an Australian jargon, in spite of the fact that our vocabulary and grammar differ but slightly from his. But a familiar word sounds strangely when its pronunciation is altered ever so little, and when the outward form of a whole group of words is thus changed, the most skilled philologist would find himself at fault.

Can anything, therefore, be more absurd than an endeavour to mummify an extinct phase of pronunciation, especially when the mummy-shroud was at its best but a rude and inadequate covering which pourtrayed but faintly and distantly the features of the corpse beneath? English spelling has become a mere series of arbitrary enigmas, an enshrinement of the wild guesses and etymologies of a pre-scientific age and the hap-hazard caprice of ignorant printers. It is good for little else but to disguise our language, to hinder education, and to suggest false etymologies. We spell, we know not why, except that it is so ordained in dictionaries. When Voltaire was told that *a-g-u-e* was pronounced *ague*, and *p-l-a-g-u-e plague*, he said he wished the *ague* would take one-half the English language and the *plague* the other half; but the fault lay not with the English language, but with English spelling.

Ignorance is the cause of our bad spelling as it is the cause of most of the mischiefs which afflict the world. The brief sketch of the history of writing we have been studying to-night has shown us the goal at which writing should aim, the end in which the labours of previous generations should find their fulfilment. Writing should represent clearly, tersely, and as nearly as possible the individual sounds of words, and unless it does this it has not advanced much beyond those infantile stages of growth through which we have watched it struggling to pass. The principal sounds of a language should each have a special symbol set apart to denote them, and each symbol should denote one sound, and one sound only. We ought never to hesitate for a moment over the pronunciation of a proper name or a word we have never heard pronounced. Until we have an alphabet which fulfils these conditions, our system of writing is still imperfect and misleading, and our civilisation on this side is less advanced than that of the ancient Hindus. We may well envy the rude races of the Pacific or Southern America, for whom the missionaries have provided adequate and rational alphabets in which to write their first essays in literature. An alphabet which allows us to express the sound of *e* in thirteen different ways, which has no special symbols for such common sounds as *th* in *then* or *a* in *man*, and yet possesses otiose and needless letters like *c* and *x* is unworthy of its name, and still more of being the final result of all that toil and thought which first worked out the Phœnician alphabet and then fitted it to express the idioms of Athens and Rome. We are sometimes told that to reform our alphabet would destroy the etymologies of our words. Ignorance, again, is the cause of so rash a statement. The science of etymology deals with sounds, not with letters, and no true etymology is possible where we do not know the exact way in which words are pronounced. The whole science of comparative philology is based on the assumption that the ancient Hindus and Greeks and Romans and Goths spelt pretty nearly as they pronounced, in other words were the happy possessors of real alphabets. It lies with ourselves to determine whether we, too, shall be equally happy. The spread of education which we are witnessing, and the general interest taken in it, afford an exceptionally favourable opportunity for breaking the yoke of bondage in which the printers have kept us. If our board-schools are to be tied down to the particular mode of spelling advocated by Walker or some other maker of unscientific dictionaries, the opportunity will have been lost, and the yoke of bondage will be bound more tightly round the necks of our children than it is even round our own. I know the practical difficulties that lie in the way of reform, but I know also that they are not insurmountable. Too often the difficulty is but an excuse for our own lazy disinclination to go to school again and learn to read English in a new way. But it is not by laziness, by shrinking from trouble and exertion, that England has gained the place it now holds among the nations of the world, and the value of a thing is measured by the labour it demands to achieve it. After all, the introduction of a new alphabet is not much to ask for. It is no more than was asked for and obtained by the old Phœnicians of the Delta, by the Greeks, by the Romans, nay, by our own ancestors also. And many of them, too, had to give up their cherished idols before they could accept it; I fancy it must have cost the Anglo-Saxon cutter of runes as hard a struggle to adopt the new-fangled alphabet of the Roman missionaries as it may cost some of us to give up the alphabet of the printers for one which would fitly express our own splendid inheritance of speech. But let there be no mistake upon the matter; it is not a reformed spelling, as is often erroneously and injudiciously said, but a reformed alphabet that is required. We cannot work to good purpose with imperfect and worn-out instruments. High farming needs steam-ploughs, and not the primitive instrument of the Egyptian peasant. If the history of writing has taught us anything, it is that writing is perfectible, and that what was done in old days by those whose civilisation we are apt to consider inferior to our own can be done also by ourselves.

NOTES

At the anniversary meeting of the Geological Society on Friday the Wollaston medal was assigned to M. A. Daubrée, of Paris, and the Wollaston fund to Mr. Thomas Davis, of the British Museum. The Murchison medal and fund were presented to Mr. R. Etheridge, F.R.S., Palæontologist to Her Majesty's Geological Survey and the School of Mines; the Lyell medal to Mr. J. Evans, LL.D., F.R.S.; and the Lyell fund to Prof. Quenstedt, of Tübingen, on whose behalf it was acknowledged by Prof. H. G. Seeley, F.R.S.

M. Hervé-Mangon has been appointed director of the Paris Conservatoire des Arts et Métiers, in succession to General Morin.

MM. Antoine Breguet, son of the celebrated member of the Institute, and Richet have taken the joint direction of the *Revue Scientifique*, the largest and most influential French scientific periodical. M. Antoine Breguet will write more specially on physics, and M. Richet on chemistry. It is understood that M. Alglave, the former editor, has resigned in order to devote himself more entirely to the propagation of Spencerism and Monism.

M. Lœwy, sub-director of the Observatory of Paris, is conducting very delicate researches for determining the different flexions arising from the weight of meridian instruments when they are pointed in any other position than the zenith. The study of these small differences is conducted on a new principle invented by M. Lœwy. A biconcave lens has been placed in the central part of the instrument, and arranged so that an image of the spider-thread can be placed in coincidence with the threads in a certain position. In moving the instrument the coincidence is destroyed, and can be re-established by the micrometer. The image of the threads can be seen (1) with the eye-piece reflected on the edges of the lens illuminated through the axis by a lamp placed as usual, (2) by the anterior part of the lens illuminated by a lamp placed in front of the eyepiece, (3) by a reflection on the object-glass. The sensibility of the process is so extraordinary that a difference was found when a weight of ten kilogs. was suspended at each end of the instrument, whose total weight exceeds a ton. These experiments are conducted by M. Lœwy at the meridian telescope which is used for small planet observations from full moon to new moon. During that time the instrument is not employed, observations being made at Greenwich according to the co-operation established by Leverrier and Sir George Airy twenty years ago.

IT has been remarked by Admiral Mouchez that the number of small planets observed at Greenwich last year did not reach the twentieth part of that observed at Paris. A member of the Institute has derived from this fact the inference that, irrespective of the differences of weather produced by the difference of situation, the view must have been clearer as a whole during the waning moon than during the other part of its revolution. The suggestion is worth being tested by direct observation, and is one of the most obvious instances where the advantages of connecting astronomical observations with meteorology, so much advocated by Leverrier, may be illustrated.

THE building of the Nice Observatory established by M. Bischofsheim, is progressing favourably. M. Perrotin, one of the astronomers of the Paris Observatory, has been appointed director, and will leave for Nice as soon as the state of the works may require his presence in this magnificent establishment.

IT is proposed to establish a meteorological and magnetical observatory on the Island of Réunion.

THE wide-spread and daily-increasing applications of electricity have caused the formation in Berlin of an "Electrotechnischer Verein." Its establishment is in a great measure due to the energetic German Postmaster-General Stephan, whose lively interest in the latest advances of science we have already had occasion to notice. The officers include, besides Herr Stephan, such well known names as Prof. Kirchhoff and Dr. Werner Siemens. The membership already numbers over 700, and embraces prominent representatives from all departments of science and art.

IT being now twenty-one years since the Geologists' Association was established, the event is to be marked by a social meeting of the members at St. James's Restaurant on Thursday, March 4, at 6.30 P.M.

THE already large number of periodicals devoted to chemistry in the German language is increased by the appearance in Vienna of the *Monatshefte für Chemie und verwandte Theile anderer Wissenschaften*. This new journal will contain all the chemical memoirs presented to the Imperial Academy of Sciences, whither with but rare exceptions, the results of chemical research in Austria are forwarded for publication. By its rapid publication it is intended to meet a want felt by Austrian chemists, whose patience is tested by the slow appearance of their investigations in the *Sitzungsberichte* of the Academy, a lapse of four or five months often intervening between presentation and publication. There is perhaps also a tribute to the national pride in possessing finally, like their *confrères* in Russia and Italy, their own chemical journal, and ceasing to be dependent on French and German periodicals for bringing the results of their work before the great mass of chemists. The *Monatshefte* will appear ten times during the year, and form a volume of about 800 pages. In the first number, which was issued in January, there are articles by Weidel and Herzig, on Derivatives from Bone Tar; by Hönig, on a New Isomeride of Gluconic Acid; by Exner, on the Theory of Inconstant Galvanic Batteries; by Herth, on the Synthesis of Diguanide, &c.

AT the annual public *séance* of the Belgian Academy on December 16, 1879, interesting discourses were delivered by Baron de Selys Longchamps, on the classification of birds since Linnæus, and by M. Gilkinet on the development of the vegetable kingdom in geological times (see *Bulletin*, No. 12). A report was presented on the work of the Academy in the mathematical and physical sciences during the last five years, the jury awarding the quinquennial prize to M. Houzeau, for his "Uranometrie générale." The Academy having several years offered a prize for researches on torsion, has, last year for the first time, received a memoir on the subject, which receives honourable mention, but is not thought worthy of the prize. The deaths recorded during the year have been those of one member, Chappuis, and three associates, Dove, von Lamont, and Gervais.

HAVING made numerous observations of the enigmatical red spot of Jupiter, M. Niesten finds (Belg. Acad. *Bulletin*, No. 12, 1879) the duration of rotation a period of 9 hours $55\frac{1}{2}$ minutes. Comparing past observations of the reappearance of this spot since Cassini's time, he observes that the time elapsing between two successive returns of the spot, seems to be comprised between five and six years, that is to say, that in one revolution of Jupiter, which is 11·86 years, the spot appears to attain twice its maximum intensity, the one when the planet reaches the heliocentric longitude 324°, *i.e.*, when it is about 50° distant from its perihelion (as Maroldi indicates); the other when it reaches the longitude 157°, *i.e.*, when it is near its aphelion. In the return of this "*tache fixe et passagère en même temps*," as Cassini designates it, may we not (the author asks) find the indication of a permanent spot on Jupiter, a spot which reveals itself to the investigations of astronomers, though concealed at certain epochs by an atmosphere more or less thick?

THE philosophical Faculty of Göttingen University have just had occasion to cancel a doctor's diploma granted *in absentia* to a Greek, Demetrius Menagius, who had presented a paper in 1871 on Xenophon's Hellenica, professedly his own, while it was really a copy of one published in Athens in 1858 by A. Kyprianos, the title-page being falsified, and Menagius's name given as the author's.

FROM Prof. Piazzi Smyth's Meteorological Report appended to the last Quarterly Return of the Births, Deaths, and Marriages for Scotland, we take the following interesting remarks:—"Like its two preceding months of this last quarter of 1879, December had an unprecedently high barometric pressure. But, unlike them, it began with a furious blast of low temperature, chiefly in the south of Scotland, so that there no less than five stations chronicled special temperatures actually below zero of Fahrenheit. And when the Botanical Society met in Edinburgh during the beginning of the month, there was rather a fearful account of the much greater degree of cold that the members had been thus far chronicling this December to what they had registered during the terrible December of 1878. But their fears for the future were needless; the solar phenomenon of sun-spot activity had already passed its lowest point; the low temperatures measured were chiefly confined to the south-eastern divisions; and a warm period set in so decidedly, and generally, over the whole country towards the end of the month, that the mean temperature of the whole of December, 1879, though lower than the mean of all former years, yet has proved 4° higher than that of December, 1878; and together with this so-far improved feature of temperature, the month shows less humidity, less number of rainy days, less rainfall, less cloud, a little more sunshine, but stronger wind, and now chiefly from the west. Territorially, the lowest mean temperatures were not on the hill-tops, but at moderate elevations and in the south, so that there Thirlestane Castle recorded 29°·2, and Stobo Castle 30°·2; while in the extreme north Scourie recorded so much as 42°·8, and Sandwich 40°·2—a memorable inversion of ordinary latitude effect. Rain was most abundant in the north-west and north, so that there Dunvegan measured 6·71 inches, Stornoway 5·72 inches, and Scourie 5·30 inches; while in the south-eastern, East Linton measured only 0·50 inch, and Smeaton 0·52 inch. A few lightnings and rather more auroras were seen, chiefly in the north."

FROM an interesting paper in a recent number of the *Revue Scientifique*, on "Fire and Water in Paris," we learn that fire claims a larger number of victims in London than in any other large city in Europe. The lowest percentage of those who meet their death by fire is in Munich, where the percentage is ·4 per 100,000 inhabitants; in Glasgow it is 1·7, in Berlin 2, in Paris 2·4, Naples 4·1, Hanover 5·7, Cologne 7·1, and London 8·3.

IT is stated that Prince Onroussoff, Russian Secretary of State, is engaged on a scheme for introducing the Gregorian Calendar into Russia.

SIGNOR DENZA, of the Moncalieri Observatory, points out the coincidence of a shock of earthquake in Lombardy and Piedmont on the 9th inst. with the great activity of Etna the same day, and an eruption of a volcano in St. Domingo.

DETAILS are now to hand regarding the earthquake at Carlsruhe on January 24 last. The phenomenon consisted of a very slight shock followed immediately by a more intense one. It occurred at 7.47 p.m. The direction was from west to east. In many parts of the Palatinate an earthquake was observed on the same date about 6.45 p.m. It lasted for seven or eight seconds and was accompanied by loud subterranean noise, ending with a dull explosion. Its direction was from south-west to north-east. Another shock occurred on January 25 at 3.35 a.m. Further earthquakes are reported from Nevesinje (Bosnia), where a violent shock occurred on January 27 at 4.30 p.m., and from San Salvador, where an earthquake did serious damage in the capital on January 10.

A FEW years ago Dr. Legoff subjected himself to an operation of transfusion of blood, in order to save the life of a wounded soldier lying in Val de Grace Hospital in Paris. The operation was successful, inasmuch as the patient escaped, but the health of the doctor declined. He went to Algiers to recover, but with no avail. We learn from an address by M. Wohl, a Professor to the Lycée, on the occasion of his funeral that he died in the beginning of February.

THE "Ornis" (Society for Ornithology and Bird-culture) of Berlin will hold its biennial exhibition from February 27 to March 2 next. The last exhibition, in the spring of 1878, was a great success. The Society will now give gold, silver, and bronze metals to the most deserving exhibitors. Dr. Karl Russ, of Steglitz, near Berlin, is the president, and requests all breeders of birds and possessors of rare and costly specimens who would like to participate in the exhibition to communicate with him.

M. DREYFUS, of Paris, has just published a second edition of M. W. de Fonvielle's recent work, "Comment le font les Miracles en dehors de l'Église," with a new preface and a number of additions relating to recent events.

A CRAYFISH epidemic has broken out from some unexplained cause in almost all the waters of Alsace-Lorraine. Possibly like most epidemics it may be due to some fungus. The German Government has applied to several eminent zoologists for their opinion, and resolved to prohibit the capture of crayfish in this province for the next three years. A number of female crayfish from the piscicultural establishment at Hüningen are to be imported into the Alsatian waters.

AT a recent meeting of the Berlin Academy of Sciences Prof. Conze spoke on the archæological investigations which are being made at Pergamon, and in which besides himself Engineer Humann and Herren Bohn, Stiller, Raschdorff, Jun., and Lolling took part. The principal interest centred round a magnificent altar which was found close below the highest point of the Pergamon Acropolis. We must refer our readers for details to the *Transactions* of the Academy.

THE Low-Rhenish Antiquarian Society at Xanten are having extensive excavations made outside the Cleve gate of that town, where very large Roman foundations have been discovered, dating from the Colonia Trajana.

THE Sixth Annual Report of the Postal Microscopical Society, for the distribution of microscopical slides by post, gives a favourable impression of the work carried on by the Society, which has now 138 members, distributed over the country. Mr. Alfred Allen, 1, Cambridge Place, Bath, is the secretary.

NATIVE Japanese papers state that arrangements for constructing a railway between the Uronchi coal mines and the Ishigari river in the island of Yezo are progressing, and that an agent of the Colonisation Department will shortly proceed to America to purchase necessary material.

HERR ALBIN KOHN has examined various tumuli near Czekanow, in Poland, in which well-preserved skeletons have been found, exhibiting in point of greater height, convexity of the frontal and the occipital, straightness of the facial line, and other cranial characteristics, a Caucasian rather than a Slave type. Near the Cetynia, an affluent of the Bug, prehistoric graves of similar form to those of Czekanow have been opened, but owing to the want of care of the workmen it was impossible to determine whether, as in the latter, the bodies were ranged on the back, side by side. The Polish chroniclers speak of a nomadic race called Jadjvinges, whose origin was unknown, and who, after ages of aggressive warfare, were only wholly subdued in the thirteenth century; and it is not improbable that in the tumuli of the Cetynia Herr Kohn and his coadjutor, Herr Eichler, may have come upon the representatives of this people.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Macauley; a Water Rail (*Rallus aquaticus*), European, presented by Mr. T. J. Mann; three Black Leopards (*Felis pardus*, var.) from India, three Burrhel Wild Sheep (*Ovis burrhel*) from the Himalayas, a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, deposited; four Common Blue-birds (*Sialia wilsoni*) from North America, a Grey Plover (*Squatarola helvetica*), a Bar-tailed Godwit (*Limosa lapponica*), European, an Ocellated Monitor (*Monitor ocellatus*) from East Africa, purchased.

PHYSICAL NOTES

TWO independent sets of observations of the electro-magnetic rotation of the plane of polarisation in gases have recently been made—one by MM. Kundt and Röntgen in Strassburg, the other by M. Henri Becquerel, of Paris. The details of the systematic and elaborate research of the former are given in *Wiedemann's Annalen*. The general result was arrived at, though without sufficient precision to formulate the mathematical law of dependence, that those gases which have the highest indices of refraction possess the greatest rotatory power under magnetic strain. The gases examined—air, oxygen, nitrogen, carbonic oxide, carbonic dioxide, coal-gas, ethylene, and marsh-gas, gave a rotation agreeing in sense with that of the magnetising current. The authors also speculate upon the probability that the plane of polarisation of the atmosphere would be found to be rotated under the influence of terrestrial magnetism, and calculate from their results that a thickness of no less than 253 kilometres of air would be necessary to produce a rotation of 1° in a north-easterly azimuth. M. Becquerel approached the subject from a completely different point of view. Some months ago, when examining the vapour of carbon disulphide, he had found an abnormal apparent difference in its optic rotatory power according to the position of the tube in which it was examined. While studying another matter, however, a flood of light was thrown on this observation. In the endeavour to determine as exactly as possible the position occupied by the plane of polarisation of the sky with respect to the position of the sun, he designed an instrument by means of which the traces of the plane containing the line of sight and passing through the sun could be compared with those of the plane of polarisation as observed in a Savart polariscope. With this instrument it was soon found that, contrary to what has always been hitherto supposed, these planes do not coincide with one another, but that the angle between them may even exceed 6 degrees. The plane of polarisation is, moreover, always nearer the horizon than the sun, while the angle between the planes presents diurnal maxima and minima, a point of extreme interest. The electro-magnetic rotation of the plane of atmospheric polarisation is distinctly proved by the following observation:—At noon the position of the sun is such as to produce an illumination of the sky symmetrical with respect to the meridian, which ought therefore to coincide with the plane of polarisation; but as a matter of fact the coincidence of the two planes does not occur at noon, but at a later hour, so that the plane of polarisation has obviously been rotated through a certain angle. This rotation corresponds with the results obtained by direct observation by M. Becquerel upon the magnetic rotatory power of air, as regards both the magnitude and the sense of the rotation. The existence of rotatory power in gases is thus confirmed from a most unexpected source.

A SUGGESTION has been made by M. d'Arsonval for the improvement of Planté's secondary batteries. M. Planté employed as electrodes in his secondary cells two sheets of lead immersed in dilute sulphuric acid, which became spongy by use, holding the hydrogen and oxygen liberated at the respective poles in loose combination. The limits of the performance of such cells appear to be fixed by the escape of hydrogen bubbles from the kathode, and by the low conductivity of the film of peroxide of lead formed over the surface of the anode. M. d'Arsonval therefore proposes to obviate the one difficulty by electrolysing a salt of zinc instead of a dilute acid, and the other by increasing the available surface of lead at the anode. For the latter he employs shot heaped about a carbon plate. The liquid is a strong solution of sulphate of zinc. During the charging of the cell, zinc is deposited out of the solution upon the surface of a lead plate, or better, upon a free surface of mercury amalgam, suphuric acid being formed in the solution, which attacks the zinc so soon as the cell is employed to generate a current. Whether this modification is really an improvement upon the form devised by Planté, remains to be seen. An electromotive force of 2·1 volts is claimed for the new cell.

ALBUMIN is employed by M. Regnard in the place of collodion for the purposes of microphotography, and is said to afford perfect freedom from the harshness which appears inseparable from the use of collodion films.

DR. SYDNEY MARSDEN has discovered a substance in which carbon is soluble, and from which it crystallises out partly in graphitoidal, partly in adamantine forms. The adamantine crystals exhibit beautiful octahedral shapes under the microscope, and scratch sapphire readily. There seems every reason, therefore, to regard them as true *diamonds*.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday last, Sir T. Fowell Buxton, after a few explanatory observations, read an account of a visit to the famous Lukuga creek in May, 1879, by Mr. E. C. Hore, of the London Missionary Society's station on Lake Tanganyika. The result of Mr. Hore's trip from Ujiji across the lake is believed to be the vindication of Cameron's theory that the Lukuga creek was the long-sought outlet of Lake Tanganyika. From the Kiyanja ridge Mr. Hore saw the Lukuga, flowing westwards with a rapid stream, on its way to join the Congo, until it became lost to view among the hills of Kwa, Mekito, and Kalumbi's, in Urua. Mr. Hore, it is well to add, was well qualified for the investigation of this matter, being well acquainted with currents, &c., from his former experience when in the service of the Peninsular and Oriental Steam Navigation Company; he is now surveyor and scientific officer attached to the Mission station at Ujiji. Commander Cameron stated to the meeting at some length the history of Lake Tanganyika, from its discovery by Burton, and gave in detail the various theories regarding its outlet. Dr. Emil Holub followed with an address on the Marutse-Mabunda empire in South Central Africa. This empire is of recent formation out of two peoples, the Marutse and the Mabunda, who inhabit the Zambesi region near the confluence of the Chobe with that river, and have their capital at Shesheke. After a few remarks on their geographical position and the neighbouring tribes, Dr. Holub addressed himself to the ethnographical side of his subject, and gave many interesting particulars respecting the people and their manners and customs. Among their peculiarities, as distinguished from other South African tribes, the more noteworthy are a belief in a supreme being and in a life after death, and the respect and consideration in which women are held.

THE arrangements relating to the reception of Prof. Nordenskjöld in France have been somewhat altered. The celebrated explorer having expressed his determination to accomplish personally the *periplus* of the Mediterranean coasts of Europe, he will proceed, *viâ* Gibraltar, to Havre, where he will be received by a deputation from the Paris Geographical Society, and be conducted to Paris, where he will be magnificently treated. The Municipal Council of Paris has subscribed a sum of 200*l*. to the funds. It is certain that he will land at Lisbon, where the Portuguese Geographical Society is preparing a reception. It is said that the Geographical Society of Algiers will send a requisition to Prof. Nordenskjöld asking him to visit their town, and witness their festive installation. He will not be present at the meeting of the Academy of Sciences on March 1. At a large meeting of the Geographical Society of Rome, on Sunday, its gold medal was conferred upon Prof. Nordenskjöld, who was present along with his staff. Speeches were delivered in praise of the enterprise, and Prof. Nordenskjöld replied briefly in French. King Oscar of Sweden has ordered four gold and forty-six silver medals to be struck for the officers and crew of the expedition.

THE Rev. F. Coillard, of the French Basuto Mission, in company with whom it will be remembered Major Serpa Pinto made his journey from the Zambesi to the Bamangwato country and to the Makarikari, has recently delivered a lecture at Capetown, chiefly on missionary topics. He stated that he had sojourned principally among a tribe known as the Banyai in the neighbourhood of the Zambesi. On his journey thither he had passed through a tribe which was divided into small communities, and led a miserable life owing to the oppression of the Matabele. Mr. Coillard also visited the Matabele country, of which he had but a poor account to give; the climate, he says, is most unhealthy, not only for Europeans but even for the natives.

THE new *Bulletin* of the Antwerp Geographical Society contains a paper by Dr. L. Delgeur, entitled "Les Endiguements de la Néerlande: Lutte des Hollandais contre la Mer," and the text of some interesting letters which the International African Association have received from East Central Africa.

THE *Colonies and India* gives a brief description of the magnificent Tequendama Falls near Santa Fé de Bogota, in the Colombian Republic, and draws attention to the fact that it has been visited by but few English travellers.

As supplementing No. 59 of *Petermann's Mittheilungen*, an abstract of an itinerary in Japan, by Dr. Knipping, is published. The itinerary extended from Kioto by Shimonosura to Tokio, and contains much valuable information on the country traversed. It is accompanied by three maps.

No. 8 of *Globus* describes the journey of Rohlfs and Stecker last summer from Battisal, south of Jalo, in Tripoli, to the oasis of Kufra, which lies about half-way between the western frontier of Egypt and the eastern boundary of Fezzan, and has not before been visited by Europeans. The oasis of Kufra lies between 21° and 24° E. and 26° and 24° S., and is happily described in the map which accompanies the paper as an oasis archipelago. It is represented as a series of regions covered with palms, amid a country of hills and sand dunes.

A STRANGE PHENOMENON

THE following letter from R. E. Harris, Commander A. S. N. Co.'s s.s. *Shahjehan*, dated Calcutta, January 19, appears in the *Calcutta Englishman* of January 21:—

"The most remarkable phenomenon that I have ever seen at sea was seen by myself and officers on the 5th instant between Oyster Reef and Pigeon Island (Malabar coast). At 10 P.M. we were steaming along very comfortably; there was a perfect calm, the water was without a ripple upon it, the sky was cloudless, and, there being no moon, the stars shone brightly. The atmosphere was beautifully clear, and the night was one of great quietude. At the above-named hour I went on deck, and at once observed a streak of white matter on the horizon bearing south-south-west. I then went on the bridge and drew the third officer's attention to it. In a few minutes it had assumed the shape of a segment of a circle measuring about 45° in length and several degrees in altitude about its centre. At this time it shone with a peculiar but beautiful milky whiteness, and resembled (only in a huge mass, and greater luminous intensity) the nebulæ sometimes seen in the heavens. We were steaming to the southward, and as the bank of light extended, one of its arms crossed our path. The whole thing appeared so foreign to anything I had ever seen, and so wonderful, that I stopped the ship just on its outskirts, so that I might try to form a true and just conception of what it really was. By this time all the officers and engineers had assembled on deck to witness the scene, and were all equally astonished and interested. Some little time before the first body of light reached the ship I was enabled, with my night glasses, to resolve in a measure what appeared, to the unassisted eye, a huge mass of nebulous matter. I distinctly saw spaces between what again appeared to be waves of light of great lustre. These came rolling on with ever-increasing rapidity till they reached the ship, and in a short time the ship was completely surrounded with one great body of undulating light, which soon extended to the horizon on all sides. On looking into the water it was seen to be studded with patches of faint, luminous, inanimate matter, measuring about two feet in diameter. Although these emitted a certain amount of light, it was most insignificant when compared with the great waves of light that were floating on the surface of the water, and which were at this time converging upon the ship. The waves stood many degrees above the water, like a highly luminous mist, and obscured by their intensity the distant horizon; and as wave succeeded wave in rapid succession, one of the most grand and brilliant, yet solemn, spectacles that one could ever think of was here witnessed. In speaking of waves of light I do not wish to convey the idea that they were mere ripplings, which are sometimes caused by fish passing through a phosphorescent sea, but waves of great length and breadth, or in other words, great bodies of light. If the sea could be converted into a huge mirror and thousands of powerful electric lights were made to throw their rays across it, it would convey no adequate idea of this strange yet grand phenomenon.

"As the waves of light converged upon the ship from all sides they appeared higher than her hull, and looked as if they were about to envelope her, and as they impinged upon her, her sides seemed to collapse and expand.

"Whilst this was going on the ship was perfectly at rest, and the water was like a millpond.

"After about half an hour had elapsed the brilliancy of the light somewhat abated, and there was a great paucity of the faint lustrous patches which I have before referred to, but still the body of light was great, and, if emanating from these patches, was out of all proportion to their number.

"This light I do not think could have been produced without the agency of electro-magnetic currents exercising their exciting influence upon some organic animal or vegetable substance; and one thing I wish to point out is, that whilst the ship was stopped and the light yet some distance away, nothing was discernible in the water, but so soon as the light reached the ship a number of luminous patches presented themselves, and as these were equally as motionless as the ship at the time, it is only natural to assume that they existed, and were actually in our vicinity before the light reached us, only they were not made visible till they became the transmitting media for the electro-magnetic currents. This hypothesis is borne out by the fact that each wave of light in its passage was distinctly seen to pass over them in succession, and as the light gradually became less brilliant, they also became less distinct, and had actually disappeared so soon as the waves of light ceased to exist."

THE NEW HYDROGEN LINES OBSERVED BY PHOTOGRAPHY, THE STAR LINES, AND THE DISSOCIATION OF CALCIUM[1]

IN the month of July, 1879, I published in the Reports of the Royal Berlin Academy of Sciences, some photographs of the spectra of Geissler tubes, filled with rarefied hydrogen. In these photographs are visible, besides the old well-known hydrogen lines, H, α, β, γ, δ, a great many other lines in the violet and ultra-violet at the extreme end, very thin and faint, but of a character very similar to the old well-known hydrogen lines. One of the most intense of these new lines coincided almost exactly with the H line (Fraunhofer) of the sun-spectrum.

I inclined to the idea that these new lines, whose wave-length I published six months ago, were real hydrogen lines, but an objection was made to the effect that the hydrogen employed would not have been quite pure. I will mention here that I got exactly the same lines with hydrogen of different sources.

I have recently repeated my experiments, and filled Geissler tubes with the purest hydrogen, developed by electrolytical decomposition. The photographs of the spectra of these tubes show nearly all the same lines as I have published, and I venture now to declare these new lines to be *real hydrogen* lines, so that this body, besides its four chief lines in the visible spectrum, has certainly five chief lines at least in the ultra-violet part.[1]

The wave-lengths of these new lines, which I have published in the Reports of the Berlin Academy, 1879, p. 590, are as follows:—

3968 bright lines coincident with H (Fraunhofer)
3887 ,,
3834 fainter lines
3795 ,,

The fifth line was not very distinct; its wave length, which I have not published till now, is nearly 3770.

I have received NATURE, which contains an abstract of Huggins's highly interesting paper read before the Royal Society on the photographs of the spectra of stars. Huggins gives a list of the wave-lengths of the dark lines he obtained in the ultra-violet part of the spectra of white stars, and I was much astonished to find that they corresponded almost exactly with my hydrogen lines above mentioned. I put here Huggins's and my own numbers together:—

Huggins's star lines in the ultra-violet wave-length.	My hydrogen lines in the ultra-violet wave-length.
3968	3968
3887·5	3887
3834	3834
3795	3795
3767·5	3770

This conformity is so surprising that I venture the conclusion that the *chief lines of the spectra of white stars are hydrogen lines.*

Lockyer, whose admirable investigations I highly esteem, but with whose conclusions I cannot agree, regards the line 3968 (coincident with the calcium line H, Fraunhofer) in the star spectra as a calcium line, and deduces a dissociation of calcium from the fact that the second calcium line K is not visible in the star spectra. My opinion is that the line 3968 in the white star spectra is *not* a calcium, but a *hydrogen line*, and I base this theory on the fact that the well-known hydrogen lines in these spectra are much more intense and thicker than in the sun spectrum. I may point out that this line is not exactly, but very nearly, coincident with H (Fraunhofer); the first is a little less refrangible.

Lockyer supposes that calcium is also dissociated in the sun's atmosphere. He mentions the observation of Prof. Young, who observed the H seventy-five times and the K line only fifty times in the atmosphere of the sun. My opinion is that the so-called inversed H line, if visible without K in the chromosphere, is not the calcium line, but the fifth hydrogen line.

[1] By Dr. H. W. Vogel, from the *Photographic News* of February 20.

[1] I have only five in my photographs, because I worked with glass prism and lenses, which absorb a good deal of the ultra-violet rays.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In the event—which seems most probable—of the report of the Board of Natural Science Studies being adopted by the Senate, the Natural Sciences Tripos will, in and after 1881, be divided into two parts, each of which will include a practical examination, and will extend over five days. The names of those who have passed the first five days will be alphabetically arranged in three classes, although this part of the examination will be considered to test only the general proficiency of candidates in several branches of science. The subjects will be grouped thus: (1) Chemistry, (2) Physics, (3) Mineralogy, (4) Geology, (5) Botany, (6) Zoology and Comparative Anatomy, (7) Physiology, (8) Human Anatomy and Physiology.

THE Cambridge Botanic Gardens Syndicate have procured plans for a Curator's House and Syndicate Office, to be placed adjoining and overlooking the entrance from Panton Street to the Gardens. Mr. W. M. Fawcett, the architect, estimates its cost at 620*l.*

A REAL compulsory matriculation examination at entrance is absolutely needed, otherwise those who are endeavouring vigorously to bring about improvements will find their life worn out in elementary teaching and examination. If Senior Wranglers can be spared to examine thousands of arithmetic papers and to lecture upon arithmetic in Cambridge year after year, it can be only because they too tamely continue to do it, finding that the Philistine spirit of modern days provides no better pay for them if they preferred higher work. Either this lecturing is superfluous, or their pupils have never been to a good school till eighteen. Why should any student be entered on the books of a university if he does not know at the least the elementary principles of number and of grammar?

A MEMORIAL is being signed in various parts of the country to the Vice-Chancellor of the University of Cambridge, praying that the Senate will grant to properly qualified women the right of admission to the examinations for University Degrees, and to the Degrees conferred according to the results of such examinations.

OXFORD.—The examiners in the Burdett-Coutts Geological Scholarship have elected Mr. H. N. Ridley, B.A., of Exeter College, to the vacant scholarship.

THE following science scholarships have been awarded, after examination in Chemistry, Physics, and Biology:—Mr. T. H. Walker and Mr. J. H. Makinder, from Epsom College, to Natural Science Studentships at Christ Church; *Proxime*, Mr. G. C. Chambres, from Dulwich College; Mr. Alfred Shackleton, from Bradford Grammar School, to a Natural Science Exhibition at New College.

DR. GLADSTONE, finding that several teachers were unable to obtain admission to the lecture delivered by him in the Board Room of the London School Board in October last, on the Apparatus for Illustrating Object Lessons, has consented to repeat the lecture at the following schools on the dates named:—Westmoreland Road, Walworth, S.E. (near Walworth Road Station), on Tuesday, March 2; Saffron Hill, Cross Street, Farringdon Road, E.C. (near Farringdon Street Station), on Tuesday, March 9. Each lecture will commence at 7.30 o'clock. The apparatus recommended and described by Dr. Gladstone are all of the cheapest and commonest kind, such as a clasp-knife, frame-saw, two tin basins, tobacco-pipe, magnifying glass, &c. Such lectures are well adapted to encourage the teaching of science in schools.

THE report drawn up by M. Paul Bert, acting as referee of the Parliamentary Committee of the French Chamber of Deputies on Primary Instruction, has been published as a separate volume, and is selling largely.

THE new law on the organisation of the Superior Council of Education in France has rendered this body a representative one. Not only the several academies, but also the several faculties have been invested with the right of appointing delegates. The Faculties of Sciences have resolved to send delegates to Paris, in order to hear the *profession de foi* of several candidates, and to interrogate them on their opinion on the different topics ventilated by teaching bodies. This example will be shortly followed by other faculties. M. Gerard, Professor of Philosophy to the Faculties of Nancy, having sent a circular summoning the Faculties des Lettres to send a delegate to Paris, their appointed meeting is to take place at Easter, during the usual holidays.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, February 5.—Wm. Carruthers, F.R.S., vice-president, in the chair.—Mr. Chas. Stewart exhibited and explained a stained microscopic section of the ovary of *Hyacinthus orientalis*, showing the intercellular network in the cells of the ovules. The nuclei before dividing increase in size, and there is a well-defined highly refractile fibrous network which becomes aggregated at opposite sides of the nucleus, forming two star-shaped masses connected by fine fibres; the latter rupture when the stellate masses, becoming rounded, form the nuclei of the two new cells.—Dr. Francis Day presented for inspection examples of Salmonidæ, some of which had been reared under natural and others under unnatural conditions. A *Salmo fontinalis* which had passed its existence in the Westminster Aquarium, had the head preternaturally elongated and a very narrow suboperculum, thus in striking contrast to examples reared from the same batch of imported eggs, and kept in a wild state in Cardiganshire.—Mr. R. Irwin Lynch brought under notice pods of *Acacia homalophylla*, wherein each end was attached by a very long and bright red funicle, which doubly folded on the sides of the seed. The funicle is supposed to be always detached with the seed, and from its brilliant colour to serve as an attraction to birds, and so assist in the dissemination of the plant.—Mr. A. Hammond drew attention to a larva of *Tanypus maculatus*. He mentioned that the coronet and appendages of the thoracic and anal regions had been said to be homologous with the respiratory organs of the larva and pupa of gnats, &c. This he doubted, inasmuch as the former originated from the ventral and not from the dorsal surface, as did the latter, and no trachea of any size could be traced in them. He also stated his opinion that the two oval bodies in the thorax attributed by De Geer to the air reservoirs were more probably salivary glands similar to those previously described by himself in the larva of the crane fly.—Mr. C. B. Clarke then gave an oral *résumé* of the order Commelynaceæ, which order he had lately worked out for De Candolle's "Prodromus." He defined the order by the position of the embryo, as not surrounded by the albumen, but closely applied to the embryostega, which is always remote from the hilum. An important auxiliary character is that the three segments of the calyx are always imbricated, so that one is entirely outside the two others. Mr. Clarke divides the Commelynaceæ into three tribes, as follows:—1. *Pollieæ*, fruit indehiscent; (2) *Commelyneæ*, capsule loculicidal, fertile stamens 3–2; (3) *Tradescantieæ*, capsule loculicidal, fertile stamens 6–5. The author remarked on the character of the two ranked seeds on which the genus *Dichospermum* had been founded, but which character is exhibited in species of various genera. He also alluded to the manifest and important change of colour in the petals of several of the Commelynaceæ (*Aneilema versicolor*, to wit), where from a bright yellow when fresh, they become of a deep blue when dry.—The Secretary afterwards read a paper on the Salmonidæ and other fish introduced into New Zealand waters, by H. M. Brewer, of the Wanganui Acclim. Soc., N.Z. The author herein gave data concerning the British salmon (*S. salar*), Californian salmon (*S. quinnat*), trout (*S. fario*), sea trout (*S. trutta*), American charr (*S. fontinalis*), perch (*Perca fluviatilis*), tench (*Tinca vulgaris*), Prussian carp (*Carassius vulgaris*), cat fish (*Pimelodes catus*), white fish (*Coregonus albus*), and lastly a New Zealand fish called by the natives Upukororo.

Physical Society, February 14.—Annual General Meeting, Prof. W. G. Adams, president, in the chair.—The President read the report for the past year, which showed that the position and prospects of the Society are in every way satisfactory, and that more papers were communicated during last year than on any previous year.—The following list of Council and Officers was elected for the ensuing year, and votes of thanks were given to the President, the Lords of the Committee of Council on Education, and to the Treasurer, Demonstrator, and Secretaries. President: Sir W. Thomson, LL.D., F.R.S. Vice-President (who has filled the office of President): Prof. W. G. Adams, M.A., F.R.S. Vice-Presidents: Prof. R. B. Clifton, Dr. Huggins, Lord Rayleigh, Dr. Spottiswoode. Secretaries: Prof. Reinold, and W. Chandler Roberts, F.R.S. Treasurer: Dr. Atkinson. Demonstrator: Prof. Guthrie; and Members of Council: Captain Abney, Walter Bailey, M.A., J. H. Cotterill, F.R.S., Dr. Warren de la Rue, Major Festing, R.E., Prof. G. C. Foster, Prof. Fuller, Dr. J. Hopkinson, Dr. Shuster, G. Johnstone Stoney, F.R.S. Honorary Member: J. E. R. Clausius.—After this business the meeting resolved itself into an ordinary one, and the following New Members were elected:—Senor Roig y Torres, of Barcelona, Mr. Mollison, Mr. Hare, Mr. J. C. Lewis, Miss Caroline Martineau.—A paper on a quartz and Iceland spar spectroscope, corrected for chromatic aberration was then read by Dr. W. H. Stone; the spectroscope consists of two Iceland spar prisms and a quartz train. It differs in no respect from those ordinarily made, except in the fact that the object glasses of the telescope and collimator are doublets with a positive lens of quartz and a negative of Iceland spar. The latter has a dispersive power so far greater than that of quartz that an approximation to achromatism may be easily obtained.

In a spectrum there is less fear of indistinctness from superposition of images than in a telescope, but a greater amount of focussing is required with unachromatic lenses, insomuch that lines in the field at one time need alteration to obtain distinctness. Moreover it is an obvious advantage to transmit the whole of the rays coming from the collimator as nearly as possible parallel through the intra-objective space and the prisms. The object glasses were made by Mr. Ahreas about four years ago, and sent to Prof. Macleod. They were put aside but have been recently re-mounted, owing to Mr. Cornu having recently published a similar device. A paper on an automatic switch for telephone circuits was then read by Dr. Wynne. The object of the switch was to enable any client of a telephone exchange to communicate with any other through the central office without the need of an assistant at the office. Mr. Varley and Prof. Ayrton criticised the device and the latter thought that the contacts might not be always reliable. Profs. Ayrton and Perry then read a note on their theory of terrestrial magnetism. Prof. Rowland of Baltimore had pointed out an error in their calculation which vitiated their results, and they therefore admitted that the charge statical electricity on the surface of the earth, assumed by them as competent to account for the earth's magnetism, was not sufficient to account for the whole but only a portion of that magnetism. Nevertheless they thought that the changes in the distribution of such a charge due to changes in the condition of the dielectric medium between the earth and the sun, might account for the observed perturbations in the magnetic elements.

Statistical Society, February 17.—Sir Rawson W. Rawson, C.B., in the chair.—The business of the evening was the reading and discussion of a paper by Mr. Thomas A. Welton, on certain changes in the English rates of mortality.

GÖTTINGEN

Royal Academy of Sciences, January 10.—The following among other papers were read:—On some Indo-Germanic, especially Latin and Greek, numerals, by Herr Benfey.—Remarks on some Thracian and Mæsian coins, by Herr Wieseler.—The chronology of Julius Africanus, by Herr Trieber.—Report on the polyclinic for ear diseases, by Dr. Bürkner.

PARIS

Academy of Sciences, February 16.—M. Edm. Becquerel in the chair.—The following papers were read:—Meridian observations of small planets at the Greenwich and Paris observatories during the fourth quarter of 1879, communicated by M. Mouchez.—Determination of the difference of longitude between Paris and Bregenz, by MM. Lœwy and Oppolzer. The difference between Paris Observatory and the station of Pfender on a mountain near Bregenz (which is about the most western point of Austria) was found 0h. 29m. 45·14s. (By Pfender Austria was already connected with Germany, Italy, and Switzerland.) The operations are described.—Studies on persulphuric acid; its formation by electrolysis, by M. Berthelot. He has got liquors containing 123 gr. of the acid (S_2O_7), but this could not be exceeded or easily maintained, the rate of spontaneous decomposition becoming equal to that of formation. The liquor also contained 375 gr. sulphuric acid, and 850 gr. water. For these results, dilute sulphuric acid ($SO_4H + 10\,HO$, *e.g.*) is electrolysed in a porous vessel surrounded by a concentric vessel holding the same liquid. The liquids are cooled by water flowing in interior serpentines. The electrodes are large platinum wires projecting 2 or 3 ctm. from glass tubes, and six or nine Bunsens are used. (The electrolytic pheuomena are studied). Persulphuric acid left to itself is destroyed gradually and wholly. Agitation, or rise of temperature, promotes decomposition; also diminished dilution.—Note on new derivatives of nicotine, by MM. Cahours and Etard. An isomer of *dipyridine* (*isodipyridine*) is obtained by a certain treatment of *thiotetrapyridine*.—Evolution of inflorescence in the *Gramineæ* (3rd part); order of appearance of the first vessels in *Phleum*, *Cynosurus*, *Poa*, by M. Trécul.—On the divisions of cyclotomic functions, by Prof. Sylvester.—Equations of the small oscillations of an inextensible wire in motion in space, by M. Léauté.—On the linear differential equations with doubly periodic coefficients, by M. Picard.—On the same, by M. Mittag-Leffler.—On the hypergeometric series of two variables and on linear differential equations with partial derivatives, by M. Appell.—On Legendre's law of reciprocity extended to numbers not prime, by M. Genocchi.—On the impossibility of the algebraic relation $X^n + Y^n + Z^n = 0$, by M. Korkine.—On the approximation of circular functions by means of algebraic functions, by M. Laguerre.—On new fringes of interference, by M. Gouy. A collimator, with slit horizontal, and a telescope, are placed in line, and between them a glass trough containing half water, half saline solution, diffusion having been allowed a few minutes. Light being transmitted, a series of fringes appears in the telescope, owing to variation in the index of refraction through diffusion, causing the plane wave to be no longer plane after traversing the trough. M. Gouy proposes to study the progress of diffusion by means of these effects.—On the density of some gases at a high temperature, by M. Crafts. He describes some results with his improved apparatus, having experimented with ammonia, carbonic acid, hydrogen, hydrochloric acid, &c. For the last named a normal density was obtained at the highest temperature of the furnace.—Action of water on fluoride of silicium and fluoride of boron; dissolution of cyanogen in water, by M. Hammerl. Numerical results for the heat liberated are given.—Reproduction of amphigene, by M. Hautefeuille. Vanadate of potash which (as formerly indicated) may replace alkaline tungstates and phosphates in preparation of felspars, furnishes crystals having the form and composition of amphigene whenever the mixture of silica and alumina treated contains a large proportion of alumina. The density of artificial amphigene is 2·47 at 13°, that of amphigene 2·48 (Damour).—On the martite of Brazil, by M. Gorceix. By the hypothesis of alteration of pyrites he explains certain facts of pseudomorphism and filling up, observed in certain metamorphic rocks of the province of Minas; also the disappearance of iron pyrites in auriferous itabirites, where gold has for gangues ordinary or arsenical pyrites.—Experimental researches on the phosphorescence of Lampyris, by M. Jousset de Bellesme. He removed the cephalic ganglions, to abolish all spontaneous phosphorescence, then stimulated electrically. He could always thus produce phosphorescence if oxygen was present. He shows reason for thinking that the phenomenon is a chemical one, but produced in Lampyris only under biological conditions. It is of the same order as muscular contraction, or liberation of electricity by the torpedo, which are doubtless due to chemical combinations effected in protoplasmic matter. The phosphorescent substance is probably gaseous, and phosphoretted hydrogen. The author is led to regard phosphorescence as a general property of protoplasm, consisting in liberation of the gas just named.—Researches on the action of salicylic acid on the respiration, by M. Livon. First retardation, then acceleration, then retardation and stoppage.—The temperature of frozen lakes, by M. Forel. The depths reached by Mr. Buchanan (NATURE, vol. xix. p. 421) were not sufficient to cover the limit of surface cooling, which may descend to 110 m. (Lake of Zurich). The penetration of cold is very gradual and progressive. A layer of ice on Lake Morat was found absolutely to stop the cooling, and the water, under ice forty days, underwent an equalisation of temperature, far, however, from complete uniformity.—Torrential deltas, by M. Desor. These deltas will have to be distinguished more than has hitherto been done from the deltas of great rivers.

CONTENTS

THURSDAY, MARCH 4, 1880

THE MEDUSÆ

Das System der Medusen; erster Theil einer Monographie der Medusen. Von Dr. Ernst Haeckel, Professor an der Universität Jena. (Jena: Gustav Fischer, 1879.)

THIS is one of the most beautiful books which the science of zoology, which is rich in beautiful books, can boast of. The Medusæ are the most graceful, delicate, exquisitely formed and withal the most rare and inaccessible of living things. No inlander has any notion of what these tender, translucent beings can show in the way of colour, symmetry, and rhythmic movement. They cannot be carried to distant aquaria—but live only in the clearest, brightest parts of the sea at some distance from the coast. No system of pickling fluids is known which can keep them for us undistorted. To study them, even to see them at all as they are, the naturalist must betake himself to the coast and in calm weather sweep the surface of the sea with his towing-net, much as the insect-man sweeps the hedge-rows. Many and some very lovely forms occur on our own coast—but our capricious climate renders it always uncertain when or where any of the Medusæ may be found, sensitive as they are to every change in the movement of the waters, and sinking far out of reach in certain states of weather. The Mediterranean, with its more genial atmosphere and sheltered bays, has always furnished naturalists with the richest supply of pelagic animals, whilst even the mid-ocean is more favourable as a hunting-ground for them than our ever-restless Channel and North Sea.

The term Medusa dates from the time of Linnæus. Peron and Lesueur and after them Eschscholtz were the first naturalists who devoted monographs to the Medusæ, and valuable as was their work it contained descriptions of only some dozen genera and species (1829). After a long interval (1848) Edward Forbes, who was attracted by the symmetrical forms and delicate contours of these animals as he was by the more rigid and less beautiful starfishes, published his monograph of the naked-eyed Medusæ (Ray Society). After him we have, amongst others, the valuable anatomical investigations of Gegenbaur (*Zeitschr. für wiss. Zoologie*, 1857), and the important treatises of the two Agassizs, father and son (Louis Agassiz, "Contributions to the Nat. Hist. of the United States," 1857-62; Alex. Agassiz, "Catalogue of Acalephæ," 1865). Still later we have the magnificent volumes of another artist-naturalist—Prof. Allman—who shows in every line of his pencil how keenly he appreciates the grace and elegance of the hydroid polyps and their medusa-offspring, to which his two large volumes are devoted (Ray Society, 1871). Allman's treatise more especially aims at giving an account of the naked hydriform polyps and the medusæ which are produced like fruit upon their branches, separating and swimming away in many instances as free independent creatures, though sometimes aborted and fixed as sporosacs. Ernst Haeckel, on the other hand, has not proposed to himself to trace the individual life-history of the Medusæ. He takes them as he finds them, and whilst giving us in this first part alone twenty quarto plates of drawings mostly from the life, exposes their agreements and variations of structure in the most masterly, exhaustive, and logically conceived treatise which it has been our lot to encounter in zoological literature. The symmetry and precision which Haeckel is able to exhibit in his systematic discussion of the Medusæ is no doubt in large degree attributable to the isolated and strongly marked character of the natural group which they form; it is however also in no small measure due to the exhaustive knowledge of their structure which his own researches spread over some twenty years, and more recently those of his pupils, the brothers Hertwig have brought together.

There are very few if any groups of animals so extensive in distinguishable variety of form, the detailed anatomy of which is so well known as is now that of the Medusæ. Hence the thoroughly satisfactory character of the systematic classification of them which is possible.

Unfortunately the life-history of a large number of Medusæ is not so well known, and probably for a long time will not be known. It is a fact familiar to even the least profound student of zoology, that whilst some medusæ are produced by budding from colonies of hydriform polyps and give rise by their eggs to such hydriform colonies which again produce these sexual medusa-forms by budding, yet other medusæ develop directly from the egg of a parent medusa into young medusæ without ever having anything to do with hydriform colonies or "persons." This interposition of a hydriform stage and an act of fissiparous generation appears to have little if any relation to the varieties of structure presented by medusæ. Medusæ closely allied may some have hydriform young and others not. On the other hand the hydriform polyps exhibit the same kind of irregularity in their proceedings, some species producing the neatest of medusæ which swim away to carry their seed far and wide, whilst closely similar species produce not free-swimming elegant medusæ but aborted wart-like knobs (sporosacs), evidently the degenerate representatives of medusæ; and these, without being detached, develop the eggs and the sperm from which a new generation of hydra-forms will spring.

Clearly, then, there was room for a treatise on the Medusæ which should, without waiting for the long process of growth of knowledge, ignore the hydriform phase, just as the admirable monograph of Allman treats of the hydra-forms (of a limited group) without touching those medusæ not yet traced to hydriform parentage.

It appears that in certain large outlines a classification is possible which shall hit off simultaneously the relationships of both medusa-forms and their respective hydra-forms. But that this should extend into the details of small groups, such as families and genera, is not to be expected. Beyond a certain limit the Medusæ and their parentally related hydra-forms *do not vary concomitantly*

A systematic and exhaustive treatise on Medusæ, as such, was then, we would insist, a great want. No one but the most energetic and industrious of men endowed with the greatest skill as a draughtsman and devoting himself for years to work on such coasts as those of the North Sea, Bay of Biscay, Adriatic, Mediterranean, and Red Sea, such a man as we have in Prof. Ernst Haeckel, could have produced the desired treatise. Besides living specimens, Haeckel has studied those received in alcohol from all parts of the world, including some collected by the *Challenger*.

We could wish some of our readers who may know Ernst Haeckel only as the populariser of Darwinism and the opponent of Virchow's proposal to establish a scientific popery, to go through the work which he has just produced. Much as we value Haeckel's speculations and his championship of free science, we are ready to admit that in such work as the present he is seen at his best. Speculation and polemics are here far out of sight indeed —the work is of the most solid and genuine character. Page after page is devoted to the systematising and exposition of an immense mass of facts—facts as hard and stubborn as any anti-theorist could wish—yet to a large extent new or little considered hitherto, and at the same time as beautiful and fascinating as any region of nature to which the naturalist can turn his attention.

A medusa may be compared in form to an umbrella, a mushroom, or a clapper-bell. This does not suggest the most beautiful set of objects; it is, however, our own fault if we do not finish off our umbrellas and bells with the same elegance which characterises the medusa. The handle of the umbrella, stalk of the mushroom, or clapper of the bell is sometimes quite short and broad, sometimes very long, reaching far away beyond the disk, dome, or bell from which it hangs. It is known as the manubrium, whilst the expanded disk is called the umbrella. The manubrium is hollow and leads up into a wide cavity in the disk, which originally extended right up to its margin, but by the concrescence of its walls is reduced to four or more radiating pouches or canals and a marginal circular canal. The edge of the disk has longer or shorter hollow tentacles (rarely solid) depending from it, and these vary to any extent in the different kinds of medusæ as to their number (from one to some hundreds) and length. The shape of the umbrella is either flat or more or less elevated until it may be quite like an oriental bell or even globular. Besides tentacles we may find on the margin of the disk three kinds of sense-organs, simple eye-spots, simple auditory sacs, or lastly, what I have elsewhere termed "tentaculocysts," modified tentacles which act as auditory organs and have often eye-spots on them as well.

The generative organs (spermaries and ovaries) are usually in separate individuals, and are placed either in the walls of the manubrium or in the walls of the radiating canals or pouches of the disk. All the parts of the disk and manubrium are arranged as radii around a common axis. The first four radii to appear in the course of the growth from a simpler phase of development are called the per-radii, the next four (between these) the inter-radii, the next eight between these the adradii. An organ (lobe, tentacle, canal, or sense-organ) may be therefore per-radial, inter-radial, or adradial in position. The whole of this symmetrically arranged structure is usually of glass-like appearance, yet with some exceptions quite soft and gelatinous. Often the canals, eyes, and generative bodies are picked out with brilliant colour, red or orange, or of a more delicate pink or blue.

The large variety of medusæ now known, amounting to many hundred species, are divided primarily into two great groups, the Hydromedusæ and the Scyphomedusæ. Prof. Haeckel uses Gegenbaur's terms for these, viz., Craspedotæ and Acraspedæ. Eschscholtz and Forbes had long ago sought for characters by which to define these two large groups. The Hydromedusæ never as medusæ nor in their hydriform phase possess gastral filaments or phacellæ, they always (?) develop their generative organs from the superficial cell-layer known as ectoderm, as shown by Haeckel's pupils, the Hertwigs, and at the margin of the umbrella they always present a delicate in-turned rim, the velum, which is muscular and not penetrated by canals. Further, whenever they do not develop directly from the egg of a parent medusa but pass through a hydriform phase—the polyps are of the shape and character known as hydroids or hydræ. On the other hand the Scyphomedusæ always possess gastral filaments or phacellæ, which are tufts of tentacle-like processes placed in four groups inter-radially on the oral floor of the stomach, where it widens out in the umbrella; they always develop their generative organs from the deep cell-layer known as endoderm, and they never have at the margin of the umbrella a true velum, though one (Charybdæa) has a membranous inturned rim which is very like the velum of Hydromedusæ but penetrated by vessels (as shown by Claus). Further the sense-organs of Scyphomedusæ are always tentaculocysts (though these occur also in one group of the Hydromedusæ), and whenever the hydriform phase is exhibited in development from the egg, the polyp is not a "hydra" but a "scyphistoma," with broad disk-like body, and gives rise to medusæ *not* by budding (as in Hydromedusæ) but by transverse fission.

The Scyphomedusæ (Acraspedæ of Gegenbaur) are deferred by Prof. Haeckel for another volume; they comprise the large jelly-fish Aurelia, Rhizostoma, Cyanæa, and such forms, as also the very beautiful and interesting Charybdæa, and the Lucernariæ, these last being forms which combine the characters of polyp and jelly-fish, for they can both fix themselves by a foot-like process of the aboral pole of the umbrella, or loosen their hold and swim the other way up as a medusa. Though medusæ usually swim mouth downwards, yet it is quite common for them to swim sideways or to float mouth uppermost or even to rest on the sea-bottom in that position.

It is to the "Legion" Hydromedusæ that Prof. Haeckel's first volume and twenty plates are devoted. He divides them into two sub-legions—the Leptolinæ and the Trachylinæ—in each of which are two orders parallel to one another. The Leptolinæ are Hydromedusæ, with soft and mobile, originally hollow tentacles; with ECTOdermal otolith cells, usually budded from a hydriform colony. The Trachylinæ have hard and stiff, originally solid tentacles with ENDOdermal otolith cells (belonging to tentaculocysts), and, as far as is known, develop direct from the egg. The Leptolinæ contain the orders Anthomedusæ and Leptomedusæ; the Trachylinæ contain the orders Trachomedusæ and Narcomedusæ. One order from each sub-legion, the Anthomedusæ and the Narcomedusæ, is characterised by having its generative organs placed in the wall of the manubrium; whilst the other order in each sub-legion is characterised by having these organs placed in the course of the radiating canals.

The ANTHOMEDUSÆ are further characterised by never having otocysts or auditory organs at all, but always marginal eye-spots. Their tentacles may be simple, neither forked nor branched when they fall into one of the three families—Codonidæ, Tiaridæ, or Margelidæ. If the tentacles are branched or forked they belong to the family Cladonemidæ. These medusæ all are borne as buds upon hydroid polyps of Allman's sub-class Gymnoblastea, sometimes called the Tubularinæ. Fifty genera of Anthomedusæ with one hundred and twenty species are described, and many are beautifully figured in the plates of Haeckel's work.

The LEPTOMEDUSÆ are characterised in addition to the points above noted by very often possessing marginal otocysts or auditory vesicles. Those which have none have eye-spots instead and belong to the families Thaumantiadæ and Cannotidæ; whilst those with otocysts usually have no eye-spots, often have more than one hundred tentacles, and belong to the families Eucopidæ and Æquoridæ. Whenever the life-history of the Leptomedusæ has been traced they have been found to be budded off from those hydriform colonies known as the Calyptoblasteæ or Campanularinæ; but many have never been traced (Æquoridæ) and perhaps develop direct from the egg. Sixty-one genera and one hundred and forty species of Leptomedusæ are described by Haeckel.

Of the two Trachyline orders the TRACHOMEDUSÆ, with canal-genitals, vary according as the stomach is elongated, tubular, and devoid of a solid stalk (Petasidæ and Trachynemidæ), or short, bell-shaped, and placed on the end of a freely hanging solid stalk (Aglauridæ and Geryonidæ). Thirty-six genera and sixty species of Trachomedusæ are described and many new ones figured. It is to the genus Carmarina of this group and Cunina of the next that Haeckel seventeen years ago devoted most careful study, making known then in a most admirable monograph (*Jenaische Zeitschrift*, vols. i. and ii.) the excessively elaborate structure of these forms, far exceeding in histological differentiation and complex adaptation of structure to function anything known in the other Hydromedusæ. Here long since Haeckel had described a highly complex nervous system and sense-organs which recent investigations have confirmed and extended to other groups.

All the details of this work are fully summarised in the most systematic way in the present volume. Under the heading "Order—Trachomedusæ" we have, as in the case of each previous order, a systematic survey of the various organs, their histology, and external form; again, under each family a similar survey, narrower in scope and minuter in detail is given and finally each genus and species in turn has its special features not already included in what has been said of the family, fully exposed.

The second order of Trachylinæ, the Narcomedusæ, with gastral-genitalia, have, in addition to the characters noted in the paragraph above, their auditory tentaculocysts provided with otoporpæ or rivets, which fix them into the jelly-like substance of the umbrella, and which are similar in origin and character to the curious peroniæ by which the tentacle-roots plunged as it were into the sides of the umbrella-jelly (not therefore placed at its margin) are connected with the hard marginal ring of the umbrella. The Cunanthidæ and Peganthidæ are the families which possess otoporpæ, whilst the Æginidæ and Solmaridæ, though possessing peroniæ, have no otoporpæ. Twenty-three genera and seventy-five species of Narcomedusæ are described, and several figured.

We thus have no less than four hundred species of Hydromedusæ described by Prof. Haeckel, but he is careful to point out with reiterated emphasis in reference to each order, that since the Medusæ described are known in the course of their individual growth and development to alter their characters very much—such as number and position of tentacles, of radiating canals, and of sense-organs—and since at the same time it is known (just as in the vertebrate Amblystoma) that these Medusæ may and often do become sexually ripe before they have completed their changes, in fact whilst they are still very far from full growth or elaboration (pædogenesis)—it is not obvious what we are to consider a "bona species" among medusæ. What, again and again, asks Haeckel, is the criterion of a good species among Anthomedusæ, among Leptomedusæ, among Narcomedusæ, among Trachomedusæ? The inference is that there is no criterion, there are no such things as "good species." We must be content with form-species; which, in fact, is all that we, as a rule, can get at or know anything about, even in other animal groups.

It need hardly be said that this splendid book is one which every zoologist must study and enjoy.

E. RAY LANKESTER

LIGHTNING CONDUCTORS

Lightning-Conductors; their History, Nature, and Mode of Application. By Richard Anderson, F.C.S., F.G.S., M.Soc.T.E. (London: E. and F. N. Spon, 1879).

MR. ANDERSON deserves the thanks not only of the scientific world but of the public at large for the very excellent and readable volume which he has produced upon the subject of lightning-conductors. There are few persons who can lay claim to the amount of practical experience which Mr. Anderson brings to bear upon the subject, and still fewer who add to practical experience an extensive and accurate knowledge of all that has been done and written upon the subject on the Continent, in America, and in this country.

The earlier chapters of the author's work are almost purely historical; and, beginning with the days when von Guericke first produced sparks and flashes from his rude globe of sulphur, and when Hauksbee and Gray speculated on the analogies between the crackling sparks and the grander phenomena of thunder and lightning, the reader is made acquainted with the various stages of experimental discovery down to the time of Franklin. From Franklin's letters the author quotes the following memorable and characteristic extract, giving in his own words the reasons which suggested to him the experiment which rendered him famous:—

"Electrical fluid agrees with lightning in these particulars:—

"1. Giving light.
"2. The colour of the light.
"3. In the crooked direction of the flame.
"4. In the swift motion.
"5. In being conducted by metals.
"6. In the crack, or noise, of the explosion.
"7. The subsisting in water, or ice.
"8. In the rending of bodies it passes through.
"9. In destroying animals.

"10. In melting metals.

"11. In firing inflammable substances.

"12. The sulphurous smell. The electric fluid is attracted by points, and we do not know whether this property is in lightning. But since they agree in all the particulars wherein we can already compare them, is it not probable that they agree likewise in this? Let the experiment be made."

The early experiments with lightning-rods, and their gradual spread in Europe, are detailed in the succeeding chapters, with a variety of information of various kinds extremely interesting to the general reader, and dealing with such topics as the priestly opposition to the "heretical rods," the childish jealousy of the Abbé Nollet, and the dispute whether the rods should be furnished with points or balls at their summit. Sir W. Snow Harris's labours are treated of in a chapter by themselves, and another is devoted to full descriptions of the systems of lightning-protectors adopted in the Hôtel de Ville, Brussels, and in the Houses of Parliament—both complete in their way. A chapter on weather-cocks and the methods devised for making them do duty also as lightning-conductors, gives practical information on points which we do not recollect having met with elsewhere. The concluding sections deal with Newall's system of protecting buildings, with accidents from lightning—a black catalogue—and the book ends with two suggestively practical chapters on the earth connection and on inspection of lightning-conductors. Apart from mere literary merits, these two chapters constitute the strong point of the work. At great pains Mr. Anderson points out how a good earth connection is the alpha and omega of protection from lightning. He shows how the pretentious *paratonnerres* which adorn with their immense proportions so many thousands of buildings in France, often fail for want of thorough continuity to "earth;" and, after citing case upon case, declares as the result of his experience that "probably in nine cases out of ten, whenever a building provided with a conductor is struck by lightning, it is for want of 'good earth.'" He quotes Franklin's advice drawn up for the Royal Society in 1772, on the occasion of the Government providing protection for the great powder-magazines at Purfleet, that "at each end of each magazine a well should be dug, in or through the chalk, so deep as to have in it at least four feet of standing water," in which to terminate the conductors. Mr. Anderson prominently advises the utilisation of the systems of gas and water-pipes to this end in all buildings which stand upon a dry soil.

Very strongly, but not too strongly, does the author dwell on the importance of connecting to the main conductor all large masses of metal about a house, all lead roofs and gutters, all metallic ridge-tiles and roof-ornaments, and all water-spouts. In the absence of these he would even carry conductors over all the prominent edges of buildings. The foolish system of insulating the lightning-conductor from the building by glass or porcelain holders, he unsparingly condemns. With his remarks on the importance of periodic inspection of lightning-conductors to test by galvanometer and battery the actual efficiency of the rod, and, above all, its earth connection, we cordially agree. There can be no doubt that a bad conductor is far worse than no conductor at all; and that the inmates of many "protected" houses dwell—so far as their fancied security from lightning is concerned—in a fool's paradise.

The author describes a simple and portable form of apparatus specially adapted for testing the efficiency of lightning-conductors. It consists of three cells of a modified Leclanché battery of small internal resistance, a tangent galvanometer, and five keys for throwing at pleasure three different resistances into the circuit and comparing them with the resistance of the conductor.

While making no show of a knowledge of electrical theory, the author's language and arguments seldom clash with modern ideas as to the nature and laws of electricity. Nevertheless, in a work of this kind we should have been glad to find a little more direct reference to the scientific and theoretical aspects of the subject. We hardly think that the explanation given on p. 70 of the "return stroke" would be found adequate by one who met with the subject for the first time in these pages. The definitions of units given on p. 59 are unfortunately incorrect. The connection between the normal and abnormal electric conditions of the air is barely touched; indeed, the only reference to the subject of "atmospheric electricity" we have found in the text is to the rather antiquated views of Peltier. The researches of Sir W. Thomson, Dr. Everett, and others on this subject are not even alluded to. We regret that the author speaks somewhat disparagingly of the valuable little "note" on the protection of buildings, published a few years ago by Prof. Clerk Maxwell, and we think the author has not quite apprehended it, in the matter of the earth connection, in the sense intended by its late lamented writer.

The work contains also a list of books relating to the lightning-conductor, a list of all the important observations of accidents by lightning, and an excellent and singularly complete bibliography of the whole subject. The illustrations are numerous and good, and are free from the objectionable sensational character which writers on this and kindred topics sometimes tolerate. S. P. T.

OUR BOOK SHELF

Medicinal Plants; being Descriptions, with Original Figures, of the Principal Plants employed in Medicine, and an Account of their Properties and Uses. By Robert Bentley and Henry Trimen. 4 vols. (London: J. and A. Churchill, 1880.)

It is not often that a reviewer can rise from a critical examination of a *livre de luxe* with such an unmixed feeling of satisfaction as in the case of these handsome volumes. At the close of their four years' labours the authors have succeeded in maintaining the high standard which they set before them at the outset. We do not mean that the level is absolutely uniform throughout. Admirable as the coloured plates—nearly all of them new—are on the whole, there are some few which fail in giving a perfectly satisfactory representation of the plant depicted. The letter-press descriptions also vary, in quantity if not in quality, for which the authors account "from the varying interest taken in substances at different times, some new remedies exciting much attention, and thus demanding a full description, though not, perhaps, of great permanent value." But when we recollect that the number of species described and depicted is 306, including every medicinal plant recognised by the official pharmacopœias of Britain, India, and the United States, with a few others in addition, small inequalities of this kind are to be expected rather than severely commented on; especially considering the imperfect material which the authors had in some cases at their command, and the doubt which still hangs over the origin and preparation of some drugs familiar to pharmaceutists in this country. Only in a few instances is the species depicted for the first time; but in all other cases it has been, where possible, drawn afresh either from a living plant or from a dried specimen in the herbarium of the British Museum. No botanist's or pharmaceutist's library will be complete without this work, which will long be the standard book of reference on all subjects connected with the origin, preparation, and uses of the products of medicinal plants.

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.*]

Novel Source of Frictional Electricity

I WISH to put on record the fact which I communicated to the Physical Society last week, that the motion of a chalk cylinder under a metallic surface generates an electric current having an E. M. F. of rather over one-third of a volt.[1] The strength of the current depends on the rate of rotation and the pressure on the surface of the chalk; the latter simply diminishes the internal resistance, which is of course very high. The discovery is due to a suggestion made to me so long ago as last November, by Prof. Silvanus Thompson, who wished me to try whether the motograph receiver of the Edison telephone could be used as a transmitter. I was unsuccessful at the time, but under favourable circumstances I find the voice is faintly but accurately transmitted on speaking into the receiver, so long as the chalk is made to rotate.

W. F. BARRETT

Royal College of Science, Dublin, March 1

[1] The chalk had been impregnated some months before with a solution of phosphate of soda, but when used was practically dry, and had a hard, smooth surface, almost like polished marble.

Carnivorous Wasps

IN NATURE, vol. xxi. p. 308, there is a statement as to an exceptional case of carnivorous habits in honey-bees, which I can believe all the more easily, as I know that bees, apparently from a lack of their usual food, occasionally attack plums and other fruits, of which in ordinary seasons they take no notice.

Several years ago, when grouse-shooting in the county of Sutherland, I observed a wasp (a rare insect in those parts) struggling with something on the ground, and found that it was in the act of devouring a caterpillar, which was still alive, but considerably mangled by the mandibles of the wasp. In Sutherland this species of smooth, green caterpillar is abundant, and is a favourite food of the black game, whose crops are sometimes full of it.

Is it not unusual for the common wasp to eat living creatures of any sort?

To all of our party the thing appeared extraordinary, and I thought of writing to NATURE at the time, but omitted doing so until reminded of the occurrence by reading about bees devouring moths.

DAVID WEDDERBURN

March 2

Stags' Horns

MISS BIRD sends me, in answer to my inquiry, the following additional information as to the cast stags' horns found in the high valleys of the Rocky Mountains:—

"There are several small valleys opening from Estes Park, Colorado, which were resorted to by elks for the purpose of shedding their horns. In one of these, at the time of my visit in 1873, they lay quite thick. Some were quite recent, and others were bleached with age. I have not myself seen any but elk horns, but hunters told me that the spotted deer resorted to a valley near Long's Peak to shed their horns. I also came upon a large number of elk horns in a valley near Tarryall Creek, South Park, Colorado.

"Near Estes Park some of the horns were so recent and in such good order, that I hoped to procure some to take home; but on examining even the most recent closely, I found that they were all more or less injured by abrasion against some hard substance, as I thought. Two hunters, named Comstock and Nugent, told me that with good glasses, from certain points which they named, they had seen the elk violently rubbing their heads against the rocks, with the view, as they supposed, of ridding themselves of their horns. I am sorry that I cannot contribute more accurate observations on the subject."

B. W. S.

PIERRE ANTOINE FAVRE

WE are called upon to chronicle the death, at Marseilles, on February 17, of Prof. Pierre Antoine Favre, whose name is so intimately connected with the history of thermo-chemistry. Born at Lyons, February 20, 1813, he entered upon a career of scientific study at Paris, devoting himself especially to chemistry, under the direction of Peligot. After completing the usual course of study, he accepted a position in the laboratory of Prof. Audral, under whose guidance, as well as under that of Dr. Jecker, he made a series of researches in physiological chemistry. Returning to his former teacher, Prof. Peligot, at the Conservatoire des Arts et Métiers, in the capacity of assistant, he speedily created a reputation by his investigations in thermo-chemistry, and was appointed Assistant Professor of Chemistry in the Medical Faculty of Paris. After filling this position for nine years, Favre was appointed to the Chair of Chemistry in the Scientific and Medical Faculties of Marseilles. Here his marked abilities caused his election as Dean of the Scientific Faculty. Failing health forced him to give up the active duties of his professorship in 1878.

Favre's first research (1843) was on the atomic weight of zinc, and had in view the ascertaining of its being a whole multiple of that of hydrogen. Following this (1844) came an extensive research on mannite, yielding a number of new and important reactions. The most noteworthy of his investigations in physiological chemistry were those on the blood of persons suffering from scorbutic complaints (1847), in which he signalled an increase of fibrine and a decrease of the number of corpuscles and on the composition and properties of the perspiration of the human body (1852). For this latter purpose he succeeded in collecting no less than 40 litres of perspiration, a quantity which allowed him to discover the hydrotinic acid peculiar to this liquid, as well as to show the predominating presence of NaCl among its soluble constituents. Favre's only contribution to technical chemistry was his proposal in 1856 to decompose the refuse sulphides of the soda works by hydrochloric acid, and conduct the sulphuretted hydrogen liberated to the pyrite furnaces or into solution of sulphurous acid.

Apart from the above-mentioned researches, his career as an investigator—extending over a period of nearly thirty years—was devoted almost exclusively to solving the problems of thermo-chemistry, devising necessary apparatus of the most exact precision, gathering an enormous mass of experimental data, correcting and comparing the results of other workers, and elaborating the entire structure of this important branch of chemical physics. For the first six years J. T. Silbermann, like himself at the time assistant in the Conservatoire des Arts et Métiers, was associated with him in the investigations. The first requisite for the correct determination of thermic equivalents was a series of calorimeters of the utmost exactitude, and this want was met by the construction of the two well-known pieces of apparatus bearing the names of the two chemists. The first, intended for the determination of the heat given off by reactions between solids and liquids, consists of a large mercurial thermometer with a reservoir of iron or glass inclosed by a non-conducting material. In the sides of the reservoir tubes of glass or platinum are introduced, extending deep into the mass of mercury. In these tubes the reactions between weighed amounts of various substances take place, and the heat given off to the surrounding mass of mercury causes a corresponding rise in the thermometer tube. The second apparatus devised for measuring the heat ensuing from the combustion of gases, is much more complicated, being modelled after Dulong's classical calorimeter, but altered in a variety of ways so as to ensure the utmost accuracy in the results. It is to these instruments, or modifications of the same, that we owe a large proportion of the data serving as a basis for our present knowledge of thermo-chemistry. Among the long series of observations carried out by their means, the most important were the series of experiments on combustions in oxygen gas; on the action of gases on each other, and on liquid or solid bodies; on the influence of dimorphism on the heat evolved by combustion, as in the case of red and vitreous phosphorus, where there is a difference of 16 per cent. in the number of units of heat resulting from oxidation; on the influence of polymerism, in which it was shown that the amount of heat evolved decreases with the increase of density in the vapour resulting from combination with oxygen; on the property of metameric bodies to yield different degrees of heat; on the relative diminution in the heat evolved by the combustion of a compound body, compared with that due to the combustion of its various constituents; on the combination of bases with acids, in which it was shown that the amount of heat evolved by the union of equivalent quantities of different acids with a given base is nearly always the same; on the heat evolved by metallic precipitations; on the heat developed by the solution of salts and gases; on the heat evolved by the absorption of gases in porous bodies, especially in connection with the condensation of hydrogen by means of palladium or platinum; on the phenomena of heat resulting from the mixture of liquids; on the development of heat in connection with the compression of liquids; on the specific and latent heat of a number of bodies; on the heat developed by the electrolysis of various compounds, and on the development of heat in electric conductors, and in electric action generally. Closely allied to some of the above researches were studies on the changes in volume consequent upon solution; on the dissociation of crystals; on the chemical effect of light; on electrolysis; and on the influence of pressure on solubility, in which connection he ascertained that the solubility of certain salts was increased when submitted to a pressure of from thirty to sixty atmospheres. Of the labour attendant upon the observation and recording of so extensive a series of experiments, it is difficult to form an adequate idea. As a monument of the patient, painstaking, conscientious collation of valuable physical constants, they rank among the achievements of modern physical chemistry, while too much praise cannot be accorded to the address and ingenuity with which the mechanical difficulties of so wide and varied a range of experiment were successfully met and overcome.

The results obtained by Favre alone or in connection with Silbermann, united with those due to the classical contemporaneous researches of Andrews, form practically the basis of modern thermochemistry, the introduction of their methods of exact measurement having much the same influence as Lavoisier's introduction of the chemical balance. Under the impetus given by their investigations, Berthelot in Paris, and especially Thomsen in Copenhagen, have during the last decade rapidly perfected and elaborated this subject, until at the present day there are few branches of chemical physics based on so numerous and varied experimental data.

The labours of Prof. Favre were recognised in France by his nomination to the Legion of Honour, and by his election as a Corresponding Member of the Academy of Sciences in the Section of Chemistry.

ARAGO

WE recently gave some account of the inauguration of a statue to Arago at Perpignan. We now give an illustration of that statue, with some extracts from the interesting address delivered by Dr. Janssen, who was present at the ceremony as representative of the Paris Academy of Sciences. After speaking of Arago's visit to Spain, and his election as a member of the Academy, Dr. Janssen went on to say:—

The young physicist was not long in surpassing the hopes which they (the Academicians) had placed in him. Within two years of his election he had laid before the Academy many very important memoirs, and a noble discovery which gave birth to a beautiful chapter of optics, the discovery of chromatic polarisation, as it is now called. He observed that polarised light acquired certain entirely new properties when made to pass through properly prepared crystalline plates. The brilliant phenomena of colours to which polarised light could give birth in these circumstances had a great theoretical bearing, and in the hands of Arago they became the bases of the most ingenious and important applications, the principle one being the invention of a polariscope which disclosed the least traces of polarised light, and which Arago was able to employ in determining the gaseous nature of the sun's dazzling surface.

Gentlemen, it was a great and glorious epoch for our Academy. The discoveries regarding light and the principles which regulated its phenomena succeeded each other almost regularly. Malus, Arago, and Fresnel were at the head of this great scientific movement in France. After Malus, who in 1808 discovered polarisation by reflexion, and a little later assigned its laws, Arago published this series of his beautiful works on chromatic polarisation, on circular polarisation, and the photometer; he adduced in favour of the wave theory the capital fact of the retarding influence of a thin metal plate in this system of two interfering rays of light. Finally Fresnel appeared on the scene, and this genius, so simple, yet so profound, connected these discoveries without an effort, and attached them again to the principle of undulations, of which he showed the fruitfulness, and which in his hands received its final definite triumph. Arago then has taken his place in this aristocracy, but posterity owes to him a still greater obligation. Thanks to his perspicacity in divining merit, thanks to the natural generosity of his disposition, exempt as it was from all jealousy, Fresnel, an obscure provincial engineer, was found out, encouraged, and called to Paris, where he had a situation. Arago formed a friendship for him which was never dimmed by a cloud and he missed no opportunity of supporting his works and the interests of his fame. Between such rivals in glory, a sentiment so pure and noble is one of the finest spectacles which the human mind can offer us. Truly, gentlemen, posterity should delight to allow a moral share to Arago in the grand scientific monument which it has received from the genius of Fresnel.

"The movement which produced these remarkable discoveries in light began to slacken when there came to us from Denmark in 1820, the announcement of a scientific fact of a very different character but of immense importance, and which threw back on electricity almost all the activity of the scientific world. Every one knows Œrsted and the discovery of the action of the current on the magnetised needle. The relations which ought to unite magnetism and electricity had long been foreseen, but the common bond had always eluded those who attempted to seize it. Now the bridge was thrown, and two distinct sciences, in appearance so different, were resolved into one, and all the facts which they comprehended were connected by one identical principle. If the theoretical consequences of Œrsted's discovery were considerable, those which had regard to economic and industrial applications were incalculable, and were to cause a veritable revolution in the relations of mankind. But if this grand discovery opened out such vast horizons and disclosed a new world, it required the concourse of genius to effect the conquest. France has still the best part of this honour, thanks to Ampère and Arago.

Within a week Œrsted's experiments had been repeated before the Academy. Already Ampère brought before it his discovery of the reflex action of the currents, and he

Arago.

had laid the foundation of that magnificent chapter of electro-dynamics, one of the finest, most profound, and most perfect of which the science of all times can boast. A week later and it was Arago's turn, he having discovered the attractive action of the current in iron filings, a discovery of which he made good use as we shall soon see.

Arago then, as he himself informed us, showed his experiments to Ampère, and these two great physicists for a brief period united their efforts. The object pursued was the magnetisation of steel by the current. From the first, Ampère guided by his new views on the constitution of the magnetism in the magnet, saw at once the conditions of success. He indicated that in order to obtain a steady and powerful magnetisation, it is necessary to roll up in screw-form a part of the wire conductor and at that point to place the needle; and his theory is so sure, so precise, that he assigned the position of the poles in the magnet so as to give in the spiral the force of the current and the direction of the screw. The prediction has been entirely confirmed by experience.

These leading experiments thus established the principle of the electro-magnet, on which has been based for the most part the mode of action in electric-telegraphy.

But all the world knows that this admirable mechanism by which the properties of the magnet are associated with those of electricity, has since received almost numberless applications in science and industry. We might cite by the thousand these magneto-electric motors, these clocks which disseminate in every town the time which the electric wire draws up to a central regulator, these checks on the railway which arrest a train so efficiently in the presence of a danger signal, &c.

And now, gentlemen, a still greater future seems reserved for the electro-magnet. This marvellous facility of developing at a distance by means of a simple electrical-conducting wire a magnetic power capable of raising enormous weights occupies the engineers of the present day, and it seems that the time is not far distant when the telegraphic wire will transport afar mechanical force even as it now transmits human speech.

Such, gentlemen, were the fruits of the momentary union of these two men, so great and yet so different.

Perpignan, to its great credit, pays this day to Arago, a portion of the debt of France. I desire to express here the hope that the city of Lyons will equally honour the memory of Ampère, the immortal founder of electro-dynamics, the geometric scholar, the philosopher who has pointed out the principle in galvanometry on which is based to-day the grand system of inter-oceanic telegraphy, the man, finally, whose candour equalled his genius, and whose slightest ideas are almost always marked with the stamp of keenness and profundity.

In order to conclude the grand series of Arago's discoveries, I ought to recall that of magnetism by rotation; it belongs to the year 1824. Humboldt tells us that Arago made it on the slope of the beautiful hill at Greenwich during some operations bearing on the measurement of magnetic intensity. Arago remarked that a magnetic needle attained repose sooner when it oscillated within its copper frame than when separated. This was but the first link in a chain of fertile truths which led Faraday to the great discovery of induction.

Gentlemen, it is impossible in sketching the life of Arago, not to recall the importance of his teaching and of the writings which he devoted to the diffusion of scientific learning. If his discoveries and his labours merit the recognition of posterity, his pen and his speech were the better part of the great influence which he exercised in his time. We know with what avidity his memoirs were read on their appearance. The collection of our *Annuaires du Bureau des Longitudes* preserves also the trace of an incident which shows the impatience of his readers. One year Arago, absorbed by some important work, allowed his *Annuaire* to appear without a summary. The press rebelled and made itself the echo of the public displeasure. They even went the length of contending that the *Bureau* had failed in the duties which were imposed by its regulations. There was nothing of the kind; but Arago understood to what an extent this sentiment was flattering to him, although expressed in an indirect and hardly courteous manner. He executed and published apart a memoir which was given gratuitously to all purchasers of the *Annuaire*. His biographic memoirs, his academic reports, his sessional lectures, his analysis of correspondence as permanent secretary were the object of an interest which is never disappointed. His admirable career at the Observatory has left memories which are still living among us. Wherever Arago was to read or speak there was eagerness to hear him, and this eagerness was manifested by all classes and by men in all stages of education, from the scholar who was charmed to see with what art the master could, in treating a difficult subject, seize the side which would render it intelligible to all, to the artisan astonished at being able to understand and to receive clear, precise ideas on matters which he believed for him to be absolutely inaccessible. The cause of this success, gentlemen, lay in the harmony of mental and physical gifts, which I attempted to characterise at the beginning of this speech. They lay above all in that superior comprehension of subjects which he had developed by his labours and discoveries. He who has created in science, teaches very differently from the most educated professor who has never stirred the bowels of a subject in order to get at fresh truths. There are three degrees in the knowledge of truth; namely, those of student, teacher, and discoverer. In order to practise in a superior manner in one of these degrees, it is necessary to be raised to a stage which dominates it. As has been truly said, one does not thoroughly understand that which one is unable to teach. I say even that inventors alone can teach in a transcendent manner. That is not to say that all inventors are popular teachers. There are men of genius who like to hold themselves aloof, and whom it pleases to keep from others the truths of which they possessed themselves without effort; there are others, who although rich in the faculties of invention, have none of those which make the professor. But when all these gifts are united, and when to a zealous spirit are added the faculties of a superior mind, then we have one of these great popular teachers whose action extends over a whole epoch. Such was Arago, and such the real character of his greatness.

Gentlemen, Arago's writings shall not only have been of service to the generation which enjoyed them so eagerly. We inherit them and we shall not be their sole posterity. Among them, indeed, how many *chefs-d'œuvre* will always be consulted, in spite of the advance of science, on account of the perfection of their form and their rare historical ideas.

This speech would be incomplete if we did not add some touches to the grand and sympathetic figure. Arago, indeed, has not only served science by his discoveries, his labours, his writings, and his teaching; he has served it also by the protection and the encouragement which he delighted to lavish on the young philosophers of the future, on inventors of merit, and on all those who called upon him with any title. Just now I cited the case of Fresnel, but twenty other examples, many of them illustrious, could still be invoked.

If we survey our *Comptes Rendus* we shall see the name of Arago constantly intervening, whether he deals with an important discovery, a meritorious work, or a remarkable invention. If the affirmations which he makes, or the praises which he believes to be merited encounter opposition, his speech then takes fire, he becomes excited and indignant, and overturns all obstacles. How many have had him as their all powerful advocate, who have subsequently forgotten it?

When Arago had to deliver a speech at the Academy on an important subject, it was quite an event. We know by tradition, for example, the impression caused at the sitting when Arago expounded the discovery of Daguerre, and the interest, the pleasure, the admiration which was produced in the hall on hearing this master of the mysteries of light, revealing the operations which allowed of the fixing of the figure in the camera-obscura. Among so many applications which his perspicacity foresaw for the admirable discovery, he was always struck by those which concerned astronomy.

Faye, one of Arago's students and our eminent co-worker, has sustained this idea and has signalised by many claims all the ways which can be devised for the application of photography to celestial phenomena.

Let us also recall the sittings when Arago explained the success of Grenelle's operations in the boring of wells, with which he was desirous of endowing the capital, and which we owe to his sagacity and to the perseverance by which he was able to triumph over general incredulity.

Finally among so many fruitful initiatives, let us remark in particular that which Arago took with regard to Vicat's pension. Arago proposed that a national pension should be given to the great engineer, to whom France owed so many fine works. There was only one almost forgotten precedent. Arago wished to create a brilliant one. This great spirit felt how much the institution of national pensions accorded to those who had wrought gloriously for the benefit of the country, and who in the struggle have forgotten themselves, would produce devotedness to the country. Let us apply generally, gentlemen, the example which is offered to us under the patronage of Arago. Let us give to the men, never very numerous, whose conspicuous services have received the recognition of the country, that proof of its justice. Then, even, though the recompense be materially modest, there will always be attached to it a special value, it will always excite the noblest emulation, because each reward that is thus offered in the name of the country becomes a medal.

Gentlemen, in the decline of his career, this great soul had worn out the body on which it had made such severe demands. His organs were no longer able to serve that powerful intelligence in realizing his scientific conceptions. Arago then gave a last proof of his generosity. Having conceived the project of a magnificent experiment on light, he went to the Academy, expounded his ideas, and invited the young philosophers to follow them out and to gather the glory of their realization. Thus it was that Foucault and Fizeau, aided by our eminent artist and colleague Bréguet, were brought to the works by which they have begun their great scientific reputation.

Shortly after, Arago, broken by disease, and feeling his end near, wished to bid a last farewell to that Academy which had held so great a place in his life, of which he was the organ for so many years, and where his voice, listened to, loved, and admired, had resounded for almost half a century. His death, on October 2, 1853, was a loss to the whole world.

VESBIUM

PROF. A. SCACCHI, who has been for some time engaged in chemical investigations on the lava which issued from Vesuvius during the year 1631, has recently made an interesting communication to the Royal Academy of Sciences at Naples with regard to the probable presence in these deposits of a new metal. The material which Prof. Scacchi has operated upon consists of delicate yellow incrustations found in the crevices of the lava, in company with atacamite and azzumite, and has been named by him *vesbine*, while the supposed new metal is termed *vesbium*. Both words are derived from the ancient name for Vesuvius mentioned by Galen in his work, "De Morbis Curandis" (Book v. Chap. 12). Vesbine is found to consist of silicates of copper, the alkalies, iron, aluminium, &c., together with small quantities of the salts of what receives the name vesbic acid. The latter is obtained in an impure state—containing traces of iron, aluminium, lead, and copper—by evaporating the solution of vesbine in hydrochloric acid to 170° C., extracting with water, treating the residue of silicic acid, and vesbiates with hydrochloric acid, filtering from silicic acid, evaporating again to 170°, and extracting with water. The dark green residue thus obtained formed the material for the series of investigations on which the discoverer bases his claims to the existence of the new element. The characteristic properties thus far noted are the following:—When fused with phosphor salt, its compounds yield in the oxidising flame a reddish or brownish yellow bead, and in the reducing flame a green bead. The alkaline vesbiates are soluble in water. The compounds with the other bases are soluble in acids, but insoluble in water—with the solitary exception of the manganese salt. The zinc salt is green, the silver salt is of a reddish yellow. The acid solutions of the iron and aluminium salts are green. Addition of sulphuretted hydrogen causes a flocculent brown precipitate, while the liquid assumes a deep azure blue hue—one of the most distinctive properties of the acid. The yellow vesbiate of potassium when fused, turns black, and if then cooled is insoluble. If on the contrary the temperature is further elevated, the fused mass becomes transparent and is soluble on cooling. The analysis of the silver salt showed it to contain 47·58 per cent. of vesbic acid. This would give 105·29 as the equivalent weight of vesbic acid, and an atomic weight of about 130 or 162, according to the amount of oxygen in combination.

In view of the small quantity of but three grammes of vesbic acid which Prof. Scacchi has thus far succeeded in isolating, he very prudently desists from making any definite claims with regard to the certainty of the existence of vesbium, until he has obtained quantities sufficient to insure purity in the compounds and exactness in the analytical results.

Thus far it appears allied to vanadium or molybdenum, although not responding to the special tests of these metals. A more accurate determination of the atomic weight will also show whether it can fill the gaps in the groups containing these metals according to Mendeleeff's classification. T. H. NORTON

PRIZES OF THE PARIS ACADEMY OF SCIENCES

At the annual meeting on March 1, the Academy of Sciences distributed a large number of prizes, besides the extraordinary prize awarded to Mr. Crookes for the "Ensemble de ses Expériences." The Poncelet prize has been granted to M. Moutard, Professor at the Polytechnic School, for his works in analysis; the Dalmont prize to M. Collignon, Engineer of the Ponts et Chaussées, for similar services rendered to mechanics. M. Collignon is the author of a treatise on rational mechanics, containing not less than five large 8vo volumes. The Lalande prize was granted to Mr. Peters, the well-known astronomer of Clinton, for the discovery of forty-three small planets, eighteen of them discovered in 1879. M. Trouvelot, the French astronomer who was banished in 1851, and settled in the United States, took the Valz prize for his descriptive designs of Mars, Jupiter, and Saturn, which are exhibited in the large hall of the Paris Observatory. M. Trouvelot's observations on Jupiter's spots were considered as deserving of special mention. The Lacaze prize for physics was awarded to M. Leroux, Professor to the School of Pharmacy for his researches on vapours, on chronographs, magneto-electric machines, and peripolar induction. The Lacaze prize for chemistry was granted to M. Lecoq de Boisbaudran for his discovery of gallium

A large number of the questions proposed for solution by the commissions of the Academy, have been left unsolved and unrewarded, such as the Plumey prize for improvements in steam navigation, the great prize of mechanics for any invention tending to enlarge the efficiency of French men-of-war, the Damoiseau prize for a revision of the theory of Jupiter's satellites, the Vaillant prize for improvements in phonetic telegraphy, the Breant prize (4,000*l.*) for a remedy against choleraic infection, and others.

It is alleged that the failure of these competitions is caused by the too narrow limits imposed on the competitors, and the want of interest felt by the learned public in the proposed subjects. It may be noticed that the practice of rewarding men of science for the whole of their works is gradually gaining ground. Mr. Crookes's prize, an "extraordinary" one, was proclaimed after all the others.

One of the most important functions of the Academy of Sciences is the distribution of these annual prizes, the number of which is considerable—not less than thirty-one, whose aggregate value is about 10,000*l.*, exclusive of the Breant prize for cholera (4,000*l.*). Four of these prizes are paid out of public money, others from sums bequeathed by individuals whose number is yearly increasing. Generally these sums are vested in the funds, and the interest is employed in granting prizes, sometimes yearly, sometimes every two or three or four years. Some of the prizes to be delivered in 1880 are an exception to the rule, and the money is to be given *at once* if any one be found deserving it, according to the verdict of the Academical Commission.

The sitting was opened by an address delivered by M. Daubrée, and after the proclamation of the prizes, M. Bertrand, Perpetual Secretary, read the *éloge* of M. Belgrand, a free Academician, who died recently. He was engineer of the Ponts et Chaussées, and the head of the water service in the city of Paris. It was M. Belgrand who superintended the construction of the aqueduct, which from an immense distance brings within the fortifications of Paris an inexhaustible supply of pure spring water. In prefacing his address M. Bertrand remarked that the number of departed academicians who, from 1666 up to 1880 had not had the advantage of having their *éloge* pronounced by the Perpetual Secretary, amounts to seventy-two, amongst whom are Napoleon I., who was a member of the section of Mechanics, Leon Foucault, and Arago!

ARTIFICIAL DIAMONDS

An unusually large audience gathered at the Royal Society last Thursday to hear Mr. Hannay's account of his artificial diamonds.

The President, after inviting discussion of the paper by Messrs. Hannay and Hogarth, observed that probably the large audience had assembled more especially in consequence of the general interest attaching to the next paper on the artificial formation of the diamond, and he felt that the valuable investigation just detailed showed Mr. Hannay to be a person worthy of attention when he claimed to have made even so startling a discovery as that on the face of this next communication. With regard to this the President observed that the attitude of science was always sceptical, and the Society would need ample proof that the metamorphosis of carbon into diamond had been really effected. But when once it has been proved, even with regard to the most microscopic particle, the scepticism of scientific men would cease for ever. And he reminded the Society that the present was only a preliminary notice dealing with the statement that headed it, and that a more complete memoir detailing the process would be eagerly expected by the Fellows of the Royal Society.

The following paper by Mr. Hannay was then read by Prof. Stokes:—

While pursuing my researches into the solubility of solids in gases, I noticed that many bodies, such as silica, alumina, and oxide of zinc, which are insoluble in water at ordinary temperatures, dissolve to a very considerable extent when treated with water-gas at a very high pressure. It occurred to me that a solvent might be found for carbon; and as gaseous solution nearly always yields crystalline solid on withdrawing the solvent or lowering its solvent power, it seemed probable that the carbon might be deposited in the crystalline state. After a large number of experiments, it was found that ordinary carbon, such as charcoal, lampblack, or graphite, were not affected by the most probable solvents I could think of, chemical action taking the place of solution.

A curious reaction, however, was noticed, which seemed likely to yield carbon in the nascent state, and so allow of its being easily dissolved. When a gas containing carbon and hydrogen is heated under pressure in presence of certain metals its hydrogen is attracted by the metal, and its carbon left free. This, as Prof. Stokes has suggested to me, may be explained by the discovery of Professors Liveing and Dewar, that hydrogen has at very high temperatures a very strong affinity for certain metals, notably magnesium, forming extremely stable compounds therewith.

When the carbon is set free from the hydrocarbon in presence of a stable compound containing nitrogen, the whole being near a red heat and under a very high pressure, the carbon is so acted upon by the nitrogen compound that it is obtained in the clear, transparent form of the diamond. The great difficulty lies in the construction of an inclosing vessel strong enough to withstand the enormous pressure and high temperature, tubes constructed on the gun-barrel principle (with a wrought iron coil), of only half an inch bore and four inches external diameter, being torn open in nine cases out of ten.

The carbon obtained in the successful experiments is as hard as natural diamond, scratching all other crystals, and it does not affect polarised light. I have obtained crystals with curved faces belonging to the octahedral form, and diamond is the only substance crystallising in this manner. The crystals burn easily on thin platinum-foil over a good blowpipe, and leave no residue, and after two days' immersion in hydrofluoric acid they show no sign of dissolving, even when boiled. On heating a splinter in the electric arc, it turned black—a very characteristic reaction of diamond.

Lastly, a little apparatus was constructed for effecting a combustion of the crystals and determining their composition. The ordinary organic analysis method was used, but the diamond crystals were laid on a thin piece of platinum-foil, and this was ignited by an electric current, and the combustion conducted in pure oxygen. The result obtained was, that the sample (14 mgrms.) contained 97·85 per cent. of carbon, a very close approximation, considering the small quantity at my disposal. The apparatus and all analyses will be fully described in a future paper.

Extract from a letter from Mr. Hannay, dated February 23.

"I forgot, in the preliminary notice, to mention that the specific gravity of the diamond I have obtained ranges as high as 3·5; this being determined by flotation, using a mixture of bromide and fluoride of arsenic."

The President having called for any observations on the notice by Mr. Hannay, Mr. Maskelyne said that the present differed from the numerous announcements and other communications that have been heretofore made to scientific societies at various times purporting to record the artificial production of the diamond in this, that here the product so claimed to have been manufactured is really diamond. He had himself proved this by the simple tests of the mineralogist. He had deeply abraded topaz and sapphire with a particle of the substance and abraded them with the greatest ease; the angle of the cleavages of a crystalline fragment sent him by Mr. Hannay was the angle between faces of the regular octahedron, and he had burnt a small grain of the substance on a platinum foil with the characteristic glow of the diamond, and without its leaving a residue. And on polarised light it had no action—or rather one particle had a very slight action, just as many diamonds have when turned between crossed tourmalines, and the lustre of the body was truly adamantine. All the particles he had seen as yet were fragments; none were complete crystals. They were characterised by the laminated structure of diamond. One indeed forwarded to him by Prof. Roscoe had exactly the appearance of a chip from a small diamond that might originally have been from $\frac{1}{8}$th to $\frac{1}{32}$nd of a carat in size; it may have been about $\frac{1}{100}$th of a carat in weight itself. Prof. Roscoe had recognised the close similarity of this fragment to one of native diamond, and had declared his scepticism of the reality of the transmutation of carbon until it should be proved to be an established scientific result; and Mr. Maskelyne considered Prof. Roscoe was *primâ facie* justified in this scepticism, and wished, on the part of Prof. Roscoe, to place on record this hesitation on his part to accept the results claimed by Mr. Hannay without further proof, though no one would accept them when proved with greater pleasure than would Prof. Roscoe. And, on the other hand, Mr. Maskelyne, while supporting warmly the observations of the President, and vindicating for the Royal Society its prerogative of holding a sceptical attitude towards new discoveries, and especially towards one so novel and so long desiderated as this, felt confident that the gentleman whose beautiful investigation had led him up to what might so well be the threshold of this discovery, may, until at least his further communication shall have been made, be fairly credited with the moral qualities that would render any approach to falsification of his results impossible. At the same time the rigid scrutiny of science must be called in to establish or refute those results, and the advantage of such a process and of the sceptical attitude that dictates it, is all to the advantage of him whose results are thus accepted. Mr. Maskelyne observed that the employment of a nitrogen compound appeared to be a novel and most important feature in Mr. Hannay's process, though what compound he used was not yet publicly announced. One point of difference he had observed in Mr. Hannay's fragments distinguishing them from ordinary "cleavage" diamond is that they present sometimes a curved lamination, which he would designate as a kind of nacreous lamination, like the rounded and parallel scales of mother-of-pearl. Prof. Stokes subsequently illustrated this by a drawing on the black board. Mr. Maskelyne subsequently explained that his own share in announcing Mr. Hannay's discovery was undertaken with that gentleman's concurrence as asserting his priority of claim.

Mr. Hulke suggested that the fragmentary character of the diamonds might be due to the disruption caused by gaseous inclosures in them on the removal of the enormous pressure under which they were formed.

Prof. Dewar remarked that the somewhat indefinite statements in Mr. Hannay's paper of the presence of a stable compound of nitrogen being necessary for the success of the process bear a strong analogy with known facts regarding the formation of graphite. Until within the last few years the transformation of carbon into the form of graphite had only succeeded by dissolving it in cast-iron. This involves a temperature of twelve or fourteen hundred degrees; but Dr. Pauli had shown that the oxidation of cyanides in crude caustic soda at a temperature not exceeding a low red heat, say 500°, resulted in the production of a quantity of graphite. Now under ordinary conditions of pression diamond will withstand a high temperature without changing into the stable form, and in this it resembles graphite. From all that is known of the thermal relation of diamond and graphite it would appear that the passage from the one state to the other involves little or no absorption or evolution of heat—quite unlike the corresponding changes in the allotropic modification of phosphor; and therefore it would appear that some such process of separating nascent carbon, probably through the presence of cyanides, at a relatively low temperature and under great pressure, is one not unlikely to produce the diamond form of carbon.

Some questions asked by Mr. De la Rue and by Dr. Debus regarding the principle of Mr. Hannay's process were responded to by Prof. Stokes, who pointed out the relation of the process sketched at present only in outline by Mr. Hannay, and the paper which had been communicated just previously to it by that gentleman.

A large tube some four inches in diameter, made of wrought iron, and bored with a small cylindrical hollow along its axis, was shown as one of the tubes in which Mr. Hannay's experiments were performed.

NOTES

THE following grants have been made by the Council of the Chemical Society from their Research Fund :—100*l*. to Dr. C. R. A. Wright, for determinations of chemical affinities in terms of electrical magnitudes; 100*l*. to Mr. F. D. Brown, for experiments on vapour tensions.

MR. J. R. HIND has been elected president of the Astronomical Society.

THE French Government has appointed M. Hervé-Mangon, the new director of the Conservatoire des Arts et Métiers, as one of its representatives in the International Metric Commission. The death of General Morin has created a vacancy on the Committee of the Breteuil International Observatory. This observatory has been constructed in the Parc de Saint Cloud on the site of an old imperial mansion, at the expense of the associated nations. The contribution levied is in proportion to the population multiplied by one, if the nation does not make any use of the metric system, by two if the metric system is permissive as in the United States, and by three if it is the only legal measure as in Belgium, Italy, or France. The president of the Committee is General Ibanez (Spain), the secretary, Dr. Hirsch (Switzerland), and the director of the Breteuil Observatory Dr. Broch (Norway). England declined to join the Association. Bavaria, Saxony, and Würtemberg has each a vote and a representative, as well as Prussia.

THE boring of the St. Gothard Tunnel was completed on Sunday morning at 9 o'clock. The length of the tunnel is 9¼ miles, and the boring was begun in 1872, with machinery worked by compressed air, devised by the engineer, Prof. Colladon, of Geneva; the piercing of the tunnel has taken seven years and five months. The tunnel is expected to be ready for traffic by the end of September, and the entire system of which it is the centre in the summer of 1882.

THE savage process of producing fire by the friction of wood, so often described in books of travel, but seldom seen in this country, was performed by Farini's Zulus at the Westminster Aquarium on Monday, in the presence of Dr. Tylor, Gen. Lane Fox, Mr. Francis Galton, Col. Godwin-Austen, and other members of the Anthropological Institute. Some straw being laid on the ground as a bed, two sticks were placed on it a few inches apart to form a support for the third stick, which was laid across them, having a deep notch cut in it to receive the blunt point of the drilling-stick; this was twirled like a chocolate-muller between the palms of the hands, and when the twirler's hands reached the bottom they were either dexterously shifted to the top again, or another of the Africans squatting round took on and relieved the first. A spark was got in the charred dust in about five minutes, and was received with shouts and leaps of delight by the fire-makers, one of whom, carefully shielding it in a handful of the straw, soon fanned it into a flame. We understand that the operation will be made a regular part of the afternoon performance of these interesting barbarians. They are physically fine specimens of the Kafir type, varying in complexion from negroid blackness in some of the men to dark *café au lait* colour in the women. Their show-scenes, such as the marriage procession, war-dance, &c., are genuine exhibitions of native life. The Zulus are in exuberant health and spirits, and as yet but little spoilt by contact with civilisation.

THERE died at the Rectory, Newcastle, Lyons Hazlehatch, county of Dublin, on January 20, the Rev. Eugene O'Meara, M.A., for some nineteen years curate of Saint Mark's Parish, in the City of Dublin, and for nineteen other years Rector of Newcastle Lyons. Amidst the hard struggles of a laborious life Mr. O'Meara found time to do some scientific work, on account of which he deserves a brief notice in our columns. Born about the year 1815, he entered Trinity College, Dublin, in 1834, taking his B.A. degree in 1840, and that of M.A. in 1858. He soon obtained the post of Curate in St. Mark's, one of the poorest parishes in Dublin. Finding the necessity of having some definite object of research to serve him as a recreation after the toils of his daily labours, O'Meara began the study of the diatoms, attracted to them at first by the ease with which their siliceous frustules could be preserved and observed. He soon showed that he had a good eye for minute differences in outline and markings, and many a refreshing hour was spent by him in the investigation of the seemingly endless forms, for we will not call them species, of these interesting algæ. His first published communication was made to the British Association at its meeting in Dublin in August, 1857, on "Diatoms occurring in the Chalk of the County Antrim;" this was speedily followe by "Notes on Diatoms and Sponge Spicules in the Cambrian Rocks of Bray Head, near Dublin;" and a very long list might indeed be given of his numerous contributions to a catalogue of Irish diatoms, and of his descriptions of new forms. He was one of the original founders of the Dublin Microscopical Club, and continued to the very last one of its most diligent working members. It ought to be remembered that all this work was done at stray leisure moments snatched from more serious business; and however open to criticism his largest work, the "Report on Irish Diatomaceæ," is, none were more conscious of its defects than its author. Pleasant and cheerful in his manners, he was often a great source of encouragement to his many friends. The small circle in Dublin, bound together by many ties for these now more than twenty-five years, will very sadly feel his loss, and there are doubtless others, too, who, when they read this notice, will sympathise with them, and feel that they may add to the names of Harvey, Jones, Kinahan, and Moore, that of O'Meara.

THE Municipal Council of Paris have decided with respect to the electric lighting of the Avenue de l'Opéra, to continue the agreement with the Jablockhoff Company up to May 1, 1881. We understand the gas experiments in the Rue de Quatre Septembre are not to be continued.

THROUGH the Clarendon Press, Col. A. R. Clarke, C.B., is about to publish a treatise on Geodesy, in which the whole subject is treated in the light of the latest researches.

A TELEGRAM from Prof. Milne, of Japan, to Prof. John Perry, dated February 25, at 2 p.m., states that there had just occurred in Yedo a severe earthquake. Prof. Perry states that about two months ago occurred the most severe earthquake felt in Yedo for twenty years, so that we must regard the present as a period of great seismic activity. Mr. F. V. Dickins, writing to the *Times* in connection with this announcement, states that up to the end of 1878, when he left Japan, after some years residence in that country, the natives constantly predicted severe and destructive earthquakes in this present year 1880. "The Japanese are singularly accurate observers of natural phenomena and of their cyclical periods, and are also, according to the experience of residents among them, unrivalled weather prophets. Mr. Perry's news confirms in a remarkable manner the precision of their calculation, based no doubt upon a close observation of seismic periods."

THE last number of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland contains an elaborate paper, amply illustrated by plates, on the proposed Forth Bridge, with some remarks on the structure and cause of the fall of the Tay Bridge, by Mr. St. John V. Day, C.E.

AN unusually well organised and successful *conversazione* was held by the Birmingham Natural History Society on February 25.

THE Royal Order of the Crown has been bestowed upon Prof. Pettenkofer, of the University of Munich, so widely and deservedly known by his researches in chemical hygiene.

ON the completion of Prof. W. K. Parker's course of lectures at the Royal College of Surgeons, Prof. W. H. Flower's have commenced, in continuation of his previous series of lectures on the Comparative Anatomy of Man. We expect to give a full account of these lectures in future numbers of NATURE.

AT the end of a discussion in the last session of the Paris Academy of Sciences, with regard to the dissociation of chloral hydrate in the gaseous state, Prof. Sainte-Claire Deville gave utterance to the following frank expressions of belief in modern theories:—"I admit neither Avogadro's law, nor atoms, nor molecules, nor forces, nor particular states of matter, and I utterly refuse to believe in what I can neither see nor imagine. I confess that if complex combinations were invariably decomposed before undergoing volatilisation, my opinion would in no wise be changed. While waiting for absolute proofs I find that the chlorides of ammonium, and of the volatile organic bases, as well as a considerable number of bodies, occupy eight volumes in the gaseous state; and I admit that which I see, as long as I do not believe that my eyes are betraying me, or that I am labouring under a hallucination. It is this which remains to be shown."

As the laws of the freezing of great surfaces of water have hitherto been but insufficiently known, the Municipality of Neuchatel has entrusted Professors Rougemont, Weber, and Raoul Pictet with the measurement during the thaw of the frozen lake, of the thickness of ice in its various parts. The ice, in opposition to what was observed on the lakes of Morat and Bienne, had a very varying thickness. Close to the shores its thickness was about 25 centimetres; at a distance of 100 metres from shore it was 14 centim., and further out the ice was so thin that it could not support the weight of a man; but some 15 metres further off the ice reached anew a thickness of 10 centimetres and more, and the greatest thickness was discovered in the middle of the lake, where it reached as much as 43 centimetres, being formed by the superposition of pieces of floating ice. It is worthy of notice that nearly throughout the surface of the lake, the ice was covered with a red powder, which sometimes coloured the ice and even the cracks in it with an intense red colour. The powder will be analysed to discover whether it is not due to diatomaceæ.

THE pilous system in man is just now attracting a special amount of attention from physiologists. Not only have Mad. Royer and Mr. Stainland Wake treated the subject from various points of view—the former considering it in reference to the question of atavism and its relation to certain changed conditions of the dental system—but Dr. Ecker also has contributed his part to the discussion by passing in review the anomalies of the hairy system in man. The instances of hypertrichosis in woman, collected by him, include cases from the time of Aristotle to our own day. Herr Ecker having himself assisted at the autopsy at Friburg of a woman, otherwise of normal development, with thick moustaches and a long flowing beard.

A PARIS engineer, M. de Combettes (we learn from *La Nature*), has contrived a curious toy, in which imitation fish are made to perform evolutions in a vessel of water. The fish are of tin similar to those sometimes drawn about with a magnet. But in the present case the mechanism is concealed, and at the operator's will the fish swim in circles, now in one direction, now in the opposite. In the wooden support of the vessel is concealed a small magneto-electric motor, which acts on a piece of soft iron in the fish, and by its motion carries them along with it. With the aid of a commutator the motion is reversed.

Ciel et Terre is the title of a new popular journal of Astronomy and Meteorology, to be published fortnightly at Brussels, edited by several astronomers and meteorologists of Brussels Observatory.

"A YEAR'S Work in Garden and Greenhouse," by Mr. George Glenny (Chatto and Windus) will, we have no doubt, be found serviceable to amateurs.

THE *Annual Reports* for 1878-9 of the Belfast Naturalists' Field Club speak favourably of its progress and of increased work by the members. Several of the papers read are given in abstract; they are mostly geological.

THE *Natural History Journal* of the Societies of Friends' Schools for February is as good and varied as usual. There is an interesting paper on "Some freaks of Polypods and Heartstongue," by Mr. J. E. Clark, with a fine photograph from nature.

THE Second Annual Report of the Dulwich College Science Society, speaks favourably of its progress. Some good papers by members of the Society are given in the report, and others by outsiders, as Mr. W. L. Distant on Entomology, and Mr. Meldola on Spectrum Analysis.

FROM the Harvard Museum of Comparative Zoology we have received a useful "List of Dredging Stations occupied by the U.S. Coast Survey Steamers *Corwin*, *Bibb*, *Hassler*, and *Blake* from 1867 to 1879."

THE Algerian paper *Akhber* announces the formation of an Algerian Company for cultivation of the Sahara. The means proposed are the systematic boring of artesian wells in carefully selected spots. The Company is to be connected somehow with the future Transalgerian Railway Company.

MR. F. WATTERS, one of H.M.'s Consuls in China, has lately published at Shanghai a work, entitled "A Guide to the Tablets in a Temple of Confucius," which forms a complete key to the official hagiology of China.

FROM Cooktown in Queensland it is announced that some Chinese have formed a company and taken land for growing sugar, rice, and coffee. They are thought to have a good chance of success, as the soil is very rich.

THE additions to the Zoological Society's Gardens during the past week include a Fallow Deer (*Cervus dama*), European, presented by Mr. Louis Hirsch; a Scops Eared Owl (*Scops giu*), European, two Rufous-necked Weaver Birds (*Hyphantornis textor*) from West Africa, presented by Mr. W. H. St. Quintin; an Allen's Galago (*Galago alleni*) from Fernando Po, a Serval (*Felis serval*), a Broad-fronted Crocodile (*Crocodilus frontatus*) from West Africa, eight Mandarin Ducks (*Aix galericulata*) from China, eight Summer Ducks (*Aix sponsa*), a Kittiwake Gull (*Rissa tridactyla*) from North America, two Grey-headed Love Birds (*Agapornis cana*) from Madagascar, five Common Lapwings (*Vanellus cristatus*), European, purchased.

THE GREAT SOUTHERN COMET

By letters from Mr. Gill received by the mail leaving Cape Town on February 3, it appears that the large comet of which Dr. Gould telegraphed from Buenos Ayres was discovered, so far at least as regards a part of the tail, on February 1, from the west side of Table Mountain. Mr. Gill received information that a comet's tail "had been seen to set" from this quarter on the following afternoon, and the same evening the extreme portion of the tail was visible over the mountain from the Royal Observatory; by going a quarter of a mile south of the Observatory, the near shoulder of the mountain was cleared, and the tail, rapidly brightening, was traced further; it passed parallel to a line joining β and δ Gruis, about 10′ to W., but could not be traced beyond the former star. Mr. Gill thought the nucleus had set almost at sunset.

The following telegram has been received by the Academy of Sciences at Paris from the Emperor of Brazil, who takes a personal interest in the affairs of the Observatory at Rio Janeiro, which is in charge of M. Liais:—"Rio de Janeiro, 20 février, 1880. Deuxième note de Liais. Comète seulement observée 4 et 8. Renseignements; observations faites ailleurs. Approximativement, distance périhélie, 0·05 à 0·10; passage périhélie, 11; inclinaison, 80°; longitude du nœud ascendant, 120°; longitude du périhélie, 85°.—PED. ALCANTARA."

If the time of perihelion passage is assumed February 11·5 G.M.T., and the perihelion distance 0·075, with direct motion in the orbit, the comet's position on February 2 at 8h. 30m. mean time at the Cape would be in R.A. 314°, with 22° south declination; so that it would be distant only about 5° from the sun, thus confirming Mr. Gill's conjecture as to the position of the nucleus, but unless the comet became very rapidly fainter, after perihelion, it is difficult to explain with the above elements, its not being observed in Europe.

The last great comet which was observed in the southern hemisphere without becoming visible in these latitudes was that of January, 1865, which had also a small perihelion distance with large inclination; this comet was north of the ecliptic less than twenty-eight hours. It became suddenly visible in Tasmania, near the western horizon, on January 17, and was observed until the last week in March. The best orbit is that given by Mr. Tebbutt, from his own observations at Windsor, N.S.W. (*Astron. Nach.*, No. 1541).

GEOLOGICAL NOTES

A LITTLE pamphlet under the title of "Mélanges géologiques," by MM. Cogels and Baron van Ertborn, has just appeared at Antwerp, in which some interesting new facts are given respecting the post-tertiary formations of Belgium. Much controversy has for a long time been carried on as to the relative positions of some of the quaternary deposits of that country. The "Sables campiniens" and the "Limon hesbayen" were regarded by Dumont as of contemporaneous origin, albeit he placed the Limon above the Sables in the legend of his geological map of Belgium. D'Omalius d'Halloy and M. Dewalque ranged the Hesbayan mud above the Campinian sands and gravels. MM. Winkler, Cogels, and Van den Broeck, on the other hand, have concluded the reverse to be the more probable order. But in no case had the true order of succession been observed in any actual section. This question, which might have been answered long ago by a few shallow borings, appears to have been recently settled in this way by the gentlemen above named. They have found that at Menin and Courtrai, places some ten kilometres apart, the same order of sequence is observable, and that in each case the yellow sands of the Campinian series overlie the yellow and grey mud with *Cyclas*, *Pupa*, *Lymnea*, &c., forming the Hesbayan zone.

THE same authors have in a similar manner fixed the horizon of the deposit from which were obtained the numerous bones of the mammoth found in 1860, the more perfect of which form so imposing a part of the remarkable collections in the Brussels Museum. According to their reading of the data the following is the section at Lierre:—

	Metres.	
Sands with gravelly base ...	5·30	Campinian.
Peaty sand and peat	0·70	Fluviatile Quaternary (containing the mammoth bones).
Black glauconitic sand ...	0·60	
Gravelly glauconitic sand ...	0·70	
Argillaceous glauconitic green sand	0·10	Antwerpian (sands with *Panopæa menardi*).

The sands containing *Panopæa menardi* and *Pectunculus pilosus*, which MM. Cogels and Ertborn include in their widely distributed "Antwerpian" group were evidently succeeded in the Lierre district by a wide marsh which must have been a favourite haunt of the mammoth and its contemporaries. Arranging the geological formations of the neighbourhood of Antwerp in chronological order these writers regard them as capable of the following subdivisions:—

Polder clay		Recent.	
Stratified sand with derivative fossils			
Peat			
Grey clay...			
Peaty black clay			
White sand			
Sand	Upper	Campinian.	Quaternary.
Massive argillaceous sand	Lower		
Stratified sands and clays			
Gravel and shell *débris*			
Stratified sands and sandy clays		Fluviatile Quaternary.	
Peat and peaty clay			
Various sands with broken and rolled shells, bones *in situ* or rolled			
Sandy clay with marine shells, gravels, pebbles, and large rolled fragments ...		Lower Quaternary.	

E. Pure or argillaceous green sand	Sands with *Trophon antiquum*.	Scaldesian.	Pliocene.	Tertiary.
D. Sands with *Corbula striata* ...				
C. Upper shell-bed				
B. Middle sands ...				
A. Lower shell-bed				
Bluish-grey glauconitic sand	Sands with *Isocardia cor*.			
Gravels				
Glauconitic sand ...	Sands with *Terebratula grandis*.	Diestian.		
Black glauconitic sand	Sands with *Pectunculus pilosus*.	Antwerpian.	Miocene.	
Green or black glauconitic sand, pure or argillaceous	Sands with *Panopæa menardi*.			
Do. with or without fossils, scattered gravels				
Bluish-grey fossiliferous argillaceous sand, glauconitic black sand				
Gravels, and large rolled blocks ...				
Boom clay		Rupelian ...	Oligocene.	

IN a recent communication to the Royal Geological Society of Cornwall Mr. J. H. Collins continues his observations on the existence of Lower Silurian rocks in Cornwall, and shows that they cover a much larger area than has been supposed. He has found remains of *Orthis* in the quartzite of Manaccan like those already known from the quartzite of Carn Gowan. He is engaged in a microscopical and chemical investigation of the hornblende-rock and serpentine of the same district, and is disposed to regard these masses as highly altered Lower Silurian stratified rocks.

PROF. MARSH chronicles the discovery of a new species of *Sauranodon* from the upper Jurassic series of Wyoming. Since the first discovery of the genus by him eight additional specimens have been obtained, enabling him to distinguish two species (*S. natans*, the original form, and *S. discus*) and to throw considerable light on the limbs of this interesting type of mesozoic reptile, which he regards as representing an earlier stage of differentiation than *Plesiosaurus* and *Ichthyosaurus*.

UNDER the name of Titanomorphite, A. von Lasaulx describes a new lime-titanate from the gneiss of the Eulengebirge. It forms a fibrous granular aggregate surrounding kernels of rutile or titanic iron, of which it must be regarded as an alteration-product. Its theoretical composition he gives as—titanic acid, 74·55; lime, 25·45; or CaO, $2TiO_2$.

IN his recent annual address to the "Geologische Reichsanstalt" at Vienna, Ritter von Hauer gives some interesting particulars regarding the steps that have been taken to investigate the geological structure of Austria's last territorial acquisition. On the occupation of Bosnia and Herzegovina, the Government requested the director of the Reichsanstalt to make a geological reconnaissance of these provinces, which had formed until that time an almost totally unknown tract of Europe, though their area at least equalled that of Bohemia and Saxony combined. Their rough mountainous character and want of means of communication and transit made the task by no means a light one. An original plan of co-operation with the Geological Survey of Hungary had to be abandoned on account of the want of disposable force in that service, and the work was accordingly undertaken by three members of the Austrian Survey, Messrs. Mojsisovics, Tietze, and Bittner, with some assistance from Prof. Pilár of Agram, and from previous labours of M. Paul in the saliferous region of Tuzla. As the result of this reconnaissance, an outline geological map of Bosnia and Herzegovina has been prepared on the basis of the sheets of the map of Central Europe issued by the Austrian Military Geographical Institute on the scale of $\frac{1}{300000}$. Eighteen tints of colour are employed, and with these are shown Alluvium and Diluvium, Calcareous tuff, Sarmatian, Marine and Freshwater Neogene, Trachyte, Flysch (Younger Flysch-sandstone, Nummulite-limestone, and limestone of the Flysch zone), Eruptive rocks of the Flysch-zone (Serpentine and Gabbro), Chalk-limestone, Jurassic Aptychus-limestone, Jura-limestone, Triassic (principally limestone and dolomite), Werfen shales, Red sandstones and quartzites, Palæozoic shales, sandstones, and limestones, and granite. The map is being reduced to the same scale as von Hauer's well-known and most useful general geological map of the Austrian-Hungarian Monarchy, and will soon be published by Hölder of Vienna, as a supplement to that work.

PHYSICAL NOTES

PROF. O. N. ROOD communicates to the current number of the *American Journal of Science* a new method of studying the reflexion of sound waves. The "tremolo" effect in some American organs is obtained by a revolving fan. Prof. Rood conceives that the alternations of loudness in the sound produced by this fan are not due, as is commonly supposed, to the fluctuations of air-currents which it produces, but to the rapid alternations of reflexion and non-reflexion at its surface. A disk of zinc having sectors cut out of it, rotating in its own plane, yielded similar results. Using such disk as a reflector, when rotating at from two to four revolutions per second, and observing the intensity with which these alternations are produced, Prof. Rood obtains some interesting results. At a perpendicular incidence the short sound-waves are more copiously reflected than those that are longer, and the regular reflexion is more copious from large than from small surfaces. When the sound-waves fall upon small plane surfaces at an acute angle, the reflection is most copious in the same direction as with a ray of light, but the reflected and inflected waves can be traced all around the semicircle. The reflexion being more intense for waves of short wave-length, the components of a composite sound-wave are not all equally copiously reflected at the same angle. The reflexion of sound from very small surfaces is easily demonstrated by this method. Qualitative comparisons between the power of different substances to reflect sound can easily be made by this method. Thus a disk of cardboard in which the open sectors are covered with filter-paper gives alternations owing to the difference in reflective power between the zinc and the filter paper.

QUICKSILVER may be readily frozen by placing a small quantity of it along with anhydrous ether in the decanter used for freezing water of a Carré's freezing-machine, and exhausting in the usual manner. This experiment is due to M. de Waha.

PROF. COLLADON of Geneva, has been studying the instrument invented by Rhodes, of Chicago, and named the audiphone, whose purpose is to aid the deaf in hearing. The newest form of this instrument, as imported from America, consists of a thin flexible sheet of hard ebonite rubber, provided with a handle like a palm-leaf fan, and with a cord which can be tightened at pleasure to curve it into the form of a semi-cylinder. The edge of the sheet is pressed against the upper set of teeth, as described in a recent "Note," the convex surface being outwards, and so the vibrations impinging upon the sheet are transmitted through the teeth and bones of the skull to the auditory nerve. Prof. Colladon finds that the sheet of ebonite may be advantageously replaced by a sheet of fine elastic cardboard, the best kind being that smooth, dense variety known to the trade as *shalloon* board or satin board (*carton d'orties*). This card audiphone costs but a trifling fraction of the ebonite article, and is on all hands admitted to yield a better result. Some experiments conducted in January by M. Colladon and by M. Louis Sager upon deaf-mutes leave no doubt of the existence of cases in which, while the ordinary hearing-trumpet fails, the audiphone is successful. M. Colladon mentions the case of a professional singer who had been deaf for fourteen years, to whom the audiphone of cardboard brought back once more the power of hearing the music of a piano. It is an interesting point in M. Colladon's observations that persons deaf-mute from birth evinced emotions of a pleasurable nature on thus hearing music for the first time.

THERE appears to be no doubt as to the reality of the gems produced by Mr. Hannay being diamonds. It is now understood that the process by which they are obtained is one suggested by Mr. Hannay's recent research on the solubility of solids in gases, of which an account was given in a recent number of NATURE. Mr. Hannay observed that when a gaseous solution of a solid is allowed to expand, some of the solid is usually deposited, and is deposited in crystalline forms. Acting on this hint, it was attempted, though in vain, to procure the gaseous solution of graphite and other forms of carbon. However, it had been observed by Mr. Hannay—if we are rightly informed—that certain metals act upon hydrocarbon gases at considerable pressures, abstracting from them the hydrogen. Such a gas, on being cooled and allowed to expand, deposits its carbon. Performing this operation in the presence of nitrogen, at a pressure of some thousands of atmospheres, and at a temperature not far from a red heat, crystals of carbon were obtained. These proved to be good octohedra, some of them having the property of showing curved edges, which is unique to the diamond. Their angles, when measured by Prof. Maskelyne, gave the true value for octohedra. The crystalline fragments disappeared when heated upon platinum-foil in oxygen. A portion weighing 14 milligrams, when duly "combusted" as for an organic analysis, showed 97·85 per cent. of carbon. Mr. Hannay employed digesters resembling gun-barrels, with wrought-iron coils having an internal diameter of one inch and an external diameter of four inches. Even these strong tubes repeatedly gave way under the enormous pressure required.

O. E. MEYER has recently shown, by careful measurement of the intensity for different groups of rays of the spectrum, that ordinary daylight contains relatively a greater proportion of red and yellow rays, and a less proportion of blue and violet rays than the direct light of the sun.

NEWTON denoted by the name of "indigo" the tint of the spectrum lying between "blue" and "violet." Von Bezold, in his work on colour, rejects the term, justifying his objection by observing that the pigment indigo is a much darker hue than the spectrum tint. Prof. O. N. Rood, who follows von Bezold in rejecting the term, brings forward the further objection that the tint of the pigment indigo more nearly corresponds in hue (though it is darker) with the cyan-blue region lying between green and blue. By comparing the tints of indigo pigment, both dry and wet, with the specrum, and by means of Maxwell's disks, it appears that the *hue* of indigo is almost identical with that of Prussian blue, and certainly does not lie on the violet side of "blue." Indigo in the dry lump, if scraped, has, however, a more violet tint; but if fractured or powdered, or dissolved, its tint is distinctly greenish. Prof. Rood considers that artificial ultramarine corresponds much more nearly to the true tint of the spectrum at the point usually termed "indigo," and he therefore proposes to substitute the term "ultramarine" in its place, the colour of the artificial pigment being thereby intended.

PROF. W. F. BARRETT has recently come to the conclusion that the phenomenon of the Trevelyan "rocker," which has been hitherto regarded as produced by the rapid expansion and contraction of the metals in contact, is due rather to the action of a polarised layer of gas between the hot and cold surfaces like that existing between the hot and cold surfaces of the layer of vapour supporting a drop of liquid in the spheroidal state, and termed a "Crookes's layer" by Mr. G. J. Stoney. The Trevelyan rocker appears, therefore, to be a true heat-engine.

M. E. SARASIN has been continuing the work begun by M. Forel, of observing the phenomenon of the *seiches* of the Swiss lakes. In pursuit of this object he has constructed a registering limnimeter of a more portable form than those of MM. Forel and Plantamour. Instead of digging in the bank of the lake a well communicating with the deep water, M. Sarasin employs a tube of zinc about 35 centims. in diameter, and 150 centims. long. This is fixed vertically to about half its depth in the lake, against a wall or jetty, and communicates with the water by a narrow tube descending to a considerable depth, thus avoiding the fluctuations of mere waves. The support which holds the tube also carries a pully over which a ribbon of copper passes, having at one end the float, at the other a counterpoise. The axis of the pulley passes into a separate case containing a registering apparatus, in which a pencil rests upon a sheet of paper which is carried forward at the rate of one millimetre per minute by clock-work. This portable limnimeter when placed for comparison beside the fixed limnograph of M. Plantamour at Sécheron, gave identical indications. It was then set up at the Tour de Peilz near Vevey, in order to observe the oscillations at a station further east than those previously selected. The researches of M. Forel had shown the existence of long oscillations of 73 minutes' duration, due to uninodal waves along the length of the lake from Geneva to Villeneuve, and of shorter oscillations of 35 minutes' period, due to a binodal oscillation in the same direction. The former were observed, though not markedly, at the Tour de Peilz, and were found to be in almost exact opposition of phase to those simultaneously registered at Sécheron, and in agreement with those at Morges. The binodal waves of 35 minutes coincide in phase at Vevey with those at Sécheron. These were observed to possess extreme regularity, the exact mean period being 35·6 minutes. Other oscillations with a period of 5 to 6 minutes were observed, and are attributed to transverse oscillations in the lake from Verey to St. Gingolphe. As was observed at Morges, the new limnograph indicated incessant small oscillations due to the passage of steamboats; the first morning boat from Villeneuve could be thus detected by the oscillations produced from 12 to 15 minutes before its arrival. These observations leave no doubt of the general correctness of M. Forel's theory, and establish two points hitherto requiring confirmation; firstly, that the movements of oscillation observed at the two ends of the lake are precisely similar in type, being opposite in phase for uninodal waves, but identical in phase for binodal waves; secondly, that the oscillations of 35 minutes' period are due to binodal waves, not as was at one time thought possible to oscillations occurring in the transverse dimensions of the lake.

OUR contemporary, the *Electrician*, states that the following process for utilising old india-rubber, of which many hundred tons are thrown away as waste substances, has just been patented in Germany. The rubber waste is subjected to distillation in an iron vessel over a free fire, with the aid of superheated steam. The lighter oils which come over first are separated from the heavier products. The latter when thickened and vulcanised in the usual manner, are found to possess all the good qualities of first-class natural rubber.

MR. J. E. H. GORDON points out, in the pages of a contemporary, that Silone is the real inventor of a form of Thomson electrometer, recently attributed to Herr Edelmann. This "improved" instrument had the usual flat brass quadrants replaced by a metallic cylinder slit longitudinally into four parts, within which the "needle" was placed. Silone's instrument, which was described in *Poggendorff's Annalen* for 1875, was used for determining the specific inductive capacity of liquids, and the quadrants were of tinfoil pasted inside a glass cylinder.

GEOGRAPHICAL NOTES

PROF. NORDENSKJÖLD in a short paper to the Paris Academy of Sciences, gives a list of the collections obtained during his recent expedition, which are to be arranged and described on his return to Stockholm. There are numerous observations on climate, magnetism, auroræ, hydrography, geology, fauna, flora, ethnography, &c. Among the collections is a very rich collection of invertebrates taken during the numerous dredgings of Dr. Stuxberg in the Glacial Ocean; to judge from these dredgings, the fauna richest in individuals, at the depth of 30 to 100 metres, is not to be found in the tropics, but only in the Glacial Ocean and Behring Strait; yet here the temperature at bottom is always 1° to 2° C. below zero. Collections of phanerogams, lichens, and algæ were made by Dr. Kjellman and Dr. Almquist; masses of bones of sub-fossil whales of the Chukchi peninsula and of *Rhytina stelleri* of Behring Island; a very fine collection of tertiary fossil plants from Nagasaki and Labuan; this collection is expected to afford information on the former equatorial climate and on the ancient centres of dispersion of the present floras. Cut stones, utensils, arms, dresses, &c., of Chukchis and Eskimo; the latter at present use both weapons of stone and the Remington rifle. This collection contains among other things drawings, engravings, and sculptures in ivory, which have much resemblance to the palæolithic designs of France. Lastly, there is a collection of 1,040 works in 5,000 or 6,000 volumes of Japanese books and MSS., printed or written before the opening of the country to Europeans. The *Vega* left Naples for Lisbon and Portsmouth on Sunday.

SURGEON-MAJOR H. W. BELLEW has lately collected, from native authorities, some useful information respecting Kafiristan, that interesting country which no European has so far succeeded in exploring. It appears that it is, after all, only about 150 miles in length, by about 50 or 60 in breadth, and its boundaries may be taken as the Hindu Kush on the north, including both the northern and the southern slopes, from Latkoh Darra on the east, to the Farájgal valley on the range separating it from Panjshir, on the west; the Chitral River, down to Chaghansarae, or even Kunar, on the east, forms its limit in that direction, while the southern boundary may be taken to be a line from Darra Nur, on the east, to Tagao on the west; and on the west it is bounded by the Nijrao and Panjshir valleys. The whole area is mountainous and furrowed by a succession of long winding valleys, each of which has its own system of branches and glens ramifying into the recesses of the mountains. From information which Dr. Bellew derived from a native of the country, there appears to be "nowhere room to gallop a horse." Dr. Bellew, besides the topographical information which he has brought together, has extended his researches into the subject of the manners and customs, &c., of the Kafirs, and the results of his investigations make us regret all the more that Major Tanner was last year compelled to abandon his intended visit to Kafiristan.

THE March number of the Geographical Society's monthly periodical contains Mr. G. J. Morrison's papers on his journeys on the Grand Canal and Yellow River, and from Hankow to Canton overland, followed by Dr. Emil Holub's account of his last expedition in South Central Africa from the Diamond Fields to the upper waters of the Zambesi, the former illustrated by two maps, on one sheet, of parts of Eastern China. The geographical notes comprise some interesting remarks on the climate of Zanzibar, which it behoves intending travellers in East Central Africa to study carefully, a summary of proposals for a survey of Southern Africa, and the results of Lieut. R. C. Temple's observations on the distribution of the Afghan tribes about Candahar. The rapid progress of the Berlin Society of Commercial Geography is also alluded to. A memorandum by Mr. Alfred Simson on the boundaries of Ecuador will be found to contain matter of considerable geographical interest. We observe that in the April number we are promised a map illustrating Dr. Holub's South African journeys and Sir Michael Biddulph's valuable topographical notes on the eastern border of Pislim and the basin of the Loras in Afghanistan.

IN reference to a note in a recent issue, it is interesting to learn that a company of squatters is being formed in Western Australia, with the object of at once occupying the magnificent tract of country on the Fitzroy River, which has recently been discovered by Mr. Alexander Forrest. It is intended to take stock there, and to endeavour to cultivate tropical products.

THE Berlin Society of Commercial Geography is rapidly assuming considerable importance. As we have before recorded, it was started about a year ago, and now numbers some 1,500 members. It already has several affiliated branches among German communities in different parts of the world, and issues two periodicals. One of these, which is of a scientific nature, appears twice a month, while the other is purely commercial, and is published every week.

MR. JAMES CAMERON appears to be one of the most indefatigable of the active members of the China Inland Mission. It will be remembered that shortly after Mr. McCarthy's and Capt. Gill's journeys into Burmah, Mr. Cameron performed the same feat, and was very anxious to return to Yünnan by the same route. Being forbidden, however, to do so by the Indian Government, he went, by way of Rangoon and Singapore, to the newly-opened port of Pakhoi, in the extreme south of China. From this place he made a long journey in the interior, going through parts of the provinces of Kwangtung, Kwangsi, Kweichow, and Yünnan, in fact, across the whole south of China Proper, and visiting places where Europeans had never been seen before. Since accomplishing that arduous undertaking, Mr. Cameron has made another long journey through parts of the provinces of Kwangtung Kiangsi, Fokhien, and Chekiang. In a remote part of the first-named province, near Shao-chow-fu, he noticed a novel method of transporting stones from a hill-top to the river-side. A zigzag path was made down the hill-side, hollowed in the centre; on it a loaded sledge was placed and set in motion, the path being kept slippery by water poured on it by a man who appeared to have no other occupation. Nearer the border of the province the country people had a peculiar mode of preparing the ground for rice, in that they made straight rows and then crossed them, using a rake-like instrument with wheels instead of teeth. In the east of the Kiangsi province Mr. Cameron mentions finding the tea-plant growing wild on the mountain sides, and forming with other shrubs a fine cover for game.

AT the annual meeting of the Russian Geographical Society the great gold medal was not awarded; the gold medal of Count Lütke was awarded to Prof. Inostrantseff, for his geological work on the district of Povyenets (government Olonets). Small gold medals were awarded to M. Zolotnitsky, for the compilation of a dictionary of the Chouvashes language and researches into this language; to M. Orloff, for statistical works on the Government of Moscow; to General Stubendorf, for his continuous works in geography: to M. Kouropatkin, for his work on "Kashgaria;" M. Moshkoff, for the levelling in Siberia; M. Pyevtsoff, for his paper on Jungaria; and to M. Polyakoff, for his researches into the stone period in Russia. Silver medals were awarded in great number:—to M. Tikhonravoff, for his works during the Anthropological Exhibition at Moscow; MM. Lipin and Portsevitch, for work done during the exploration of the Obi and Yenissei watershed; M. Petrussevitch, for the exploration of the Amu River; M. Matussovsky, for his description of the highways in Western Mongolia; M. Yanovsky, for meteorological observations on the Askold Island; M. Listoff, for researches into the freezing of the Ketz salt lake; MM. Gellmann, Polouyanovsky, Stoulchinsky, and Petrovsky, for the levelling in Siberia; and to several others for ethnographical and statistical works.

IN the December number of the Paris Geographical Society's *Bulletin*, M. De Ujfalvy gives a pretty full account of Kulja, *àpropos* of the existing trouble between Russia and China as to its possession. M. J. Barraude concludes his translation of the long Russian paper on the Amu and Uzbu; and M. de Bizemont brings together the meteorological observations of Abbé Desgodins, on the meteorology of Tibet. M. Jametel describes the various routes from Jungaria to Tibet, after Chinese documents; and M. A. Lomonosof gives the itinerary from Patta-Kasar to Herat, followed by Col. Srodekof in 1878.

HISTORY OF RESEARCH AMONG THE FOSSIL FISHES OF SCOTLAND[1]

ALTHOUGH works containing notices of fossil fishes had appeared on the Continent as early as the fifteenth century, the earliest work descriptive of their occurrence in Scotland was Ure's "History of Rutherglen and East Kilbride," which was published in 1793, in which, among other Carboniferous fossils, several relics of the fishes of that epoch were figured. These are mostly the teeth of *Selachii*, or sharks, but one of them is a portion of the mandible of the gigantic ganoid fish now known as *Rhizodus Hibberti*. It was not, however, until the end of the third and commencement of the fourth decades of the present century that the palæichthyological treasures of the country began to attract any real attention.

In the year 1827 Sedgwick and Murchison, who had been exploring the sedimentary rocks of the north of Scotland, despatched to Cuvier, for his opinion, a number of fossil fishes which they had found in the dark schists of Caithness; and they sent other specimens to Valenciennes and Pentland. In 1828 they communicated to the Geological Society of London a paper "On the Structure and Relations of the Deposits contained between the Primary Rocks and the Oolitic Series in the North of Scotland," in which they founded the genus *Dipterus*, giving excellent figures of four supposed species. Cuvier's opinion was to the effect that these fishes were allied to the *Lepidosteus*, or bony pike of North America, and belonged, like it, to his division of *Malacopterygii abdominales*. The genus *Osteolepis* was also mentioned on the authority of Valenciennes and Pentland, with a figure of what is apparently a plate of *Coccosteus*, but which the authors at the time considered as having belonged to a "tortoise nearly allied to Trionyx."

In 1827 Fleming had also obtained from the Upper Old Red Sandstone of Fifeshire certain organic remains, of which in the same year he published a preliminary notice in a local newspaper. These were, in fact, the scales of the fish, which afterwards received the now well-known name of *Holoptychius*.

A year afterwards, scales and plates of fishes were found in the upper "Old Red" of Clashbennie, in Perthshire, and were by some at first considered to be *oyster shells!* But Fleming, at once perceiving their real nature, prepared a short notice, "On the Occurrence of the Scales of Vertebrated Animals in the Old Red Sandstone of Fifeshire," which he read before the Wernerian Society of Edinburgh in May, 1830.

Immediately after these beginnings were being made in opening out the rich storehouse of ancient fish-life contained in the Scottish Old Red Sandstone strata, the equally interesting treasures of the Carboniferous rocks in the neighbourhood of Edinburgh had begun to attract notice. The greatest possible interest was excited among Edinburgh naturalists by Hibbert's discovery of the fossiliferous nature of the limestone of Burdiehouse, a member of the Lower Carboniferous series, and the Royal Society of Edinburgh co-operated energetically with that gentleman in securing a large collection of the animal remains which it contained. These comprised not only entire specimens of numerous small fishes, but also large detached spines and scales, and, above all, enormous conical teeth, some of which attained a length of $3\frac{3}{4}$ inches, and a width of $1\frac{1}{2}$ inch at the base.

In the year 1833 the first *livraison* of Agassiz's "Recherches sur les Poissons fossiles" was given to the world. Already a goodly array of Continental writers had published accounts and figures of fossil fishes from various strata. Of these may be mentioned: Mylius, Knorr and Walchner, Wolfart, Scheuchzer, Volta, Bronn, Cuvier, and De Blainville; and a few also in England, such as Lhwyd, Mantell, and Sowerby had made observations upon similar fossils which had come under their notice. Large collections, both public and private, had also been formed. But as yet no satisfactory basis had been found for the comparison of fossil with living forms, and the vast treasures which were to be added to our knowledge of the succession of ichthyic life on the globe were, it may be said, as yet entirely unknown. It was reserved for Agassiz to lay the first secure foundations for this knowledge, and to become, as he is so often and so worthily styled, the father of fossil ichthyology.

Upon the studies to which he now directed his attention, and which were so largely to contribute to his world-wide reputation, Agassiz brought to bear the indispensable qualifications of an intimate acquaintance with recent ichthyology as well as with zoology and comparative anatomy in general. And in pursuing his investigations into the ichthyology of bygone ages, he soon became aware that no satisfactory place could be found in the Cuvierian system of classification for an extensive array of extinct fishes, which prevailed especially during the great palæozoic and secondary epochs. They bore affinity both to the sturgeon, classed by Cuvier among the *Pisces cartilaginei*, and to the American *Lepidosteus* and African *Polypterus*, whose place was then considered to be in the Malacoptery ian or soft-finned division of the *Pisces ossei*. The point in their configuration, by which Agassiz was more especially struck, was their possession of strong, bony, and usually glistening scales, the last-mentioned peculiarity suggesting the term "ganoid," as expressive of their distinctive aspect. The study of these ancient "enamelled-scaled" fishes seems to have formed the spring to the conception of his new classification of fishes, according to their scales, into the four orders of *Ganoidei*, *Placoidei*, *Ctenoidei*, and *Cycloidei*. Working on the basis of this classification, he commenced the publication of his great work, and had already, as he tells us, become acquainted with six hundred species of fossil fishes, when

[1] Being extracts from an Address given to the Royal Physical Society of Edinburgh, by Ramsay H. Traquair, M.D.

in 1834 he visited Great Britain for the first time, and his studies received a fresh impetus from the wealth of new forms which he found in English collections. In Scotland, too, collectors had been bestirring themselves, for besides what we have already noticed as having been done by Sedgwick, Murchison, Hibbert, and the Royal Society of Edinburgh, Traill had made a valuable collection from the Old Red Sandstone of Orkney; Knight of Aberdeen from the same formation at Gamrie; Lord Greenock had discovered the richness, in fish remains, of the Carboniferous shales at Wardie; and many Scottish specimens had also been collected by Jameson, Torrie, Buckland, and others.

The British Association met in 1834 at Edinburgh, and Agassiz was then introduced by Buckland to the Geological Section immediately after Hibbert had read a paper, in which he considered the gigantic teeth and bones found at Burdiehouse to "resemble those of Saurian reptiles." Their piscine nature was, however, at once detected by the accomplished Swiss naturalist, and the requisite material having been willingly handed over to him, he prepared and read, two days afterwards, a "Report on the Fossil Fishes of Scotland," in which several new genera are named. Most of the Scottish material obtained by Agassiz at this time was published in detail in the fasciculus of his great work, which appeared in 1835, the Devonian forms including the genera *Cephalaspis*, *Acanthodes*, *Cheiracanthus*, *Cheirolepis*, *Dipterus*, and *Osteolepis*; while those from Carboniferous rocks were referred to *Amblypterus*, *Palæoniscus*, *Eurynotus*, *Pygopterus*, *Megalichthys*, *Gyracanthus*, *Tristichius*, *Ctenoptychius*, &c.

Agassiz revisited Scotland in 1842, and was present at the meeting of the British Association held that year at Glasgow. By this time the material for the further study and description of Scottish fossil fish remains had vastly increased. Large collections from the Old Red Sandstone beds of Cromarty and Morayshire had been made by Hugh Miller, Dr. Malcolmson, Lady Gordon-Cumming, and Mr. Alexander Robertson. The collections of Lord Enniskillen and Sir Philip Egerton, which already, at the time of Agassiz's first visit to Great Britain, afforded a magnificent display of English and foreign species, now contained a choice selection also from Scotland. Carboniferous forms had been assiduously collected by Dr. Rankin of Carluke and others. The large accession of material from the Old Red Sandstone enabled Agassiz in 1842 to lay before the British Association a "Report on the Fossil Fishes of the Devonian System," which finishes with a list of fifty-five species belonging to twenty genera.

His great work, the "Recherches sur les Poissons fossiles," was completed in 1843, and in it was inserted a general list of all the fossil fishes which had till then come under his notice. Here we find ninety-nine species named from Scottish deposits, but, unfortunately, descriptions only of twenty-five were included in the text. The others he reserved for a projected series of supplementary monographs, of which only one ever appeared, namely, that on the fishes of the Old Red Sandstone, which was completed in 1846. In this work sixty-seven Scottish species are figured and described, and some improvements in classification effected by the establishment of the new families of *Cephalaspidæ*, *Acanthodidæ*, and *Saurodipterini*, the two former being dismembered from the old heterogeneous *Lepidoidei*, and the latter partly from the *Lepidoidei* and partly from the so-called *Sauroidei*.

In offering a few words of comment upon the labours of Agassiz in this department, the highest tribute of honour must be paid to him for the position to which he raised the science of fossil ichthyology, as well as for the enormous amount of work which he accomplished in so short a time. Eminent as well in other branches of zoology, his name will go down to posterity as that of one of the greatest naturalists of the present century. To him we owe the establishment of the order of Ganoid fishes, the description of an enormous array of genera and species, and the first valuable generalisations as to the history and succession of ichthyic life on the globe. An opponent of the so-called vertebral theory of the skull, as held by Oken, and modified by Owen and others, as well as of the doctrine of descent, he nevertheless pointed out what, as Prof. Marsh says, "is now thought to be one of the strongest points in favour of evolution," namely, the correspondence between the heterocercal character of the tail in the embryos of modern osseous fishes, and the prevalence of that form among the adult fishes of the older formations, stating, in fact, that "les poissons fossiles du vieux grès rouge représentent réellement l'âge embryonique du règne des poissons." But it is hardly possible for the zoologist of the present day to suppress some feeling of wonder that a man, so well versed in general zoology and anatomy as Agassiz, should have based his classification of fishes upon characters so trivial as the mere external aspect of their scales, or that he should have distinguished many of the families into which he divided the order of Ganoids by characters equally superficial. We may quote, for instance, his inclusion among the Ganoids of the Pipe-fishes, Siluroids, Globe-fishes, and Trunk-fishes, merely on account of their bony scutes; the entirely artificial nature of the distinction which he drew between his Ganoid families of "Lepidoids" and "Sauroids," and the consequent utterly heterogeneous character of both; the similarly unsatisfactory nature of his family of *Cœlacanthi*, into which he even introduced the recent Teleostean *Arapaima*;—and so on. However, it is at the same time only natural that he should have been imperfectly acquainted with the anatomy of the ancient Ganoids, considering the as yet comparatively scanty material at his disposal, and it is also evident that, had he devoted more time to the elucidation of osteological detail, he could not possibly have gone over the same enormous amount of ground within so limited a period.

Agassiz's classification of fishes was at first eagerly accepted by geologists and others, largely on account of its supposed convenience. It could not, however, stand the test of anatomical inquiry, and was soon superseded by the system proposed by Johannes Müller in 1844, which, with various minor modifications, is the one still adhered to by most zoologists. Such, however, was the influence of Agassiz, and such the supposed "convenience" of his system, that we find it in use, especially amongst geologists and "palæontologists," years after Müller's great paper "Ueber den Bau und die Grenzen der Ganoiden" was published.

The large fossil creature whose laniary teeth, sometimes four or five inches in length, suggested the idea of a "Saurian reptile" to Hibbert, and which was rightly placed among the fishes by Agassiz, received from him the not inappropriate name of *Megalichthys Hibberti*. With its remains, however, those of a much smaller fish, with glossy angular scales, were at the time unfortunately confounded, but there can be no doubt that the name *Megalichthys* was suggested by the large teeth, and properly belonged to their possessor. Nevertheless, some time afterwards, on visiting Leeds, and finding in the Museum there the head of an example of the *smaller* fish, Agassiz described and figured *it* in a subsequent number of the "Poissons fossiles," as *Megalichthys Hibberti*, while for the real and original *Megalichthys*, along with some Old Red species he founded the genus *Holoptychius*. Prof. Owen, however, in his "Odontography" (1840-45), elevated the Carboniferous "*Holoptychius*" *Hibberti* into the new genus *Rhizodus*, giving also many important details regarding the microscopic structure of the teeth. The claims of *Rhizodus* to generic distinction were stoutly disputed by Agassiz in his work on the fishes of the Old Red Sandstone. Subsequent investigation has, however, not only proved the validity of *Rhizodus* as a genus, but also that it cannot even be included in the same family with *Holoptychius*. In the same work Owen described the remarkable microscopic structure of the conical teeth from the Old Red Sandstone of Morayshire, to which he gave the name of *Dendrodus*.

The next writer on Scottish fossil fishes who claims attention is Hugh Miller, who devoted his chief attention to them, and whose collection of "Old Red" forms furnished many of the types described and figured by Agassiz in his "Monographie des Poissons fossiles du Vieux Grès Rouge," as well as many which were also figured by himself.

Among Miller's fascinating popular descriptions of scenery, geological structure, and fossil fishes, we find some genuine touches of original palæontological observation, which quite sufficiently indicate what his powers in that direction might have been, had they been properly developed. We find, for instance, that he was quite aware that *Cheirolepis* was not an Acanthodian, though it was classed by Agassiz in that family. We find a very creditable restoration of *Osteolepis*, infinitely superior to that given by Agassiz some years afterwards, and hardly inferior to that given by the accomplished Pander; and we find him correctly interpreting as the *ventral* surface of *Pterichthys* that aspect of the creature erroneously represented by Agassiz as the dorsal. He also showed that Agassiz's *Polyphractus*, supposed by him to be a genus allied to *Pterichthys*, was nothing more than the cranial shield of a *Dipterus*. He likewise discovered the dentition of *Dipterus*, which, with the structure of the palatal aspect of the skull, afterwards proved of such importance in determining the affinity of that genus to the recent *Dipnoi*. Many important original observations and figures were given by him regarding the cranial osteology of *Osteolepis* and *Diplopterus*, as well as of the gigantic *Asterolepis*.

M'Coy, while engaged in naming and describing the palæozoic fossils of the Woodwardian Museum at Cambridge, among which were a considerable number of Scottish fossil fish remains, principally from the Old Red Flags of Orkney, published in 1848 some account of his work in naming and describing genera and species. It is greatly to be feared that the enormous field over which his other palæontological researches extended had not afforded him the time and opportunity to acquire the necessary experience in deciphering fish remains, without which the liability to error is not only natural but imminent.

To M'Coy we owe the separation of the true *Cephalaspidæ* from the other fishes, *Pterichthys* and *Coccosteus*, with which Agassiz had associated them, and the establishment of the latter as a group by themselves under the name of *Placodermata;* also the term "diphycercal," applied to that form of fish-tail in which the vertebral axis is, as in the heterocercal form, gradually attenuated, but runs straight backwards instead of turning up, and the fin-rays being developed equally, or nearly so, above and below, a more or less rhombic and symmetrical form of caudal fin is produced.

The diphycercal tail is a *more primitive or embryonic* form than the heterocercal, of which the modern homocercal tail is again a further specialisation. That this is the case is evident to any one who will carefully compare a proper series of tails of recent and fossil fishes. Prof. Alexander Agassiz has recently put the matter in a perfectly clear and unmistakable light by showing that the tail in embryo *Pleuronectidæ* is first diphycercal (leptocardial), then heterocercal, and finally assumes the homocercal form of the adult in which the heterocercy becomes to external appearance completely obliterated.

Sir Philip Grey-Egerton, whom we are glad to refer to as a veteran naturalist, still living amongst us, and continuing to take the warmest interest in the progress of the science to which he has himself contributed so much, has not in his writings sought to alter the classification of Agassiz save in one or two points of secondary importance. He has busied himself with the description of new genera and species, so largely supplied by his own magnificent collection as well as by that of his close personal friend, the Earl of Enniskillen, to whom also the friends of fossil ichthyology owe a lasting debt of gratitude. Although Sir Philip's descriptions mainly relate to fishes from the newer formations in England, he has also made some important contributions to our knowledge of Scottish forms. In his paper on *Pterichthys* (1848), written in conjunction with Hugh Miller, he corrected some of the mistakes into which Agassiz had fallen with regard to the arrangement of the plates in that genus. In another communication, "On the Nomenclature of the Devonian Fishes," he offered some able criticisms on Prof. M'Coy's work in that department, and added as a supplement a series of interesting extracts from letters by Hugh Miller on the structure of *Coccosteus*. The tenth decade of the Geological Survey, published in 1861, contains also from Sir Philip's pen a description of *Tristichopterus alatus*, one of Mr. Peach's most interesting discoveries in the Old Red Sandstone of John o' Groats, as well as of several beautiful little Acanthodian fishes, two from Caithness, also discovered by Mr. Peach, and others from the grey beds of Forfarshire, brought to light by several industrious Forfarshire collectors, among whom were the Rev. Hugh Mitchell, the Rev. Henry Brewster, Mr. Walter M'Nicol, and Mr. Powrie of Reswallie. To Scottish carboniferous ichthyology Sir Philip Grey-Egerton also contributed descriptions of two new selachian species, *Ctenacanthus hybodoides* and *C. nodosus;* and his paper on the probable identity of Agassiz's genera, *Pleuracanthus* and *Diplodus*, is also of equal importance to the investigator of the fossil contents of the Scottish as of the English coal measures.

A third great era in the history of palæozoic ichthyology may be said to have commenced with the publication of the researches of the distinguished Russian naturalist, Dr. Christian Heinrich Pander. With his first great work, the "Monographie der fossilen Fische des silurischen Systems des russisch-baltischen Gouvernements," published in 1856, we have here nothing to do, save to remark that if the singular little tooth-like bodies, known as "conodonts," be in reality what many at the present day suppose them to be, namely, the teeth of Myxinoid fishes, then we shall have abundant evidence of the prevalence of these lowly organised fishes far back in Lower Silurian times. It is his three subsequent publications, on the "Placodermi," on the "Ctenodipterini," and on the "Saurodipterini, &c.," appearing respectively in 1857, 1858, and 1860, which attract our attention, dealing as they do with the fishes of the Old Red Sandstone, and very largely with Scottish specimens. Fish remains are of frequent occurrence in the Old Red Sandstone of Russia; many had been previously described by Eichwald as far back as 1839, as well as by Agassiz in his monograph of the fishes of the Old Red Sandstone. These remains are, however, mostly very fragmentary; to read them aright, comparison with more entire fishes was necessary, and this want was supplied by the liberality and enthusiasm of a member of the Russian Academy, Herr von Hamel, who undertook a journey to Scotland, and, having collected a large number of specimens both in Caithness and in Orkney, packed them in barrels, and shipped them off bodily to St. Petersburg. There they were placed at Pander's disposal for description, and the results are embodied in the three works last quoted. The main feature in Pander's work was his elucidation of structure, and his clear insight into the fact that only by careful and laborious investigation into the structural features of the skeleton, external and internal, can we hope to determine the natural affinities of fossil fishes. Here his achievements surpassed all that had been previously done in palæozoic ichthyology. The structure of the *Placodermata* (*Pterichthys*, *Coccosteus*, *Asterolepis*, *Heterosteus*) is minutely described and illustrated, as also of the *Saurodipterini* (*Osteolepis*, *Diplopterus*). A like treatment is accorded to *Dipterus*, for which he institutes the family *Ctenodipterini*, in which he also provisionally includes *Ceratodus*, then only known as a mesozoic fossil, and to *Cheirolepis*, which he also erects into a distinct family, fully corroborating the views of Hugh Miller and of Giebel as to its place not being among the *Acanthodei*, as Agassiz had imagined, as well as indicating that he was not unaware of its resemblance to *Palæoniscus*. The singularly beautiful and complicated microscopic structure of the Old Red Sandstone teeth, so well known as *Dendrodus*, *Lamnodus*, &c., is minutely described and magnificently delineated.

From his elaborate and truly scientific researches, Pander derived one interesting generalisation, which presently rose to extreme importance. Johannes Müller had long before shown that the recent *Lepidosteus* and *Polypterus*, classed together by Agassiz in one family, that of the so-called *Sauroidei*, were representatives of totally distinct groups of Ganoids; but among all the fossil fishes of the order, he could for *Polypterus* find no ally. Pander, however, pointed out that, far from *Polypterus* having no ally in past ages, it is to it rather than to *Lepidosteus* that the affinities of many of the Old Red Sandstone Ganoids point, and more especially those of the group known as *Saurodipterini*.

In 1858 Huxley published observations on the genera *Cephalaspis* and *Pteraspis*, having in the previous year described the new genera *Glyptolæmus* and *Phaneropleuron*, with observations on the genus *Holoptychius*. In 1861 his "Essay on the Systematic Arrangement of the Fishes of the Devonian Epoch" appeared, in which the whole subject of the classification of the Ganoids, and especially of those of the Old Red Sandstone was discussed.

Pander noticed the fact that many of the Old Red Sandstone Ganoids were more allied to *Polypterus* than to *Lepidosteus*. Huxley, proceeding farther in the same direction, instituted the sub-order *Crossopterygidæ*, of which *Polypterus* and *Calamoichthys* are the sole living representatives, but which in palæozoic times included an extensive assemblage of forms, collectively equivalent to Agassiz's *Cœlacanthi* and *Saurodipterini*. The heterogeneous nature of Agassiz's "*Cœlacanthi*" was pointed out, and the term very properly limited to the peculiar genera *Cœlacanthus*, *Undina*, *Holophagus*, and *Macropoma*, none of which are, however, found in the Old Red Sandstone. The remaining Agassizian Cœlacanths (*Holoptychius*, *Glyptolepis*, &c.), were placed in a new family, that of the *Glyptodipterini*, and here are also included forms both with rounded and rhombic scales. Pander's family of "Dendrodonts" was considered to be probably based on teeth of fishes belonging to the *Glyptodipterini*. But the Russian author's family of *Ctenodipterini* and Agassiz's *Saurodipterini* are retained and likewise placed in the Crossopterygian sub-order, which lastly includes also the *Phaneropleurini*, constituted by the singular genus *Phaneropleuron*.

The next important point in Prof. Huxley's "Essay" is the attention which he drew to the singular ties which connect the recent genus *Lepidosiren* (the Australian *Ceratodus* being at that time still undiscovered) with the cycloidal-scaled members of the *Crossopterygidæ*. And although he was not fully aware of the extreme closeness of the relationship between the recent Sirenoids and one of his Crossopterygian families, the *Ctenodipterini*, he, nevertheless, touched the spring which subsequently disclosed to us the true position of that family, when he compared the teeth of *Lepidosiren* with those of *Dipterus*.

On the other hand the American bony pike or *Lepidosteus*, is made the living type of another great assemblage, of which the Old Red Sandstone genus *Cheirolepis* "ought perhaps to be regarded as the earliest known form." To this sub-order of *Lepidosteidæ* merely a passing and imperfect notice is accorded, but it is nevertheless clear that the author means it to embrace both the heterocercal *Palæoniscidæ* of the upper palæozoic rocks, and that great array of semi-heterocercal rhombic-scaled forms (*Lepidotus*, *Dapedius*, *Pholidophorus*, &c.), which in mesozoic times constituted the great bulk of the Ganoid order.

These two great sub-orders of *Crossopterygidæ* and *Lepidosteidæ*, with the addition of the recent *Amiadæ*, are equivalent to Müller's *Ganoidei Holostei*. The other sub-order of the Berlin anatomist, that of the *Chondrostei* or sturgeons was accepted, and to it the remarkable Old Red family of *Cephalaspidæ*, referred, provisionally at least, while into a fifth sub-order was erected the problematic group of *Acanthodidæ*, which, in their organisation, seem to combine so many of the characters both of ganoids and of sharks.

Undoubtedly, the weakest point in Prof. Huxley's "essay" is the attempt which he made to show, by comparison of the exoskeletal plates of *Coccosteus* with the bones visible on the exterior of the skeleton of many recent siluroids, that there was a possibility at least of the enigmatical group of *Placodermata* turning out to belong to the great order of *Teleostei*, or ordinary bony fishes, "hitherto supposed to be entirely absent from formations of palæozoic age." Recent discoveries in the palæozoic rocks of America point, as we shall presently see, to another, and perhaps more probable, solution of the question.

Mr. Powrie, of Reswallie, has contributed several papers on the fishes of the Old Red Sandstone of Forfarshire, and to him we owe the definition of the genus *Euacanthus*, comprising four species, and also of a new species of *Parexus*. The remarkable group of *Cephalaspidæ* has been monographed by Prof. E. Ray Lankester in the volumes of the Palæontographical Society for 1868 and 1870.

The true affinities of the Old Red Sandstone genus *Dipterus*, and the carboniferous *Ctenodus*, foreshadowed by Mr. Huxley in 1861, were thoroughly cleared up by the discovery of the living *Ceratodus Forsteri* in the rivers of Queensland. The *Ctenodipterini* were definitely placed among the *Dipnoi* by Dr. Günther in his account of the structure of *Ceratodus* (*Phil. Trans.*, 1871), and subsequent observation has amply confirmed the correctness of his views on this point.

The discovery in the Devonian rocks of North America of the gigantic Placoderm, named by Prof. Newberry *Dinichthys*, seems at last to throw some light on the position of that remarkable group of extinct fishes. In *Dinichthys* we have a form, apparently closely allied to *Coccosteus*, but also possessed of a dentition in many respects resembling that of the recent *Lepidosiren*. It seems, therefore, not unlikely that the *Placodermata* will eventually turn out to have been an aberrant group of loricated *Dipnoi*.

Recent progress with regard to the structure and affinities of Scottish Carboniferous fishes is so inseparably connected with the study of the fishes of the same great period in England, that here the sister kingdoms cannot easily be treated separately, except as regards local and stratigraphical lists of genera and species. Descriptive papers dealing with English specimens are of equal importance to the student resident in Scotland. Scottish fossil ichthyology is therefore equally indebted to Prof. Young for his descriptions (published in 1866) of the remarkable Platysomid genera *Amphicentrum* (= *Cheirodus*, M'Coy) and *Mesolepis*, as well as of the little *Platysomus parvulus*, a species named but not described by Agassiz, as all of them occur in the Scottish coal-measures, although Prof. Young's descriptions were taken from the more perfect examples furnished by the North Staffordshire district. Prof. Young, in the same paper, also correctly pointed out the affinity to *Mesolepis*, and consequently also to *Platysomus*, of our well-known Scottish Lower Carboniferous genus *Eurynotus*, but I fear we cannot accept his sub-order *Lepidopleuridæ*, in which he sought to include both the Platysomid and Pycnodont fishes. His paper on "Carboniferous Glyptodipterines" (*Rhizodopsis*, *Rhizodus*, &c.), also published in 1866, deals largely with Scottish specimens, and with forms which constantly come under the notice of the Scottish collector. Prof. Young has given, besides, several other notices of fish remains from the Carboniferous rocks of the West of Scotland, as has also Mr. James Thomson, of Glasgow, among whose contributions may be specially mentioned his description and figure of an enormous *Acanthodes* from the Palace Craig Ironstone of Lanarkshire. Of purely local work, a very creditable example, though requiring some revision, is the list of carboniferous fishes in the "Catalogue of the Western Scottish Fossils," compiled by Messrs. Young and Armstrong, published first in the *Transactions* of the Geological Society of Glasgow, and afterwards issued as one of the "British Association Guide Books" on the occasion of the meeting of that body at Glasgow in 1876.

Here we must for the present take leave of our subject. Much remains still to be done both as regards general research into the structure and classification of palæozoic fishes, and as regards the rectification of species, and the compiling of reliable catalogues of those which occur as well in Scotland as in other divisions of our common country of Great Britain. The work must, however, necessarily be slow, as nothing is more injurious to the cause of palæontology than undue haste, whether in descriptive work or in attempted generalisation.

THE STRUCTURE AND ORIGIN OF STRATIFIED ROCKS[1]

IN his address last year the author treated exclusively of the structure and origin of limestones, and now confined his remarks to the structure and origin of all other stratified rocks. In the first place he considered the question of the origin in crystalline rocks of the material, and described those peculiarities in external form and internal structure, which would enable us to determine the true nature and origin of the grains of sand and other materials met with in stratified rocks. He next considered the formation of the very fine-grained particles met with in clays and mud, as derived from the mechanical wearing down of minerals like quartz, which cannot be decomposed, or from the chemical decomposition of others like felspar and hornblende. The materials thus formed mechanically and chemically by the complete weathering of crystalline rocks are to a great extent in a state of equilibrium, and not prone to undergo further change, whereas the minerals in volcanic ash are to a considerable extent in a state of such unstable equilibrium that they soon undergo further important changes. A deposit of this nature might thus soon be more altered than one of the other type in vast geological periods. Amongst other facts of the like kind it may be named that the large amount of very fine-grained micaceous mud deposits found in some of our earlier strata was shown to be in all probability derived from certain quartz felsites, in which the base is to a large extent composed of very minute crystals of mica.

Having thus traced the origin of the material, the method of observing loose unconsolidated deposits was described, and afterwards the general conclusions so far arrived at. In the case of quartz sands it was shown that, though they might appear almost identical to the naked eye, they may be divided into five well-marked varieties, which however pass gradually one into the other. These five types are as follows:—

1. Normal, angular, fresh-formed sand, as derived almost directly from granitic or schistose rocks.
2. Well-worn sand, in rounded grains, the original angles being completely lost, and the surface looking like ground glass.
3. Sand mechanically broken into sharp, angular chips, showing a glassy fracture.
4. Sand having the grains chemically corroded, so as to produce a peculiar texture of the surface, differing from that of either worn grains or crystals.
5. Sand in which the grains have a perfect crystalline outline, in some cases undoubtedly due to the deposition of quartz over rounded or angular nuclei of ordinary non-crystalline sand.

On the whole, then, we may say that these different types are due to different kinds of mechanical or chemical changes, affecting grains originally derived from crystalline rocks.

In further considering sands more or less worn mechanically,

[1] Abstract by the Author of the President's Address at the anniversary meeting of the Geological Society, February 20, by H. C. Sorby, LL.D., F.R.S.

it was shown that for fair comparison the coarser and the finest particles should be separated by sieving and washing, so as to obtain clean grains having on an average a diameter of about $\frac{1}{100}$th of an inch. On examining such sand from different deposits and different localities, it is seen that the amount of wearing varies very greatly. Much remains to be learned respecting the detail, but the observations made hitherto show that certain deposits are as if derived almost directly from crystalline rocks, that a very considerable amount of mechanical action is required to round angular grains of quartz $\frac{1}{100}$th of an inch in diameter, and that in proceeding from the apparent source in crystalline rocks the amount of wearing increases, until, when the sand has been drifted for 100 or 200 miles, about one-half of the grains are well worn and rounded. The uniformity in character over wide districts is sometimes remarkable and very characteristic.

Certain special questions connected with the structure of fine-grained deposits were then considered, amongst which may be specially mentioned the lamination of shales. It was shown that after complete subsidence such fine-grained muds contain so much included water that if squeezed out by the vertical pressure of superincumbent s rata, the bulk would be reduced to at least $\frac{1}{6}$th, which would necessarily develop a fissile structure in the plane of stratification, analogous to, but much less perfect than, the transverse cleavage of slates due to lateral pressure.

The nature of the more characteristic materials of fine-grained slates was next considered, and it was shown that they must originally have often differed very greatly from the more modern deposits of granular mud to a great extent derived from the decomposition of granitic rocks, this difference being mainly due to their having been derived to a large extent from the decomposition of the fine-grained basis of certain felsitic ashes. On the contrary, the characteristic features of the green slates of the English Lake District are mainly due to the material having been derived from a mere doleritic type of ash. One of the most striking facts is the great amount of true pumice, the originally empty cells of which are now filled with calcite or with various green minerals, in the same manner that the cells of foraminifera are often found filled with glauconite.

The author then pointed out how some difficulties connected with the mechanical origin of slaty cleavage could be easily removed, and traced the gradual passage from an ordinary stratified, non-cleaved slate to one with an imperfect cleavage due to the development of close joints or planes of discontinuity, and finally to a perfect cleavage, when the yielding of the mass to lateral pressure was sufficiently great.

The next questions which claimed attention were connected with the chemical changes that have occurred in the rocks since they were deposited. These have often given rise to a well-marked group of minerals, of several different kinds, but usually of green colour, and their development has played an important part in strata of nearly every age, resulting in the formation not only of the green grains of the green sand, but also in the analogous green constituents of many slates.

The author then discussed very carefully the gradual development of mica-schist, tracing it from what might be called its very germs, in grains only $\frac{1}{500}$th of an inch in diameter, formed *in situ* in some slates, to cases in which the whole of the original constituents of the slate have re-crystallised *in situ* into mica and quartz. In rocks of this type we can clearly see that the foliation is not due to deposition, but to crystallisation, which has been greatly influenced, not only by the previously existing structures due to stratification, but also by those due to cleavage previously developed by lateral pressure. Such fine-grained connecting links between slates and schists differ from true schists only in being of finer grain, which is sometimes so fine that with the naked eye it would be almost impossible to distinguish between them and slates, though the microscope shows that true slates have been deposited as mud, whilst the fine-grained schists have re-crystallised *in situ*.

The author concluded by specially considering what evidence remained in the most typical schistose rocks of the former presence of the grains of sand and of the fine granular particles found in slates, and showed that although they could sometimes be detected, yet in many cases the whole rock is so completely crystalline, that all evidence had been obliterated. The proof of crystallisation *in situ* is, however, very complete, so that, though we can see clearly that the original rock must have been greatly changed, we cannot really prove from its structure what the rock originally was—whether it was detrital or a mass of small crystals. This re-crystallisation of the material *in situ* is more especially proved by the structure of those schists which possess *cleavage foliation*. This differs most characteristically from *stratification foliation*, and clearly proves that before crystallisation took place the structure of the rock had been altered by lateral pressure.

It will thus be seen that the main object of the address was to trace the origin of the constituents of modern or more ancient sand and mud from pre-existing crystalline rocks of different types, and to show the correlation of the most modern and the most ancient deposits, and finally to trace the changes that have occurred since deposition, until they reach their extreme in the reproduction of crystalline rocks, thus completing the entire cycle of chemical and mechanical changes.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE petitions of Owens College and Yorkshire College relative to the creation of the "Victoria" University, have been printed as a parliamentary paper, with the draft of the proposed charter, the main heads of which we have already given. We believe this draft now only awaits the sanction of Parliament to become law.

DR. WILLIAM RAMSAY, of the chemical laboratory of the University of Glasgow, has been appointed to the Chair of Chemistry in University College, Bristol, in room of Dr. Letts, who has succeeded Dr. Andrews in Queen's College, Belfast.

MR. T. J. PARKER, B.Sc. (Lond.), son of Prof. W. K. Parker, F.R.S., has been selected for the Professorship of Biology in the University of Otago, New Zealand, and Curatorship of the Otago Museum. Mr. Parker has for some years been Demonstrator of Biology in the laboratory of the Royal School of Mines, South Kensington. We understand that three Commissioners were appointed by the University Council to report on the qualifications of candidates. The candidates, we believe, were numerous and highly qualified.

PROF. LÖWIG, who occupies the chair of chemistry at the University of Breslau, celebrates on April 7 the fiftieth year of his doctorate. As his laboratory courses have always been largely attended by pharmaceutical chemists, of whom over 1,000 have pursued their studies under his guidance, a movement has been set on foot to endow in honour of the occasion a pharmaceutical scholarship, to bear the name of the veteran professor. Although the University of Breslau occupies by no means the first rank among German universities, still the salary and fees falling to the share of the occupant of the chair of chemistry, form a sum far in excess of that received by any other professor of chemistry in the empire. Second on the list in this regard is the professorship of chemistry at Würzburg, now held by Prof. Wislicenus. In both cases the fact is mainly due to the large affluence of medical students who are forced to take courses of chemical lectures.

THE authorities of the Zurich Polytechnic are making preparations to celebrate next August the twenty-fifth anniversary of the foundation of the institution. In view of the widespread influence which the Polytechnic has exerted on the recent development not only of the canton but of the entire republic the occasion will be one of no slight interest.

THE *Neue Freie Presse* makes the following comparison of schools and school attendance in different European countries:—Germany, with a population of 42,000,000, has 60,000 schools and an attendance of 6,000,000 pupils; Great Britain and Ireland, with a population of 34,000,000, has 58,000 schools and 3,000,000 pupils; Austria-Hungary, with a population of 37,000,000, has 30,000 schools and 3,000,000 pupils; France, with a population of 37,000,000, has 71,000 schools and 4,700,000 pupils; Spain, with a population of 17,000,000, has 20,000 schools and 1,600,000 pupils; Italy, with a population of 28,000,000, has 47,000 schools and 1,900,000 pupils; and Russia, with a population of 74,000,000, has 32,000 schools and 1,100,000 pupils.

SCIENTIFIC SERIALS

THE *Journal of the Royal Microscopical Society*, containing its transactions and proceedings and a record of current researches relating to invertebrata, cryptogamia, and microscopy, February, 1880.—Rev. W. H. Dallinger, on a series of experiments made to determine the thermal death-point of known monad germs when the heat is endured in a fluid (Pl. 1 and 2).—Dr. P. M. Duncan, on a part of the life-cycle of *Clathrocystis æruginosa* (Kützing).—Prof. E. Abbe, some remarks on the apertometer.—A. D. Michaël, a further contribution to the knowledge of British Oribatidæ, part 1 (Pl. 3 and 4). With the assistance of C. F. George the life histories of fifteen species are mentioned as traced for the first time, the same number are described as new to the British fauna, and of these four are new species, five have been previously found in France, four in Germany, one in both of these countries, and one in Spitzbergen. Part 2, with two more plates, is promised in the April number.—G. Gulliver, the classificatory significance of raphides in Hydrangea.—W. Teasdale, on a simple revolving object-holder.—The record of current researches, bibliography, and proceedings of the Society.

Zeitschrift für wissenschaftliche Zoologie, Bd. 33, Heft 4, January 23.—Dr. Philipp Stöhr, on the history of the development of the skull in the Urodela, pl. 29, 30.—Karl Richard Krieger, on the minute structure of the central nervous system in the crayfish, pl. 31, 33.—Dr. Julius Krueg, on the fissures of the cortical surface of the cerebral hemispheres of the zonoplacental mammals, pl. 34, 38.—J. Ciamician, on *Lafoëa parasitica*, sp. n., pl. 39, figured on a species of Aglaophenia, from Trieste.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xiii., fasc. ii.—On the *trichamœba irta* of De Fromentel and Me. Jobard-Muteau, by Prof. Maggi.—On the transmission of heat between two fluids in motion separated by a solid wall, by Dr. Grassi.—On some geometrical and mechanical relations concerning lines of double curvature, by Prof. Bardelli.

Journal of the Franklin Institute, January.—Locomotive spark-arresters, by Mr. J. S. Bell.—Standard sizes in cylindrical fitting, by Mr. Richards.—Saws, by Dr. Grimshaw.—On the method of milk shipment in glass jars, by Dr. Morris.—Velocity of light, by Dr. Chase.

Gazetta Chimica Italiana, fasc. i.—Crystallographic study of some substances of the aromatic series, by Signor La Valle.—Further observations on digallic acid, by S. Schiff.—Contribution to the chemical history of the Stereocaulon Vesuvianum, by S. Coppola.—New method of determining the points of fusion of organic substances, by S. Roster.—Researches on podophyllin, by S. Guareschi.—Chemical study of the meteorite of Albarello, by S. Maissen.—Chemical researches on the yellow incrustations of the Vesuvian lava of 1631, by S. Scacchi.

SOCIETIES AND ACADEMIES

London

Royal Society, February 26.—"On some of the Effects produced by an Induction Coil with a De Meritens Magneto-Electric Machine." By William Spottiswoode, P.R.S.

In the *Philosophical Magazine* for November of last year I gave an account of a mode of exciting an induction coil by the direct application of one of M. de Meritens's alternating machines, without the intervention of a contact-breaker or the use of a condenser. The experiments of Prof. Dewar, described before the Royal Society (see *Proceedings*, February 13, 1880), have led me to think that an account of some of the peculiarities in the induced discharge, might be acceptable to the Society.

And, first, as regards the secondary discharge in air. It was mentioned in the paper first quoted that the spark produced by this machine presented an unusually thick yellow flame, and that it was accompanied by a hissing noise different from that commonly heard with a coil excited by a battery. The spark was observed in a revolving mirror, first in a vertical and secondly in a horizontal direction. The discharge, although apparently continuous, was immediately seen to be intermittent, with a period in unison with that of the machine. Tongues of flame, leading alternately from one terminal and from the other, crossed the field of view. The length of spark first used (vertically) was about half an inch. When the length was increased to about two inches flashes] or bands of continuous light were seen to traverse the field of view in diagonals of low slope (*i.e.*, nearly horizontally), showing that there were masses of heated matter passing from time to time at moderate velocity between the terminals. From the known period of the machine and the number of the discharges crossed by these flashes in their passage from terminal to terminal, it was calculated that the time of passage was about ·03 of a second. Occasionally there was a still brighter flash or meteor, which similarly traversed the field, but with a velocity apparently of about double that of the others.

On observing the discharge (vertical) in air attentively, it was noticed that whenever a true spark passed, its passage was marked, as usual, by an irregular bright line when its path was outside the aureola or flame, but by a similar dark line when its path was within the aureola.

The spectrum of the secondary spark was then examined with terminals of various metals.

Aluminium.—The spectrum showed a faint continuous background with the yellow sodium lines, and faint oxide of aluminium lines. This was with a spark of half an inch. But although the spark was subsequently lengthened, no difference in the spectrum was perceived excepting that the continuous background was rendered more bright.

It would seem that these appearances are due to some such process as the following:—The heat due to oxidation, added to that of the discharge, is sufficient to volatilise the oxide of aluminium, but that in its passage across the interval between the terminals, the oxide becomes so cooled that it gives a continuous spectrum. When the spark was lengthened, the oxide, although perhaps at first more heated than with the shorter spark, had more time to cool.

Magnesium.—In this, as in the former case, we have a faint continuous spectrum as a background, on which were seen the *b* group of magnesium lines. One other line in the blue occasionally flashed out, but was not permanently present. There was also a faint trace of the oxide spectrum. The contrast between the cases of aluminium and magnesium, in respect of the prominence of the oxide, or of the true metallic spectrum, is doubtless due to the fact that in the former case the oxide, and in the latter the metal, is the one which is more easily vaporised. On sending a blast of air on the discharge, the blue line always disappeared; the current of air having lowered the temperature so far as to prevent the vaporisation necessary for its production.

When the spark between magnesium terminals was made to pass through hydrogen, the characteristic lines of hydrogen were seen, apparently owing to a rise in temperature. This, as mentioned below, does not occur with carbon poles.

Platinum.—With terminals of this metal the spectrum was mainly continuous, with the addition of the ubiquitous yellow sodium lines. When the spark was short, a few bands were faintly visible, some apparently those of nitrogen, and others in the blue and violet belonging to the oxide of platinum. When the spark was lengthened these bands disappeared, and nothing but the continuous spectrum (with the D lines) was visible.

It appears from these experiments that the application of the De Meritens machine to the induction coil furnishes us with the means of isolating certain lines of the metallic spectrum from the rest. It has, in fact, enabled us to reduce at pleasure the spectra of aluminium, of magnesium, and of platinum, to their most persistent lines, precisely as had already been noticed as occurring by natural processes in the cases of sodium and of calcium. As a general rule, when the spark is shortened, the metallic or the oxide lines come out, when it is lengthened they disappear.

From this we may conclude (1) that the discharge which we have been examining is a real flame with metallic particles passing between the terminals in a solid condition; and (2) that in general the temperature is comparatively low, *i.e.*, that it is insufficient to cause any considerable vaporisation. This is notably the case when the arc is long, and when the matter thrown off from the terminals has sufficient time in its passage to cool.

The spark was then tried between carbon terminals in atmospheres of hydrogen and of carbonic acid. In none of them did the spectrum show any gas lines, but with hydrogen there were faint traces of the hydrocarbon group in the green. In this respect the spark differs from the discharge direct from the machine, inasmuch as the latter gives some of the hydrogen lines in hydrogen and carbon lines in carbonic acid.

When magnesium terminals were used in an atmosphere of hydrogen, the yellow sodium lines, the blue and green magnesium lines, and the red line of hydrogen were visible near the terminals, with a continuous background. When the magnet was excited, the only change observed was that the lines became slightly fainter.

When the spark was discharged in a magnetic field, known phenomena were reproduced, but owing to the thickness and mass of the flame and the extraordinary strength of the magnetic field, they were exhibited in a state of great splendour.

When the spark passed in an equatorial direction the whole flame was spread out in an equatorial plane, in which heated masses might be seen revolving in one direction or in the other in the neighbourhood of each of the magnetic poles. When the spark passed in an axial direction, or when the poles themselves were made the terminals, the phenomena described in my paper "On an Experiment in Electro-Magnetic Rotation" (*Proc.* Roy. Soc., March 30, 1876) were reproduced.

Whatever was the direction of the spark, the resistance due to the magnetic field was such as to extinguish the discharge, provided that the striking distance was near the limit that it could attain when no magnetic field was present. If a plate of glass was interposed between the poles of the magnet (which were still used as terminals) the yellow flame disappeared, and the spark divided itself into numerous ramifications of true sparks which found their way round the edges of the plate. As soon as the magnet was excited the resistance in the field became so great as to exceed that of the glass plate itself, and the plate was pierced.

Prof. Dewar was good enough to measure the efficiency of the secondary discharge, by taking an inch spark in a glass bulb placed in the centre of a calorimeter, in the same way as he had already measured the efficiency of the intermittent current direct from the machine. The former amounted to about 430 gramme-units per minute, while the latter had been found to be 6,000 per minute. The relative efficiency may, therefore, be taken at about 1 : 15. And as the machine was giving about 300 currents per second, this would give for the secondary

$$430 : 60 \times 300 = \cdot 023 \text{ units per discharge,}$$

and for the primary

$$6000 : 60 \times 300 = \cdot 3 \text{ units per discharge.}$$

Leaving the subject of the spark from the induction-coil, one of the most remarkable effects produced by this machine was the illumination of vacuum tubes by the currents taken simply from the machine. A small sphere of about two inches in diameter, with an air-vacuum, and having two parallel straight terminals reaching nearly across the sphere and about half an inch apart, was (after the first attempt, when there was some difficulty in getting the discharge to pass) readily illuminated. Owing to the alternate currents, both terminals were of course surrounded with the usual blue halo. When the speed of the machine was reduced, the discharge through the tube was not maintained, showing that only that part of the current from the machine which possessed the highest electromotive force, and perhaps also the greatest strength, was sufficient, and was therefore actually used for the purpose. As this was apparently only a small fraction of the whole current, we may herein find an explanation of the fact that, compared with the effect from the induction spark, the illumination was moderate, and the heating insignificant. It would perhaps not be easy to establish an accurate comparison between this and other sources of electricity; but some idea may be conveyed by the fact that, from experiments made with this tube with Mr. De La Rue's chloride of silver battery on a former occasion, and quite independently of the present question, it was estimated that a current having an electromotive force of 400 volts was necessary to effect a discharge.

Other tubes were tried, and were illuminated in the same way.

Chemical Society, February 19.—Mr. Warren De la Rue, president, in the chair.—The list of Officers and Council proposed by the Council for the ensuing year was read from the chair. The principal changes are: President: H. E. Roscoe. Vice-Presidents: Warren De la Rue, J. Dewar, V. Harcourt, in the place of F. Field and H. E. Roscoe. Other Members of the Council: C. Graham, H. McLeod, E. J. Mills, J. M. Thomson, instead of A. H. Church, W. H. Hartley, and E. Riley, who retire.—During the evening the President mentioned that a crystal had been prepared by Mr. Hannay, of Glasgow; its angles, lustre, hardness, &c., were identical with those of the diamond; a similar crystal when burnt was found to contain 97 per cent. of carbon; it was therefore to all intents and purposes a diamond.—The following papers were read:—On the production of ozone during the combustion of coal-gas, by R. H. Ridout. The author has observed that a Bunsen burner produces ozone, which substance is also formed by the combustion of coal-gas from a glass tube $\frac{1}{8}$th of an inch in diameter, placed in the centre of a tube $\frac{5}{8}$ths of an inch in diameter and 15 inches long. Ether and alcohol burned from wicks made of capillary glass tubes, gave similar results.—Prof. McLeod then made some remarks in reply to a criticism of Mr. Kingzett as to the formation of ozone during the slow oxidation of phosphorus. In his opinion, while fully admitting the justice of Mr. Kingzett's criticism, the evidence was quite conclusive without the quantitative results. He had made about 100 experiments and had not been able to find any proof as to the formation of peroxide of hydrogen, whilst the presence of ozone could be always detected.—Mr. R. H. Ridout gave a short account of some new and improved laboratory appliances—a blowpipe for gas or spirit, an india-rubber test-tube brush, an apparatus for saturating a liquid with sulphuretted hydrogen without the slightest escape of that gas, a filter funnel, consisting of a funnel with a stem 0·5 mm. and the sides ground to the angle of 60°, a continuous aspirator, consisting of a piece of lead tube $\frac{3}{8}$ths of an inch in diameter, bent into a circle having a small hole in the concave side, into which the aspirating tube is fixed; a filter funnel in which the vacuum is obtained by the condensation of steam, and an apparatus for taking the gravity of liquids in terms of water at the same or other temperatures.—Dr. Armstrong then made some remarks on some recent researches on the so-called unsaturated compounds.

Zoological Society, February 17.—Arthur Grote, vice-president, in the chair.—Mr. Sclater exhibited and made remarks on a skin of *Colobus palliatus*, Peters, from the Zanzibar Coast, and pointed out its apparent identity with his *Colobus angolensis*.—A letter was read from Mr. W. B. Pryer, of Elopura, Bay of Sandakan, Northern Borneo, relating to certain birds and quadrupeds of that country.—Prof. Flower exhibited and made remarks on the skull of a two-horned Rhinoceros (*Rhinoceros sumatrensis*), which had been obtained in Sandakan, Northern Borneo, by Mr. W. B. Pryer.—Mr. Sclater exhibited and made remarks on the drawing of an apparently new parrot, of the genus *Chrysotis*, now living in the Society's Gardens, which he proposed to call *Chrysotis cæligena*, after Mr. Lawrence's MS.—Prof. Flower, F.R.S., read a paper on the anatomy of the bush dog (*Icticyon venaticus*), based on a specimen lately living in the Society's Gardens.—Mr. W. A. Forbes read a paper on some points in the structure of *Nasiterna*, bearing on its affinities.—A communication was read from Mr. Geoffrey Nevill, C.M.Z.S., containing a paper on the land shells, extinct and living, of the neighbourhood of Mentone (Alpes Maritimes), with descriptions of a new genus and of several new species.—Mr. W. Tegetmeier read a note on the synonymy of the Kaffir Crane, commonly called *Balearica regulorum* (Licht.).—Lord Walsingham read a paper on some new or little-known species of Tineidæ, from North America.

Royal Microscopical Society, February 11.—Anniversary meeting, Dr. Beale, F.R.S., president, in the chair.—Twelve gentlemen were elected or nominated for Fellowship.—The reports of the Council and Treasurer showed that the condition of the Society was highly satisfactory, an exceptionally large number of new Fellows having been elected last year, and the revenue having increased by more than 200*l*. A special vote of thanks was given to Mr. Crisp in recognition of his honorary editorship of the journal accompanied by bound copies of vol. i. and ii. with suitable inscriptions. The Officers and Council were elected for the ensuing year as follows:—President: Lionel S. Beale, F.R.S. Vice-Presidents: Robert Braithwaite, M.D., W. B. Carpenter, C.B., F.R.S., Prof. P. Martin Duncan, F.R.S., Henry J. Slack, F.G.S. Treasurer: John Ware Stephenson, F.R.A.S. Secretaries: Charles Stewart, M.R.C.S., Frank Crisp, LL.B., B.A. Members of Council: John Badcock, William A. Bevington, Arthur E. Durham, F.R.C.S., Charles James Fox, James Glaisher, F.R.S., A. de Souza Guimaraens, William J. Gray, M.D., John Matthews, M.D., Albert D. Michael, F.L.S., John Millar, L.R.C.P.E., Frederic H. Ward, M.R.C.S., T. Charters White, M.R.C.S.—The President delivered his annual address, in which, after referring to the gratifying position of the Society, and the great improvement that had taken place in the journal, he discussed the nature of the changes occurring in living matter. Facts and arguments were adduced against the doctrine generally entertained concerning the physical nature of vital phenomena. Many of Dr. Allman's statements in his British Association address were called in question and serious objections raised to the acceptance of *Bathybius Haeckelii* in the existence of which Dr. Beale did not believe.

Anthropological Institute, February 10.—Francis Galton, F.R.S., vice-president, in the chair.—The following New Members were announced:—Thomas Hodgkin, Alfred Tucker, B.A., H. C. Stephens, J. A. Farrer, Bryce M. Wright, F.G.S., T. W. U. Robinson, F.S.A., and W. D. Gooch.—Dr. Emil Holub delivered an address on the Central South African tribes from the South Coast to the Zambesi. Dr. Holub had found along the South Coast traces of tribes which do not now exist, heaps of burnt bones of wild animals, none of domestic animals, and broken shells. Other tribes once belonged to the regions between the Limpopo and the Zambesi, and here were found ruins of towns, generally in the vicinity of mines, especially gold mines. The houses were of stone, on the top of mountains, put together without any cement, but so well fitted that they have stood for hundreds of years. Some of the ruins were formed of blocks of granite in the shape of bricks. The tops of small hills were fortified in this way, with openings in the walls. The remains probably belong to those who inhabited the ancient empire of Monopotapa, mentioned by the Dutch and Portuguese traders as existing two hundred years ago. When a country is conquered it is the custom to kill all the male population, take the women and children prisoners, and educate the latter as warriors of the victorious tribe; in this way whole tribes have ceased to exist in South Africa; even since Livingstone's time a powerful tribe of the Basutos, on the Upper Zambesi, named the Makololos, has been almost exterminated. Dr. Holub divided the living tribes into three races, the Bushmen, the Hottentots, and the Bantus; he found a link between the Bushmen and the Bantu family, and between the Bushmen and the negroes, but not between the Hottentots and the Bantus. The Bushmen are rapidly dying out, and are utterly incapable of civilisation. They use stone weapons and poisoned arrows, but the bows and arrows are of very simple construction compared with those in use among the natives of North and South America. The Hottentot race is divided into three tribes, the real Hottentots, the Griquas, and the Koranas. No South African tribe has taken so eagerly to the vices of civilisation as the Hottentot race. The Bechuanas observe many of the virtues of the white man, but the Hottentot adopts only his vices. Drunkenness is the chief cause of their dying out. They do not seem to have any religion, but a kind of freemasonry exists among them, the outward and visible sign of which is three cuts on the chest made with appropriate ceremony.

Meteorological Society, February 18.—Mr. G. J. Symons, F.R.S., president, in the chair.—Dr. J. S. Cameron, Dr. F. E. Carey, J. B. Charlesworth, A. Collenette, S. Forrest, J. G. Gamble, H. J. Marten, J. Nixon, B.A., W. P. Propert, LL.D., S. Rostron, W. P. Swainson, and E. W. Wallis, were elected Fellows.—The papers read were:—On typhoons in China, 1877 and 1878, by Lieut. A. Carpenter, R.N.—Note on the reports of wind force and velocity during the Tay Bridge storm, December 28, 1879, by R. H. Scott, F.R.S. These reports seemed to show that the velocity of the wind on that occasion was not so high as was generally supposed and had been frequently exceeded, but that some of the gusts were very violent.—On the frost of December, 1879, over the British Isles, by W. Marriott, F.M.S. Exceptionally low temperatures were registered all over the British Isles from the 1st to the 7th of December. On the 1st the lowest temperature was $-2°$ at Ketton, near Stamford; and the next lowest was $5°$ at Trent College. The temperature continued low throughout the day, at several places not rising above the freezing point. On the 2nd the cold was more intense, in the counties of Leicester, Lincoln, and Nottingham, the temperature fell below zero, the lowest being $-4°{\cdot}5$ at Coston, near Melton Mowbray. Temperatures between $0°$ and $10°$ were registered in the north and south of Scotland and along the central part of the north of England to the Midland and Eastern Counties; while over the whole of England, Scotland, and Ireland, with the exception of the sea-coast stations, the temperature fell below $20°$. On the 3rd the temperature was more evenly distributed and not quite so intense as on the previous day; however, in the North Riding of Yorkshire and the Valley of the Tees, readings at and below zero were registered, the lowest being $-2°$ at Gainford. On the 4th intensely cold weather was experienced over the south of Scotland and the north of England, the lowest reading obtained was $-23°$, at Blackadder in Berwickshire, $-16°$ was also registered at Springwood Park, near Kelso, and readings of $-5°$ were reported at Haddington, Melrose, and Corbridge-on-Tyne, and $-4°$ at Alston. Temperatures below $10°$ were registered over the south and south-east of Scotland, and over the north of England as far as the Valley of the Trent and also in the eastern counties, while over almost the whole of England, Scotland, and Ireland the temperature fell below $20°$. In some parts of the south of Scotland and the border counties the maximum temperature during the day did not rise to $20°$. On the 5th the minimum temperature was not so low as on the previous day, there being a cloudy sky and a general fall of snow. In Ireland, however, this was the coldest day of the month. On the 6th the temperature fell considerably in Derbyshire, Nottinghamshire, and Yorkshire, readings of $-3°$ being recorded at Trent, $-1°{\cdot}0$ at Buxton, and $0°$ at York and Stanley. At many places the maximum temperature during the day was much below the freezing point. On the 7th very low temperatures were registered over the whole of the north and the east of England; the lowest reported was $-10°$ at Ketton, near Stamford. The temperature fell below zero in the counties of Essex, Leicester, Derby, Lincoln, Nottingham, and York, and also in the south of Scotland, while over almost the whole of the north-east and central part of England as well as a portion of the south-east district, the temperature fell to $10°$ degrees or below. Readings below $20°$ prevailed over nearly the whole of England and Scotland, and the centre of Ireland. The maximum temperature during the day at a few places was extremely low, the thermometer at Appleby only recording $12°{\cdot}4$, and that at York $18°$. During the next few days a little warmer weather prevailed, but on the 11th the temperature fell below $20°$ over the central part of England, Scotland, and Ireland. Low temperatures were also experienced at most places on the 12th. Milder weather continued for the next few days, but on the 17th the temperature again fell below $20°$ over the whole of the south of England. Low temperatures also prevailed on the 18th, 21st, 23rd, 24th, and 26th, while the maximum temperatures at many places on the 21st and 26th did not reach $32°$. At almost all the inland stations frost occurred on an average of about twenty-five days during the month, and temperatures below $20°$ were registered from eight to thirteen days at several places. The only station where frost was not felt was Scilly, the lowest temperature recorded there being $33°$ on the 2nd. The only comparatively mild districts were the west and south of Ireland, and the extreme south-west of England. Even the sea-side health resorts which are reputed for their mild climates were not exempt from the cold, the temperature falling below the freezing point on eleven occasions at Ventnor, fifteen at Torquay, twenty at Sidmouth and Eastbourne, and twenty-four at Ramsgate and Worthing. During the time of the cold weather the barometer was very high over these islands, and an anticyclone was formed over those districts where the lowest temperatures were recorded. That the cold was the result chiefly of radiation is shown by the great difference in temperature at the hill and valley stations. For instance at Farley 640 feet above sea level $17°{\cdot}7$ was registered on the 7th, while at Oakamoor, 300 feet lower in the Valley of the Churnet, and less than a mile distant from Farley, the temperature fell to $1°{\cdot}1$. The effect of the cold upon the health of the community was very great. In London the number of deaths referred to diseases of the respiratory organs increased to 799 in the week ending December 20, and exceeded the weekly average by 288. The public journals record the fact that several persons were frozen to death in various parts of the country. The frost also caused great injury to plants, shrubs, and birds.

Entomological Society, February 4.—J. W. Dunning, M.A., F.L.S., vice-president, in the chair.—Mr. Patrick F. Copland, of Buckhurst Hill, was elected a Member, and Mr. John B. Bridgman and Mr. Peter Cowell Subscribers to the Society.—Mr. Stainton exhibited, on behalf of Mr. Grigg, of Bristol, a specimen of *Heliothis scutosa* captured near Weston-super-Mare.—Mr. Pascoe exhibited a specimen of the "fire-fly" of the Amazon Valley, *Aspisoma lineatum*. It has the usual intermittent light flashing at intervals of two seconds, but Mr. Pascoe believed it was capable of keeping back the light for an indefinite time. The Rev. H. S. Gorham objected to the term fire-fly being applied indiscriminately to all luminous insects, there being many luminous coleoptera, and as regards the flashing of the light from these insects, he considered it was often simply due to the creatures crawling over leaves and herbage, and thus exposing the ventral surface only at times. Mr. Meldola remarked that some years ago he had examined the spectrum of the glow-worm, and found that it was continuous, being rich in green and blue rays, and comparatively poor in red and yellow.—Mr. Pascoe also exhibited the two sexes of *Isopogon hottentotus*, a dipterous insect which was reported as hitherto unrecorded in this country, and remarked upon the gregarious habits of this species compared with those of others of the family.—The Secretary exhibited, on behalf of Mr. George Francis, of Adelaide, specimens of a South Australian moth (Anapæa, sp.), which feeds on the native Eucalypti.—Mr. Swinton forwarded a letter calling in question the specific distinctness of *Acronycta psi* and *A. tridens*, considered as separate species by Mr. Butler in a recent communication.—Mr. Meldola read a note on the protective attitude of the caterpillar of the lobster moth, extracted from *Kosmos*, November, 1879.—The following papers were also communicated:—Materials for a revision of the Lampyridæ, part 2, by the Rev. H. S. Gorham, and on some coleoptera from the Hawaiian Islands, by Dr. Sharp.

Photographic Society, February 10.—J. Glaisher, F.R.S., president, in the chair.—Dr. Huggins, F.R.S., read a paper on the photographic spectra of stars, and described the apparatus he had devised. Through a slit the 350th part of an inch, the spectrum of a star was kept by a special arrangement upon a gelatine emulsion plate in the same place, by artificial light being thrown upon a polished silver plate placed over the slit, enabling the image of the star to be seen and continuously watched during a long photographic exposure; thus any irregularity in the motion of the telescope could be instantly corrected. The slit was also provided with two shutters, so that one only being used upon a star, the other half could have a second known spectrum taken upon the same plate, and thus determine the wave-lengths of the lines of the spectra. Dr. Huggins stated that white stars gave lines due to hydrogen, as "Vega;" whilst "Arcturis," with an orange light, gave strong lines, due to "calcium," suggesting that it was farther removed in the order of change from "Vega" than is the solar spectrum.—Capt. Abney, R.E., F.R.S., read a paper on a process for printing by development. A paper is prepared with iodide and bromide potassium, sensitised with silver nitrate, and washed; after exposure, developed with ferrous oxalate and fixed with hyposulphite of soda.

Institution of Civil Engineers, February 24.—Mr. Brunlees, vice-president, in the chair.—The paper read was on the use of asphalt and mineral bitumen in engineering works, by Mr. W. H. Delano, Assoc. Inst. C.E.]

PARIS

Academy of Sciences, February 23.—M. Edm. Becquerel in the chair.—The Secretary announced the death of M. Favre, Correspondent in Chemistry, on February 17, and recalled his services to science.—Heat of formation of persulphuric acid, by M. Berthelot. The formations of oxygenated water, persulphuric acid, and ozone are endothermic, and form a graduated scale; they absorb respectively 10·8, 13·8, and 14·8 calories.—On the decomposition of oxygenated water in presence of alkalies, and on derivatives of bioxide of barium, by the same. The spontaneous decomposition of bioxide of barium is explained by displacement of the second equivalent of oxygen by water, the compound being thus changed into hydrate of baryta with liberation of heat. The same series of reactions explains the instability of oxygenated water in presence of a trace of baryta or other alkali.—On the heat of combination of hydrate of chloral, by M. Wurtz. He describes apparatus (very like M. Berthelot's) for finding whether vapours of anhydrous chloral and water, when they meet, liberate heat; the results were negative. M. Deville thought M. Wurtz had not taken sufficient account of the relation between the volumes of the meeting vapours.—On sap-vessels proper in Gramineæ, by M. Trécul.—On some linear differential equations of the second order, by M. Gyldén.—On the divisors of cyclotomic functions, by Prof. Sylvester.—On some of the collections brought by the North-East Passage Expedition by the Glacial Sea of Siberia, by Prof. Nordenskjöld (letter). These include a rich collection of invertebrates (dredged at 30 to 100 m.), and indicating a fauna richer in individuals than one finds in the tropics; lichens and algæ, bones of subfossil whales, tertiary fossil plants of Nagasachi and Labuan, implements, arms, &c., of Eskimo and Tchouktchis, and 1,040 old Japanese works.—Production and crystallisation of an anhydrous silicate (enstatite) in presence of steam at ordinary pressure, by M. Meunier. Steam is sent through a heated porcelain tube containing magnesium and receiving near one end the vapour of chloride of silicium. Enstatite is deposited in the tube of exit as an abundant white powder, and the crystals are very like those found in natural meteorites. M. Meunier remarks that the mixture of protuberantial vapours in the sun contains all the elements necessary to form magnesium silicates, if there were sufficient cooling.—Generalisation of two theorems on the functions Θ, by Mr. Elliot.—Determination of the mean tensions developed at the extremities of a heavy cord, oscillating about a position of apparent rest, by M. Léauté.—Observations of solar spots and protuberances during the third and fourth quarters of 1879, by P. Tacchini. The author's figures, from observations half at Palermo and half at Rome, by the same method, show the increase of solar activity. The protuberances have gradually extended to near the poles, showing a maximum, as usual, between 30° and 50° lat. in each hemisphere. The faculæ also continue to show their maximum between 10° and 30°. The number of faculæ and protuberances is slightly greater in the northern hemisphere, as before.—Comparison between the curves of tensions of saturated vapours, by M. Mondesir.—On a new electro-magnet, by M. Chambria. He increases the extent of the surfaces presented to each other, viz., the end of the core, and the oscillating armature; *e.g.*, a projection on the armature enters a hollow of the core, or conversely, or the circumference of the core enters a circular groove in the armature. His electromagnet applied to a Morse or Breguet telegraphic receiver requires a battery of 8 to 10 elements, as against 15 elements needed with plane magnet and armature. The remanent magnetism too, seems weakened.—Use of tempered glass in construction of condensers, by M. Ducretet. Leyden jars so made take a stronger charge and give better sparks.—On the preparation of acetylene, by M. Jungfleisch. He effects this by incomplete combustion of coal-gas; a flame being produced by a jet of air entering an atmosphere of the gas. The products of combustion are drawn off (by means of a *trompe*) into other vessels, in which the steam is condensed and the acetylene separated.—Determination of the heats of combustion of glycerine and ethylenic glycol, by M. Louguinine.—On a digestive ferment which is produced in panification, by M. Scheurer-Kestner. Meat mixed with flour and baker's yeast forming a paste, is fused into the mass of bread during panary fermentation. The author's father observed this, and he prepared, in 1873, a soup-bread containing 50 per cent. of meat, it could be kept indefinitely without alteration, and, dissolved in boiling water, made excellent soup.—M. Cosson stated that during the siege of Paris, powdered bone, that had served in preparation of glue, was incorporated with bread and biscuit, making useful panada.—On the formation of ovules and the ovary in mammalia and oviparous vertebrates, by M. Cadrat.—Study of modifications produced in the animal organism, by various albuminoid substances injected into the vessels (third series, soluble ferments), by MM. Bechamp and Baltus.—Diastase of germinated barley, so injected, is found partly in the urine, undergoes no alteration in the system, and causes considerable functional disorders.—On some examples of antagonism between heredity and environment, by M. Mer.—On a silicate of sesquioxide of iron and potash corresponding to amphigene, by M. Hautefeuille.

CONTENTS

THURSDAY, MARCH 11, 1880

THE RECENT GUNNERY EXPERIMENTS

WE have hitherto refrained from referring to the experiments carried out in December and January last on the 38-ton gun, which was removed from the *Thunderer*, in the hope that the Heavy Gun Committee would have ere now published their report. The report, however, has not appeared, but in the mean time many most illogical and probably erroneous conclusions have been drawn from the results of the experiments, and circulated amongst the public, apparently with the object of reviving confidence in a system of gun construction, to which, unfortunately, the nation is very deeply committed. These conclusions have latterly been called in question by several competent authorities, notably by Mr. C. W. Merrifield, F.R.S , in an able letter which appeared in the *Times* of the 8th inst. We consider it, consequently, to be an opportune moment to draw the attention of our readers to the extremely unscientific manner in which the experiments were carried out, and to the grave danger which may result to the country, from accepting too hastily, the conclusions which have been circulated by those interested in defending the existing system.

As is well known, the trials were instituted in the first instance with the object of testing the verdict of the Committee of Inquiry which was sent to Malta last spring, in order to investigate the cause of the original explosion. It will be remembered that the Committee, in direct opposition to the almost unanimous evidence of the officers and crew of the *Thunderer*, reported that the explosion was due to double loading. A verdict more extraordinary in the face of the evidence heard was never published, and it naturally met with a perfect storm of criticism. Many independent theories were put forward by outsiders to account for the explosion, so much so, that it was deemed advisable by the War Office authorities to test these theories, and also the verdict of the committee by a series of experiments on the sister gun.

The proper and scientific manner in which to carry out these trials, would have been to have tested each theory separately in an exhaustive manner. Had it been found impossible to burst the gun in this way, there would then no doubt have been a strong probability in favour of the double-loading theory. Instead of this, what was actually done was, first to fire a series of rounds with air spaces between the cartridge and the projectile, which were supposed to have an analogy, but really had none, with the well-known experiment of bursting a fowling-piece by plugging its muzzle with snow or mud. The result of these rounds was well known beforehand to every well-informed artillerist. Next, two rounds were fired with a papier-mâché wad placed in a slanting position in the bore, some five feet in front of the projectile. This was done with the object of testing Sir William Palliser's theory, that the shot jammed on a partially withdrawn wad, and split open the steel barrel of the gun, in such a manner that the powder gases on reaching the split, blew the gun violently to pieces. It was found in each of these rounds that the wad was blown out of the gun before the shot came near it; and immediately it was proclaimed that the jamming theory had broken down. The true conclusion to have drawn from these two rounds was, that when wads are placed in the bore of a 38-ton gun in the manner indicated, that they will be blown out of the gun before the projectile reaches them; but of what the result would have been, if the wads had been so placed that the projectiles would have jammed on them, these rounds tell us absolutely nothing.

No experiments were made with the object of testing the effect of an accidental crack in the steel barrel, and we all know, that in spite of the utmost care bestowed on the selection of the material, steel gun tubes will crack in the most unexpected manner. Of this we have only this week had a proof in the case of the bursting of a 100-ton gun made for the Italian Government, when the weapon was being fired with the mildest description of powder known to artillerists. In this case the steel tube cracked at the fore shoulder of the chamber, and the gun, incredible though it may sound, being dependent entirely on this tube for its longitudinal strength, parted into two pieces. What the result would have been had British pebble powder been used, which registers 50 per cent. more pressure than the Italian powder which was actually fired, it is easy to see.

Neither was any attempt made to cause the studded projectile to override the rifling, and to ascertain what would have been the result; but it was resolved forthwith to test the effect of double loading. The result was that the gun burst, as most people familiar with its construction supposed it would do. It was immediately loudly proclaimed that the verdict of the committee was correct, and that the Woolwich system was triumphantly vindicated, except for the case—only too likely to occur in action—of the gun being double loaded. Under the circumstance the only proper conclusion to have drawn from this result was, that Woolwich 38-ton guns will burst when double loaded. But when it is further stated that the two guns burst in totally different manners, it will be at once conceded how utterly groundless such a conclusion was. That the two bursts were totally different ought to have been apparent to the most casual spectator; for, whereas the first gun was quite uninjured as far as the forward end of the outer breech coil, the second was split from end to end. Moreover the directions of the principal lines of fracture, and the character of the broken fragments were quite different in the two cases. The second was in fact a far more violent explosion than the first one.

One useful lesson might have been learned from the experiment with double-loading, viz., what change this circumstance caused in the powder pressures. But even this chance of obtaining information was missed; for the pressure-gauges were carefully crushed up before the experiment took place, to 36 tons on the square inch, and they failed to record any higher pressure. The fact that the gauges were thus treated, so as to prevent their giving any information as to the pressure required to burst a Woolwich gun, is a most suspicious circumstance, and one which ought to be thoroughly investigated.

Such were the facts, and the only conclusion that can legitimately be drawn from them is, that Woolwich guns are not strong enough to withstand one of the ordinary chances of service. Under these circumstances, it seems to us to be imperatively necessary that a new series of experiments should be carried out on a smaller scale, with the object of finding out what other circumstances, in addition to double loading, are likely to cause these weapons to burst, and be a greater danger to friends than to foes. The destruction of the 100-ton gun is not calculated to increase confidence in this combination of steel and iron, especially when it is known that Armstrong and Woolwich guns are built up on almost exactly similar experiments. In addition to testing our own system in an exhaustive manner, guns by other makers should be subjected to exactly the same experiments, and if they yield better results, should be adopted into the service. We have lately seen that Sir William Palliser has subjected an old cast-iron gun, lined with wrought-iron tubes, on his well-known principle, to the test of double-loading with the most perfect success. Why should not the applicability of his system to guns of the largest calibre be tested? If, as it would appear, artillery officers are incapable of carrying out these experiments in a scientific manner, they should be assisted by outside talent, for the present state of uncertainty ought not to be tolerated for a day longer.

VEGETATION UNDER ELECTRIC LIGHT

THE experiments which Dr. C. W. Siemens has made in growing plants with the illumination of the electric light, and which were laid before the Royal Society at its last meeting, were deservedly received with great interest. In a country where the State does so little in aid of the systematic prosecution of scientific inquiry, it is impossible not to feel something more than appreciative when men like Dr. Siemens bring to its aid the combined resources of wealth and technical knowledge. England is rich in splendid gardens equipped with every horticultural resource. But it is due to the fortunate circumstance that the possessor of such a garden has also paid great attention to the economic applications of electricity, that experiments have been made, on a scale never before attempted, which go a long way towards proving that, as far as vegetation is concerned, all the effects due to solar energy can be artificially produced.

Anything connected with electricity has a peculiar fascination for the public mind, and even in the discussion which took place at the Royal Society, there was not wanting the suggestion that there might be something—a little inscrutable, perhaps—due to the electrical origin of the source of light to which Dr. Siemens had subjected his plants, which exercised an important influence on the results. Such a feeling is of course likely to be still more prominent in the minds of those who have paid no special attention to the processes of plant-life, and who would feel that almost all the interest of the matter was gone if they were asked to eliminate the influence of electricity from it altogether. Yet, obviously, this must be the case directly Dr. Siemens's results are studied in relation with what has already been done in the same direction.

The great physical fact on which all vegetable, and therefore all other life, depends, is the breaking-up of atmospheric carbon-dioxide by the green colouring matter of foliage—chlorophyll, or leaf-green—under the influence of light. How the thing is done is not known; what is known is that it is accomplished by light, and that chlorophyll is the means or instrument by which light is able to effect the dissociation of carbon-dioxide which is the indispensable precursor to the building up by the plant of the various components of its tissues. The plant is in consequence an accumulator of energy, and when its substance is burnt this energy is liberated, and carbon-dioxide—amongst other things—is again produced.

Now the question which vegetable physiologists have been asking themselves since the beginning of this century is this:—Are these effects producible by light from *any* source if of adequate intensity, or, as Sachs inquired in 1865, are they to be attributed to some quality specially inherent in solar light, and which cannot be artificially imitated? It is on this question that the real bearing of Dr. Siemens's experiments is of importance.

Closely connected with the conditions under which the *rôle* of chlorophyll is performed, are those necessary to its own production. Obviously as the plant grows, its chlorophyll cannot remain a constant quantity; and with some trifling exceptions which do not affect the matter, it may be laid down as an established fact that the same conditions which are essential for the activity of chlorophyll, are also favourable for its manufacture. But it is now known that chlorophyll may be developed under an amount of illumination which is insufficient to bring its functions into play. And this has been the difficulty which the problem has all along presented. In 1806 A. P. De Candolle experimented with the light of six Argand lamps; he found that this was sufficient to develop a green colour in etiolated leaves and also in young seedlings of mustard and cress, but he completely failed to obtain from perfectly healthy foliage any evolution of oxygen, and, therefore, any evidence that carbon-dioxide had been broken up. In 1860 Biot experimented with a powerful illuminating apparatus (with two Argand burners) which had been constructed for use in measuring an arc of meridian in Spain. This also failed, and it was suggested that the negative result of experiments with lamp-light was attributable to its poorness in rays of high refrangibility. The fact that these are most operative chemically has led many persons to think, on purely *à priori* grounds, that they must play the most effective part in the work done by chlorophyll. But repeated and most careful experiment has shown that this is certainly not the case. A long series of investigations, commencing with those of Daubeny (1836), and taken up successively by Draper (1844), Sachs (1864), and Pfeffer (1871), have shown without a doubt that the yellow rays are as effective in vegetable nutrition as those of all the rest of the spectrum put together.

The first experiment with the electric light in connection with vegetation was made by Hervé-Mangon in 1861. He succeeded by means of it in developing chlorophyll in young seedlings of rye, but he did not succeed in demonstrating any chlorophyllian activity by the evolution of oxygen. He found, however, that the electric light possessed one of the characteristic properties of sunlight in producing heliotropism in plants exposed to it. While it is found that the less refrangible rays of the solar spectrum undoubtedly play the most important part in the chemical work which is essential to plant life, the more refrangible rays exercise what may be described as a mechanical control. When grown in badly lighted places plants become elongated or "drawn up," while when freely illuminated, the rays of high refrangibility moderate this undue growth in length. Plants also, as is well known, bend towards a source of light; this is caused by the growth of their stems being checked on the illuminated side, which become consequently shorter. If they are grown behind red glass they are indifferent to one-sided illumination, because the rays which would affect their growth unequally are cut off. Hervé-Mangon showed that this heliotropic effect could be produced by the electric light as well as by that of the sun, and this was a fresh point gained.

In 1866 Wolkoff found that seedlings of cress grown in the dark became green after eight hours' exposure to the flame of a Bunsen burner made luminous by sodium carbonate. This was a crucial experiment as far as showing that the production of chlorophyll was independent of the so-called chemical rays of the spectrum. A few years later Prillieux completed the demonstration of the competence of light from artificial sources to perform all that the sun could do as regards the dissociation of carbon-dioxide by showing in M. Jamin's laboratory at the Sorbonne that oxygen was evolved by a water plant whether illuminated by the electric light produced by a magneto-electric machine, the Drummond light, or even gas-light of sufficient intensity.

This is the point at which the subject has remained for Dr. Siemens to take it up. He has worked on a far larger scale than is possible in a laboratory experiment, and has substituted for the sun a little sun of his own. To quote the account in the *Times*, "an electric centre of light equal to 1,400 candles placed at a distance of two metres from growing plants appeared to be equal to average daylight at this season of the year." As far as the experiments went, not merely were all the effects which from a horticultural point of view might be expected from daylight reproduced by the electric light, but, by making the latter supplement the former, double work was extracted from the plants, and the growth of vegetation under the prolonged summer of northern latitudes was artificially imitated. The observation of Hervé-Mangon was also extended, and it was found that the electric light was competent to produce all the mechanical effects of daylight such as bringing about the re-erection of the foliage of plants which during night-time exhibit the phenomenon of sleep. Seedlings of mustard which had never seen daylight were quite as green and vigorous as those which had never been submitted to the artificial light. The same result was shown by the foliage of carrots and those which had been illuminated naturally by day and artificially by night had leaves which were palpably taller and greener than those which, whether from natural or artificial sources, had only enjoyed a smaller amount of illumination. Dr. Siemens promises a more extended series of experiments, and, to give the matter a complete trial, it would certainly be desirable to compare the results during longer periods of growth when the plants were more thoroughly thrown on their own resources. It must be remembered that seedlings grow to a large extent at the expense of the materials stored up in the seeds, and the same thing is true of the foliage produced from fleshy roots like those of the carrot. In both cases the plant is mainly feeding on itself. The real test would be to take some short-lived annual and see if it would run through its course with illumination from an artificial source alone, and how the actual weight of plant-tissue manufactured would compare with that produced under an equivalent exposure to sunlight.

With regard to the action of artificial light on flowers, some caution is requisite in drawing conclusions. The *Daily News* of March 6 states that "Dr. Siemens exhibited to his audience a pot of tulips in bud, which the electric light brought into full bloom in some three-quarters of an hour." This sounds almost as wonderful as the mango-trick of the Indian jugglers. As a matter of fact the tulips were *not*, properly speaking, in bud; the flowers were fully developed, and were simply unexpanded, and all that they did when exposed to the electric light they would equally have done in the dark if exposed to a temperature as high as that in the immediate vicinity of the lamp. It is well known that the flowers of tulips are very sensible in this respect to even small changes of temperature, and the heat given off by the lamp used by Dr. Siemens is so considerable that he proposes, as one advantage of its use in horticulture, to employ it "to counteract the effect of night frost," and "to promote the setting and ripening of fruit in the open air." Dr. Siemens also showed a fully developed rose produced under the influence of the electric light, which compared strikingly with an unopened bud which had not had the same advantage. It might be suggested that here again the influence of temperature would require to be carefully eliminated. Sachs has found that, provided the foliage of plants is fully exposed to daylight, the flowers will be perfectly developed and will even mature seed in total darkness. And in the case of bulbs when the reserve of nutriment required for the evolution of flowers is already prepared, with proper conditions of temperature and moisture, the flowers will also be developed in the total absence of light. Even in woody plants this may be accomplished; the white lilac which is used for bouquets in the spring, is supplied from bushes of the ordinary kind, which are dug up in the autumn and forced the following year in perfectly dark buildings. The only difference which ever appears to occur is illustrated in this particular instance in the non-development of the colour of the flowers.

What may be the practical applications of the electric light in horticulture is still a question for the future. Dr. Siemens finds that illumination by it enables plants to sustain increased stove-heat without collapsing. This is an interesting point, because it brings out clearly the mode in which plants are naturally adjusted to exposure to sunlight without suffering injury. Light increases transpiration, and transpiration prevents the temperature of plant tissues rising to a point at which they would suffer from "scorching." The hope that the electric light might aid investigation as to the mode of formation of alkaloids such as quinine in the plant will scarcely perhaps lead to any practical result. The researches of Howard, on the one hand, show that the Cinchona alkaloids are not formed in the leaves, and making their appearance as they do in the bark, which is progressively thrown off by desquamation, they may with reason be regarded as excretions by which the plant gets rid of superfluous nitrogen. On the other hand Broughton has shown that the action of light leads to the degradation of the Cinchona alkaloids in the bark into other compounds, and the same fact has been pointed out with regard to *Strychnos*.

Its use in horticulture will in all probability be limited to the gardens of the wealthy, where there will be no difficulty in employing it to make plants grow at double their normal speed if that is ever practically found worth while. It may also perhaps be found available in accelerating and supplementing the effect of our tardy and penurious sunlight in ripening fruit. But the scientific interest of its present application must rest mainly on the fact that the cycle of the transformation of energy engaged in plant life is now complete, and that, starting from the energy stored up in vegetable fuel, we can run through the changes from heat to electricity, and thence to light, which we now know we can store up in vegetable fuel again.

MOORE'S ORNITHOLOGICAL TABLES

British Birds Systematically Arranged in Five Tables, showing the Comparative Distribution and Periodical Migrations, and giving an Outline of the Geographical Range of 376 *Species.* By G. Peter Moore, F.L.S. Captain R.S.L.M., late 3rd Hussars. Imp. 4to. (London: Van Voorst, 1879.)

CAPT. MOORE'S object in publishing this work is not very apparent, and he can hardly be said to assign sufficient reasons for it when he states that he submits it

"To those persons, without the care or leisure to become students in ornithology, to whom an easy method of obtaining a general knowledge as to the comparative distribution of our birds may be an object of interest, and who, when 'the time of the singing of birds is come, and the voice of the turtle is heard in our land,' feel a desire to know something of the nature of these welcome visitants, and the periods of their arrival, and whither they go when they leave us."

At the same time we willingly bestow on his labours that "friendly scrutiny" which he bespeaks for them, "should they fall into the hands of practical ornithologists." In the absence of any other motive we venture to believe that Capt. Moore, being laudably bent upon improving his own knowledge of the geographical distribution of the many kinds of birds which it pleases some people to dub "British," has been at the great pains of drawing up these tables for his private use, and then, conscious of the enormous toil which it has cost him to obtain his results, has felt desirous of offering them to the public in the hope of saving others from the trouble of doing the like labour over again. The question whether the results reached are worth the trouble expended on them is one that it would be ungenerous to discuss, for we rather hold that no honest labour is wasted, even if the benefit that accrues from it be not immediately evident, and of honest labour there is here enough. Besides, the study of ornithology is in this country followed by so large a number of persons, and by them in so many different ways, that it is impossible for any critic of a work which certainly strikes out a new line of treatment, if not of investigation, to predict whether it may not find a considerable body of admirers, or many at least whom it will profit. We think, indeed, that the latter is more than probable, for we are sure that the amount of information which our author's pages convey, and that in the most concise form, is vastly greater than such as is possessed by most of those who are justly considered British ornithologists. It remains, of course, for them to use it, but if they will not, the blame is not with Captain Moore. He does his best to bring the water to the horses, since it is not for him or any other author to take the horses, or other less noble animals, to the water; and, if they will not drink it, it is their own fault, for the water is drawn from good springs, and though here and there it would have been the better for a little more filtering, analysis shows that it is wholesome taken altogether.

The "Tables" are a marvellous example of the printer's skill, and reflect the greatest credit on the well-known establishment of Messrs. Taylor and Francis. We have to raise but one objection to them, and that is the occasional employment of what we may perhaps call "florid gothic" type—or, if we might be excused a Hibernicism, we should say of "black" letter which is not *black*. We profess no acquaintance with the technicalities and mysteries of the printer's art, but merely from the general reader's point of view, a good strong "clarendon" for attracting the eye is worth all the "gothic" founts that were ever invented, save only those of the most antique pattern, and in them, by the way, some of the letters are often with difficulty distinguished. Apart from this, the Tables have evidently been drawn up with a wonderful amount of patience. We have put them to a pretty severe trial, and may congratulate Capt. Moore on coming out of it with flying colours. To say that they do not in all cases adequately express the part which any particular species plays in our fauna is no real objection, for such must be the inevitable consequence of the tabulation of facts so multitudinous as those furnished by the biography of birds. It is impossible by schedules alone, without the addition of footnotes, apostilles, or some other contrivance of the like kind, to convey by any means that simple tabulation affords a correct notion of the peculiarities of distribution of such species as Savi's Warbler or the common Crossbill. These are undoubtedly extreme instances, but there are many others only less impatient of tabular treatment, and it must be remembered that we now know, or ought to know, enough of our birds to be assured that each species has its own particular life-history, which cannot possibly be served after a Procrustean method without the risk—nay, certainty—of undergoing some deformation. In a few instances Capt. Moore seems to have gone astray, as in the case of the Golden Plover, which is marked as being a regular but rare summer-migrant in the Færoes, Iceland, and Spitsbergen, and occurring in North America from lat. 35° to 70°, though a note of doubt is appended to the last statement. There seems to be no evidence at all that the true *Charadrius pluvialis* is ever found in North America, and it certainly cannot be said to be rare in the Færoes, while its appearnce in Spitsbergen is anything but regular. So, too, with the Great Auk, we have the old story repeated of its being an inhabitant of the "Polar Regions," though that story has been refuted again and again; but we suppose that to the end of time the fable will continue in spite of all contradiction, and the absolute fact that not a single example is known with certainty to have occurred within the Arctic Circle. However, slight flaws like these do not seriously compromise Capt. Moore, who has certainly succeeded in condensing a greater amount of really valuable information into a small space than any other ornithological writer with whom we are acquainted.

LINKAGES

Linkages. By J. D. C. De Roos. Van Nostrand's Science Series, No. 47. 18mo, 87 pp. (New York, 1879.)

It is not often that one is able to trace a pedigree with such success as we have been able to achieve in the case of this little book. It appears from the title-page that it is reprinted in its present form from *Van Nostrand's Magazine*, having been translated from a series of articles by M. de Roos in the *Revue Universelle des Mines*. The latter gentleman admits his obligations for the major part of his work to a translation which appeared in the *Revue Scientifique* of November 24, 1874, of the well-known lecture delivered by Prof. Sylvester at the Royal Institution in the same year, which was based on M. Peaucellier's discovery described in the *Nouvelles Annales* of 1873, but contained a large amount of original matter. For the residue, with one exception, to which we shall presently return, M. de Roos appears to be indebted to a paper by M. Liguine, which he mentions without stating where it is to be found, and which, together with a memoir by M. Saint Loup referred to by M. Liguine, is apparently regarded as all that has been written on the subject since the publication of Prof. Sylvester's lecture. M. Liguine's paper is to be found in the *Nouvelles Annales* for 1875; it discusses Prof. Sylvester's lecture, the "contra-parallelogram" of Mr. Hart, the "kite" of Mr. Roberts, and one of Mr. Kempe's earliest linkages. The description of these discoveries of Mr. Hart and Mr. Roberts is stated by M. Liguine to have been obtained from an article by Prof. Sylvester in the *Revue Scientifique* in 1875, but no mention is made of the source from which a knowledge of Mr. Kempe's linkage is derived. There is, however, internal evidence that it is M. Antoine Breguet who published an article in the *Revue Industrielle* early in 1875, which discusses the discoveries of Messrs. Kempe and Hart referred to, and states that the writer's information is derived from their original articles in the *Messenger of Mathematics* of November, 1874.

It is not to be wondered at, after this, that the work before us, though recently published, contains no information of later date than 1874, a time when the theory of linkages was in its infancy. Under such circumstances it would have been more creditable to the editor of "Van Nostrand's Science Series" if, to the statement in his preface to M. de Roos's book that "the subject has not even yet received the attention which is fully its due," he had added the qualifying words, "though very much more has been done than is contained in M. de Roos's work, which is at the present time, from the rapid advance which has been made during the past five years, somewhat antiquated." As a matter of fact, not the slightest hint is conveyed, from the beginning of the work to the end, that it does other than represent the present state of the science of linkages.

The book bears no signs, as far as editor and translator are concerned, of being only vol. i., but M. de Roos does conclude with a promise in a "future note" to discuss a "new element," of which a diagram is given, briefly noticed (not described) in a paragraph containing a misleading misprint of O A . A B for O A . O B, which in the absence of the "future note" may make it difficult for the reader to understand what the new element is. The translator proposes to name it the "Element of De Roos," "in honour of its inventor;" an examination in the light of the correction we have indicated will, however, show that whatever claim to novelty might have been advanced five years ago (though we feel somewhat doubtful whether even then the "discovery" of a combination of half a "Peaucellier" and half a "Hart" would have entitled the discoverer to have his name affixed to it), at the present time when more general linkages have been discovered of which it is only a particular case, none such could be sustained.

The bulk of the volume consists of applications of the Peaucellier inverter and Prof. Sylvester's modifications to the description of curves, the extraction of roots, &c. These, though decidedly interesting, would in many cases be superseded at the present time by less cumb some methods. The pages are plentifully supplied with diagrams, which are, however, occasionally marred by the omission of links. This is particularly to be regretted in the case of Fig. 48, which exhibits one mode of practically applying Peaucellier's parallel-motion to a beam-engine. It may not be uninteresting to note that this method is the same as that employed by M. Peaucellier in a model furnished by him to the Conservatoire des Arts et Métiers in Paris.

We cannot but regret that what appears to be a useful science series should be marred by the introduction of a work which, possibly through no fault of the author, must by its antiquity mislead its readers as to what has been and remains to be done on the interesting subject of which it treats.

OUR BOOK SHELF

The American Entomologist. New Series, No. 1. January, 1880. C. V. Riley, Editor; A. S. Fuller, Assistant Editor. (New York: Max Jaegerhuber.)

We are glad to welcome an old friend in an old face, after nine years' absence. The idea of this journal originated from that lamented entomological genius the late B. D. Walsh, in the form of the *Practical Entomologist*. This developed into the *American Entomologist*, and to this was subsequently added, as part of the title, *and Botanist*. The *American Entomologist* is now resuscitated, under its former editor, the energetic Prof. C. V. Riley, and bids fair to be a success. Purely descriptive entomology evidently finds little favour in the eyes of the editors, "descriptive" papers being limited to one page in each number, or if more extended, the cost is to be paid by the author, and the space so occupied is to be supplementary. Thus, the aims of the journal are almost exclusively biological and economic. It is just possible this idea may, at some future time, be slightly modified. The editors crave that indulgence usually accorded to first appearances, but, having no doubt fully in mind the fact that one of them is an old stager, they have produced a "first" number of a most varied and useful nature, full of information on the habits of a multitude of North American insects, good, bad, and indifferent, as to the characters borne by them. There are also several excellent woodcuts; yet we fancy some of these are old friends. In future numbers we hope to see more originality in this respect, because the constant reproduction of the same illustrations in different works, engenders a suspicion, with those uncharitably inclined, that the text may be sometimes written up to the illustrations, and the latter not made subservient to the former, as ought to be the case. We shall watch the progress of this journal with appreciative interest. The list of names of those who have promised occasional contributions includes most of the leading American entomologists.

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.*]

A Museum Conference

You did me the honour, about two years ago, of inserting an unsigned communication pointing out the extreme desirability of a conference of officials connected with museums and galleries of art throughout the country. At the time the subject received a good deal of attention from various quarters, and the numerous advantages which might be derived from such a meeting commended the suggestion to all who wrote on the subject. No one, however, ventured to make a practical move in the matter at the time, and the subject consequently dropped.

Further consideration and growing experience have deepened my conviction of the utility of the conference scheme; and as I have reason to believe I am not singular in that experience, I desire now to see some effort made to bring the question to a practical issue. With this view I shall be glad to co-operate with other museum officials who feel inclined to take part in the preliminary work of organising a conference of those interested in museums and art galleries. As to where, when, and how the conference should be held, I do not wish to offer a single suggestion which might anticipate future consideration. Neither do I consider it necessary to occupy your space with any statement as to the great and manifold advantages which ought to accrue to our scattered exhibitional institutions by a union such as might be formed. These are surely too manifest to every individual who has to do with any museum, especially in the provinces.

I hope this question will now be taken up heartily and energetically by all interested; and while I would beg that you may give space for the suggestions which others may wish to make through the medium of NATURE, I shall be glad to enter into correspondence with those who may address me privately.

Kelvingrove Museum, Glasgow JAS. PATON

The Himalayan Ranges

I HAD not intended to notice Mr. Trelawney Saunders's remarks on Mr. Medlicott and myself as the authors of the "Indian Geological Manual" (NATURE, vol. xxi. p. 96). As, however, Mr. Medlicott's reply (*ante*, p. 301) has been misinterpreted by Mr. Saunders, and as the latter has, in his rejoinder (*ante*, p. 347), brought a specific charge of omission which can, I think, be shown to be unfounded, against a portion of the "Manual" written by myself, I am obliged to take part in the discussion.

In Mr. T. Saunders's original paper (*l.c.*, p. 96) read before the British Association, two objections were raised to the views on physical geography adopted by the authors of the "Manual." The second of these objections referred to the limits of the Himalayan range, which we did not represent as extending west of the Indus. Mr. Saunders must have read very little of the "Manual," or he would have seen that this limit was not absolutely defined; on the contrary, at p. 518, it is expressly termed provisional. As Mr. Medlicott has shown, there is a good geological reason for the limit adopted; but another cause, of perhaps even more importance, is that this limit coincides with the boundaries of the area described in the work. I cannot enter into the question here, but the fact is, there are just as good reasons for making the Himalayan range terminate at the Jhelum, if not even farther east, as for prolonging it beyond the Indus.

The first objection was couched in much stronger language. Mr. Trelawney Saunders had represented the Himalayas as consisting of two chains; we were accused of having adopted an "antiquated theory." No reference was given, but from the context it was evident that this "antiquated theory" consisted in representing the range on a skeleton map by a single line along the water-shed or water-parting (I will employ the latter term to prevent any risk of misconception). Mr. T. Saunders says (*l.c.*, p. 96) that they (*i.e.*, Mr. Medlicott and myself) "do not condescend to any reason for this conclusion." This is not quite correct. If Mr. Saunders had "condescended" to read the two and a half pages in the introduction of the "Manual" relating to the physical geography of the Himalayas, he would have found a reason on p. x.

Mr. Medlicott very justly pointed out that the reason for omitting the representation of a second chain was due to the irrelevancy of the question whether there are one or two chains to the matter in hand, that is, to the physical geography of India as related to the geology. Mr. Saunders has quite misinterpreted Mr. Medlicott's meaning when he says (p. 348): "Mr. Medlicott contends that the omission was due to the irrelevancy of the great range to the matter in hand." Of course Mr. Medlicott means nothing of the kind.

In his letter just referred to, Mr. Saunders writes thus:—

"But my complaint was based, not on my delineation, but on a trigonometrical survey, and it was caused by a *description*, not of the geology, but of the physical geography of India, in connection with a map of its hill-ranges, that has nothing geological about it. It is in this expressly geographical part of the 'Manual' that I find the greatest range of snowy peaks in the world *omitted from a geographical notice* and delineation of the Himalaya."

The italics are mine. Again no reference is given, but the remarks quoted can only apply to the description of the physical geography, accompanied by a skeleton map, in the Introduction to the "Manual." In this description the "geographical notice" of the Himalayas occupies barely two and a half pages. One would have thought that before writing the sentence I have quoted the writer would at least have read this small amount of letterpress. Yet I scarcely think Mr. Trelawney Saunders can have done so, or he could scarcely have overlooked the following passage at the bottom of p. ix. and upper part of p. x.

"Many geographers distinguish two parallel ranges from the neighbourhood of Simla to the eastward: the snowy range proper, formed of the highest peaks; and a more northern ridge, forming the water-shed between the Tibetan plain and the rivers running to the plains of India."

To save space I quote no more, but I am convinced that any one who will refer to the two and a half pages headed "Himalaya," in the Introduction to the "Manual," will see that Mr. Saunders is quite in error in saying that the main range is ignored.

As Mr. Trelawney Saunders has not understood Mr. Medlicott, I can only hope that the following explanation may be clearer:—

In his original paper and in that in the *Geographical Magazine* for 1877, pp. 175, 176, Mr. Saunders contends that the Himalaya south of the Sanpu and upper Indus consists of two "chains" (these are alternately called chains and ranges). The southern chain is formed by the line of great peaks, the northern by the water-parting between the drainage areas of the Upper Indus, Upper Sutlej, and Sanpu on the northern side, and various rivers running to the plains of India on the southern.

Now it is manifest that this division of the Himalayas into two chains is due to the fact that two different, and to some extent irreconcileable, definitions are adopted for the term "chain" in the two instances. Mr. Saunders's southern chain is a line of great peaks, but is not a continuous water-parting; his northern chain is a continuous, or almost continuous, water-parting, but is not a line of great peaks. It has never been shown that the two are distinct axes or lines of elevation; on the contrary, all the evidence we possess tends to show that both are due to one great fold of the earth's surface, and until these northern and southern chains are shown to be of diverse origin, it is perfectly reasonable to decline to accept the two distinct acceptations of the term "chain," and it is consequently perfectly correct to represent both on a skeleton map as constituting one great range or axis of elevation. The sub-Himalayas consist of rocks of different age from those of the Himalayas, and there is some reason for believing these hills to be of later origin than the main chain; they are therefore represented in our map as a distinct range.

It would take too much space to criticise at any length Mr. Trelawney Saunders's Tibeto-Himalayan system (*Geographical Magazine*, 1877, p. 173). This system proposes to resolve "the leading outlines of the vast mass of which it treats into four great chains, with their outer slopes and intermediate valleys or plateaus." The chains are called the Kuenluen, Karakorum-Gangri, and Northern and Southern Himalaya. Now the greater part of the Tibetan area, including, at all events, all east of the meridian of 82° E. long., is too imperfectly known for any positive assertion to be made as to the number of ranges. In the better known western part of the area one fact alone, the omission to include as one of the main structural features, the range between the Indus and Shayok, shows the description and delineation to be geographically incorrect. The range omitted is at least of equal importance with some of those included. There are many other points open to question, such as the representation of the ranges north and south of Cashmere, as mere continuations of the so-called Northern and Southern Himalaya. In short the system will not fit into the only part of the area with which we have any adequate acquaintance. The accompanying map is doubtless an admirable sketch of the Himalayas as they would be if reconstructed according to Mr. Trelawny Saunders's hypotheses, but I think all who have ever been in those mountains will agree with me that it is not an accurate representation of the range as at present existing.

In conclusion I must decline to reply to any further remarks on this subject from Mr. Trelawney Saunders. It appears to me that Mr. Medlicott and I are entitled to express an independent opinion on the physical geography of the Himalayas without being accused of adopting an antiquated theory. In addition to the geographical data known to Mr. Saunders we have some acquaintance, imperfect, it is true, but still of importance, with the geology, and we have both some slight personal knowledge of portions of the range. Under these circumstances we have not adopted the theory advocated by Mr. Saunders simply because we consider it not supported by sufficient evidence.

February 29 W. T. Blanford

[This correspondence must end here.—Ed.]

Tidal Phenomenon in Lake Constance

Les mouvements de la glace et de l'eau du lac de Constance décrits par M. S. J. Capper (Nature, vol. xxi. p. 397) ne doivent pas être rapportés à une marée luni-solaire, ce phénomène étant inappréciable sur un lac dans si petites dimensions. Je me fonde sur les résultats négatifs que j'ai obtenus sur le lac Léman, plus grand en longueur et en surface que le lac de Constance. En utilisant les tracés de mon limnographe de Morges qui me permet d'évaluer à chaque instant à un millimètre près, la hauteur du lac en choisissant les circonstances les plus favorables, calme absolu de l'eau, et époques de syzygie, je n'ai jamais pu reconnaître de traces de marées luni-solaires.

En revanche les mouvements de balancement de l'eau que nous étudions depuis bien des années sous le nom de *seiches*, expliqueraient facilement une partie des faits signalés. Les seiches, comme on le sait, sont un mouvement de balancement de toute la masse du lac, qui oscille d'une extrémité à l'autre comme le fait l'eau d'une cuvette ou d'une baignoire. Il est vrai que le rhythme des seiches du lac de Constance, pour autant que je le connais par une seule observation du 14 septembre 1874, n'a qu'une durée d'une heure environ, et non douze heures comme l'indique le batelier de M. Capper. Il serait fort à désirer, pour l'interprétation de phénomène, que M. Capper put fournir des données et observations aussi exactes que possible des mouvements qu'il décrit. F. A. Forel

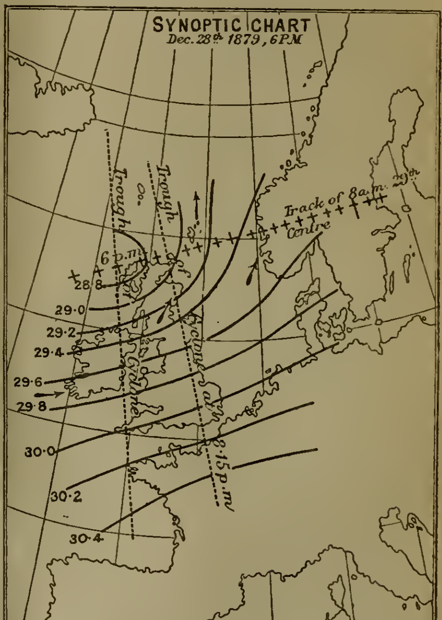
Morges (Suisse), 3 mars

The Tay Bridge Storm

A brief account of the results obtained from the examination of a large number of observations referring to the storm on December 28, 1879, may be of interest even to your non-meteorological readers.

At 6 p.m. on the evening of that day, as will be seen by the accompanying chart, Fig. 1, the centre of a cyclone of considerable intensity was situated close to Stornoway. By 8 a.m., the 29th the centre had moved a distance of about 800 miles to the vicinity of Stockholm, which gives the high mean velocity of 58 miles an hour. But by a method detailed below, it is found that between 6 p.m. and 8·15 p.m. the centre moved along the north of Scotland at the rate of 62 miles an hour, which is, I believe, the highest on record in this country. No precise relation has yet been traced between the velocity of a cyclone centre and the strength of the wind in it. In any part of a cyclone the velocity of the wind is undoubtedly principally dependent on the closeness of the isobaric lines, but there is a good deal of evidence to show that when the velocity of the centre is very great, the strength of the wind for any given gradients is increased, or at all events becomes more squally and gusty.

In this case the steepest gradient was down the west of Scotland, but only amounted to about 0·13 inch per 50 miles, which is a very moderate amount for a winter storm.



An important result of recent research has been the discovery that every cyclone is divided into two parts by a line drawn through the centre, more or less at right angles to the direction of its motion, at all points in front of which the barometer is falling while it is rising in rear. This line marks out what is called the trough of a cyclone, and while the front and rear present marked contrasts both as regards the in-curvature of the wind, and still more as regards their physical appearance, it is also found that the passage of the actual trough all along its southern portion, except very near the centre, is marked by violent squalls. In the accompanying diagram the position of the trough at 6 p.m. can only be drawn approximately from general considerations as passing down the west of Scotland, but at 8.15 p.m. I have fortunately been able to locate it with great accuracy. At that time the barometer turned upwards at Wick, and almost at the same moment my own barograph in London also turned upwards with the characteristic squall. The line of the trough joining those two points would then be about thirty-three miles east of Dundee, and by combining it with the previous data, the high centre velocity of sixty-two miles an hour was obtained.

Turning now to Dundee, observations there show that the barometer fell very fast till about 7 P.M., after which it remained nearly stationary for about two hours; at 7.15 the Tay Bridge was blown down; about 7.45 the actual trough of the cyclone passed over the town, and about 9.30 P.M. the barometer began to rise. The wind, which had been strong all day, rose to a strong gale with violent gusts and squalls at 5 P.M., and lasted till 8.30, when the weather began to moderate.

Thus it would appear that in this storm at Dundee, as is often the case, the worst weather occurred just before the barometer ceased to fall, and during the two hours it remained nearly stationary previously to rising rapidly. The Tay Bridge was blown down by an ordinary gust during this time, and not in any squall during the time of the actual passage of the cyclone's trough.

On the whole it may be said that though the storm which destroyed the Tay Bridge was in many ways of the most ordinary character, it was exceptionally squally and gusty, doubtless owing to the unusually rapid rate of its motion.

One word in conclusion, as to the destructive effect of wind. A gust strikes with a blow, which can no more be calculated from the velocity of the wind, than the blow of a sledge-hammer can be estimated by a pressure in tons, or by the energy of so much *momentum*. But observation also shows that in squalls and gusts there is a great deal of local compression of the air; fluid pressure must then come into play, and in this we have, probably, the explanation of the remarkable lifting power of wind, which has been so often described in great storms. Unfortunately in our present state of knowledge, this lifting force is as incapable of numerical estimation as the lateral blow of the gusts.

My acknowledgments are due to Dr. Copeland for his courtesy in furnishing me with copies of the meteorological records of the Dunecht Observatory, situated about fifty-six miles north-north-east of Dundee.

RALPH ABERCROMBY

7, Royal Terrace, Folkestone

A Lecture Experiment on Ice-Crystals

THOUGH different processes are at command on the lecturer's table to illustrate the artificial formation of ice, none of them may be said to yield the very forms of ice-crystals that are observed in snow-figures or in hoar-frost. I have hit upon a method for producing them in an equally simple and satisfactory way. If a glass tube (with a length of one or two decim. and four or five millim. wide) has by means of the blowpipe one of its ends reduced to a diameter of two millim., some fibrous matter, as loose cotton-wool or gun-cotton, &c., must be introduced into this part, in such a way that many single fibres protrude out of the tube. They form the lower part when the tube is now fixed in a vertical position, and some sulphuric ether dropped in through the upper end in sufficient quantity to keep the fibrous substance moist, but not enough to run over. An active evaporation favoured by a comparatively large surface and the radiation from a multitude of points, sets in immediately, and within a minute ice-crystals, as a deposit from the atmospheric moisture, are seen growing in all directions on the fibres, imitating exactly the snow-figures. If very small quantities of ether are now continually supplied, a group of crystals and needles, sometimes to a length of two centim., is readily obtained, affording, when projected on a screen, a very elegant experiment which is rapidly going on and is successful even at a surrounding temperature of 13° C.

The way by which these crystals are here obtained may elucidate the question on the formation of the ice-crystals observed by the Duke of Argyll and recently discussed in NATURE. I think that the ligneous substance, from its rotten condition, presents an innumerable quantity of very thin fibres, cooling after sunset rapidly by radiation, and their surfaces, getting to a temperature beneath the freezing-point, cause the vapour of water, with which the surrounding atmosphere becomes now surcharged, to be slowly deposited in the crystallised form exactly as in the above experiment. The crystals, ending in needles and sharp points, continue to cool by radiation, and therefore increase at their extremities, till their length is sufficient to have gravity exerting its influence in curling them round the bark.

The Hague, Holland, March

L. BLEEKRODE

Cloud Classification

THOSE who have long taken an interest in the subject of the classification of the clouds, will heartily congratulate themselves that this study is again resuming a fair share of the attention of meteorologists, and is likely to be more fully discussed than it has been for many years.

Luke Howard's Classification was, as far as he knew at the time, a first attempt to introduce order into fields of observation, then almost untried by scientific men. No one could suppose that it would at once exhaust the whole subject and be incapable of either extension or modification by later observers who possess the advantage of a much more mature stage of the science of meteorology. Still I may be allowed, without prejudging the result of the present discussion, to suggest one or two practical cautions to those who may be taking the subject in hand.

Firstly—Luke Howard's nomenclature of clouds has, since his time, been passed from hand to hand by a great number of observers, many of whom have apparently never taken much trouble to ascertain what he really intended to define by certain names, or what were the principles on which the classification was based. Therefore, before too readily finding fault either with the names or the original application of them, it might be well to give somewhat thoughtful study to the very carefully worded descriptions and definitions in Luke Howard's own work on the subject.[1]

Secondly—Clouds are by their very nature liable to frequent changes from one class to another, during which they must pass, more or less rapidly, through intermediate forms. If an attempt is made to classify all these temporary and intermediate varieties, the science will become rather unusually complicated. Were the same principle carried out in other branches of observation we should, for example, have to classify the *tadpole* as an important separate variety of the batrachians.

In conclusion I may remind the observer of the advice of Goethe in his remarks about Howard's nomenclature[2]—which advice is as applicable now as when it was first written—"Not to allow himself to be led astray by the occurrence of certain indistinct appearances, but to practice himself in referring the same to the main rules (or classes) under which they come."

Walthamstow, March

ELIOT HOWARD

Diatoms in the London Clay

SINCE you were good enough to allow me to announce in NATURE, the discovery of diatoms in the London clay, I have been able to trace the band in which they occur throughout the whole extent of the London clay in East Kent—and at one spot in Mid-Kent. In continuing the inquiry, with vol. iv. of the *Memoirs* of the Geological Survey for my guide, I have found that sections that were visible when that valuable work was published are now overgrown or have been removed. Under these circumstances will you allow me to ask your readers for information as to places where tolerably fresh sections of the lower part of the London clay can be seen, especially at or near the northern and the western outcrop of the formation?

As regards the eastern part of Kent, the investigation is complete, and therefore no correspondence need take place respecting sections in that district.

Also I should like to have information as to any wells in course of being sunk in any part of the London basin.

I may observe that I have invariably found these fossil diatoms only in clay of a uniform dark slate colour, that dries out dark grey, and has a tendency to lamination.

On splitting open a fresh piece of clay, the diatoms, if present, are easily seen with the help of a pocket lens, as shining specks, and if plentiful their metallic lustre is evident to the unassisted eye.

W. H. SHRUBSOLE

Meteor

YESTERDAY evening, when observing the zodiacal light, in order to get its limits among the stars, I remarked a fire-ball in the same direction, which may have been perceived also in England, where it was seen, perhaps, near the zenith. I give you the elements of my observation to be published in your journal.

Mean local time 7h. 20m. evening, March 3.

Direction of the apparent path from the width of the arc $\mu - \xi_2$ *Ceti* towards the width of the arc γ *Ceti* $- \alpha$ *Piscium*.

The beginning was very small, but towards the end the brightness increased very quickly, and the phenomenon ended

[1] Essay on the Modifications of Clouds, by Luke Howard, F.R.S. Third edition, with plates. (Churchill, 1865.)

[2] Quoted in preface to third edition of the essay, &c.

still brighter than Venus at its maximum brilliancy, like a suddenly appearing flame in a white colour. The bursting-point I could sharply determine $1\frac{1}{2}^\circ$ below the middle of the line *a Pisc.* – γ *Ceti*, in the given direction; the mistake being not greater than one degree.

Accident having favoured me, looking sharply as I was in the direction of the phenomenon, my observation will, perhaps, have some importance, if positions of the same fire-ball have been taken by English observers. H. T. H. GRONEMAN

Groningen (Netherlands), March 4

Sunshine

IT may interest your readers and the Fellows of the Meteorological Society to know that "the sun is always shining somewhere," even though we have so little demonstration here. In a letter received from Adelaide, from a reliable observer, I note the following:—

"Last Tuesday, January 20, was a cooker! 113°·5 in the shade, and 172° in the sun, the highest ever registered here; the latter being within 40° of the boiling-point of water."

CHAS. COPPOCK

Grosvenor Road, Highbury New Park, March 5

Lines of Force due to a Small Magnet

REFERRING to my communication in NATURE, vol. xxi. p. 370, the value of y, for which the radius of curvature (ρ) is a maximum, should have been $y = \cdot 317\ C$, not $\cdot 432\ C$ as stated.

Glasgow, February 27 JOHN BUCHANAN

Artificial Diamonds

I READ with great surprise a paragraph in NATURE, vol. xxi. p. 409, referring to an investigation which I am now making on the artificial production of various crystalline forms of carbon, and I write to disclaim all responsibility for statements which have been published without my knowledge or consent.

R. SYDNEY MARSDEN

University College, Bristol, February 27

[The correspondent who sent us the paragraph in question sent it in good faith, believing the matter to be to that extent public.—ED.]

JAS. ROCK.—The galls which your gardener found growing on the *root* of an oak-tree, about six inches below the surface of the ground, are probably galls produced by *Biorhiza aptera*.

J. W. WYATT.—The appearance in the specimen of a decayed ash bough is caused by the mycelium of *Helotium æruginosum*, Fr. [= *Peziza æruginosa*, Fr.]. See Cooke, "Handbook of British Fungi," pp. 708, 709; "Official Guide to the Kew Museums," p. 81.

PICTET'S PROPOSAL TO DISSOCIATE THE METALLOID ELEMENTS

THE task set before me is to expound in as simple and intelligible language as possible the remarkable train of reasoning which has led M. Raoul Pictet, of Geneva, to the conclusion that the so-called metalloids are really not elementary bodies at all, but capable of dissociation into simpler forms. During the last two years M. Pictet has published several important memoirs upon different branches of thermo-dynamics, and has, as is well-known, in his researches on the liquefaction of oxygen and of hydrogen shown the fruitfulness of the ideas which have thus occupied him. He is at the present moment engaged upon a large volume entitled *Synthèse de la Chaleur*, a work in which it is sought to deduce all the known laws of heat from the general principles of theoretical mechanics, by finding true mathematical definitions for the quantities which hitherto have been usually expressed as simple experimental matters. Thus the terms "temperature," "specific heat," "latent heat," &c., are capable of exact definition in a manner which enables the relations between them to be investigated analytically. These relations thus investigated are found by M. Pictet to be capable of experimental verification, and the complete acccordance of deduced theory with observed fact justifies him in giving the name of *Synthesis of Heat* to this new advance in thermo-dynamics.

To understand aright the views of M. Pictet with respect to the possible dissociation of the metalloids we must notice briefly the fundamental points of his theory of heat. If the atoms of a body are in absolute rest and equilibrium, their temperature will be at *absolute zero*. If however, kinetic energy is imparted to these atoms and they are set vibrating, the *temperature* of the body will be represented by the *mean amplitude* of the oscillations, and the total *quantity of heat* in the body will be the quantity of energy thus imparted.

Now the great decomposing force in nature is heat. It is heat which changes solids to liquids, liquids to vapours. Heat breaks up chemically combined substances and reduces them to simpler forms. It is quite certain that the limits of the power of the chemist to decompose the substances that pass through his hands are those which correspond to the temperatures which he can produce in his laboratory. We shall explain at a later portion of this article how this comes to be the case. Yet there are in nature temperatures far more elevated than the highest artificial temperature. To take the most striking example, the surface of the sun must be enormously hotter than even the hottest of the electric arcs in which even the most infusible of metals is vaporised. We know this upon evidence which accumulates evety day, and of which the most important is that afforded by the spectroscope. The researches of Kirchhoff and J. W. Draper, and the later work of Cornu, Mascart, and Lockyer, establish incontestably that the radiation emitted by a glowing substance varies with the temperature of the substance, and that at higher temperatures new rays of shorter wave-length and more rapid oscillation appear, while the intensity of all the emitted rays is also greater. The solar spectrum is much more rich in violet and ultra-violet rays at the more refrangible end of the scale than the spectrum of any artificially heated substance. The irresistible conclusion is that its temperature is far higher.

But the spectrum of the sun when scrutinized with the most elaborate skill and knowledge reveals another very striking circumstance. A large number of the substances regarded by the chemist as *elements* have now been recognised by the characteristic absorption lines of their spectra as existing in the heated matters surrounding the sun. The researches of Mr. Lockyer show that nearly forty of the metals are thus to be detected. But *not a single metalloid* is thus discoverable. Indeed so marked is their absence that the presence of hydrogen in such great abundance is held by no less an authority than Mr. Dumas to be a convincing proof that hydrogen is a metal and not a metalloid. It is true that Mr. Henry Draper of New York, has announced the discovery of *bright* lines corresponding to oxygen amongst the dark absorption lines of the solar spectrum: but it is far from certain whether the coincidence he has pointed out is real or apparent only, and all other evidence points to an adverse conclusion.

Putting together these two capital facts of solar spectroscopy, the irresistible inference is that the surface of the sun is too hot for metalloids to exist there; or in other words, *its temperature is higher than the temperature of the dissociation-points of the metalloids*. This term dissociation-point is justified by analogy with the terms boiling-point and melting-point, with which we are familiar, and with which we associate the notion of definite temperatures.

Let us examine, following M. Pictet's fundamental principles, how far this analogy can be followed out and justified. Those fundamental principles are that in hot bodies the molecules are swinging to and fro about positions of equilibrium; that "heat" *is* the energy of these molecular vibrations; and that the "temperature" of the body *is* the mean amplitude of the vibrations. If more energy is imparted to a solid, the more energetically will its particles oscillate, the longer will be the mean amplitude of their oscillations, and the higher the temperature. If we allow that the gravitation law of attraction, namely that the attraction between two masses varies inversely as the square of the distance between them, holds good not only on the grandest scale but also on the most minute, we must admit that the force acting on a vibrating particle at the furthest limits of its swing, and tending to attract it back, will be relatively weak as the amplitude of the swing is great. Hence too long a vibration may carry the particle right beyond the field of molecular attraction; and the particle will not return but will carry off with it in the form of potential energy part of the heat furnished to the body. The sum of these small quantities of potential energy which must necessarily disappear from the body during its change of state from the solid to the liquid condition constitute that which we usually term "latent heat."

Now consider a solid body at the absolute zero of temperature to which new quantities of heat are continuously imparted. What will be the successive changes to be observed? At first the temperature of the body will rise proportionately to the quantity of heat imparted to it. When the vibrations of the particles have attained a certain amplitude, fusion will take place, not all at once but gradually, each molecule passing away from the attraction of its neighbours, as soon as its vibration is sufficiently energetic. Each solid particle will thus be split up into two or more liquid molecules exactly resembling each other. Every one of these molecules will require potential energy, hence during the entire process of liquefaction, the whole of the heat imparted will be employed in producing the change of state; so that the temperature will be stationary in spite of the continual addition of heat. But when the whole substance has melted, the temperature will again rise up to a certain point determined by the commencement of ebullition, a point which will vary with the conditions of external pressure. This second change of state arises from a further splitting up of the molecules into two or more portions each, every separated portion again carrying off with it a further quantity of potential energy, the "latent heat" of vaporisation. If the gaseous molecules thus produced receive still further quantities of heat, the temperature will go on rising until another point is reached, corresponding to a first chemical *dissociation*, when, as the lengths of oscillations become excessive, the separate atoms are successively thrown apart. This process, like those of liquefaction and vaporisation, will be accompanied by the absorption of heat. The extent to which energy must be furnished in order thus to produce chemical separation, will be proportional to the chemical affinity of the separated atoms; and if the body consists of several chemical constituents it is probable that some of these will be dissociated at lower temperatures and some at higher. The limits of dissociation will have been reached when the body has been separated into its ultimate particles or true elements.

The striking feature of this series of changes is that while the addition of quantities of heat goes on continuously, the rise of temperature is discontinuous, having several stationary points in the range between the absolute zero and the highest possible temperature; each fresh stationary point corresponding to a change of state, or a decomposition of the particles into simpler forms.

Suppose next that we could reverse the order of operations, and could abstract the heat continuously from the dissociated bodies, we might expect to find the same series of changes occurring in the inverse order. But this expectation would not be realized, for reasons which are not difficult to find. In the two changes of state which are of a nature usually termed *physical changes*, namely liquefaction and vaporisation, the result of the splitting up is to produce particles all of the same kind. In a liquid—water, for example—all the liquid particles are water. In a vapour—steam, for example—the particles are all particles of steam. But in the case of *dissociation*, which is a *chemical* change of state, the result of the splitting up is to produce particles not all of the same kind. Thus, if steam is passed through a white hot platinum tube, the dissociated matters are of two kinds, oxygen particles and hydrogen particles. In the changes denominated "physical" which produce homogeneous particles, the recombination does not depend on the relative *positions* of the constituents but only on *pressure* and *temperature*. In the changes denominated "chemical" which, as we have seen, produce heterogeneous particles, the recombination of the constituents depends on their relative *positions* and on the way in which they have to be grouped in the compound, as well as on pressure and temperature. This most important distinction must not be overlooked.

Again, the dissociated chemical atoms carry away with them in a potential form the heat which has disappeared during the process of dissociation, exactly as a liquid carries in a potential form the "latent heat" which disappeared during the process of liquefaction. If we collect the separated chemical constituents—the oxygen and hydrogen for example—and make them recombine, they will evolve this potential energy and the heat will reappear. The limit of temperature, therefore, which can possibly be reached by the combustion or chemical combination of any bodies is precisely the temperature of the dissociation point of the substances formed. Hence there is obviously, as we remarked at the outset, a limit to the power of the chemist to dissociate bodies; a limit determined simply by the temperatures he can artificially produce.

It will be remarked, however, that we have in the electric current a means of obtaining many decompositions which without its aid would have been unknown to us. We may even assert upon the certain evidence of the spectroscope that the temperatures attained by the electric spark are far higher than those of any known combustion. Nevertheless there are here also limits which cannot be passed. If in the circuit of the most powerful battery we interpose a conductor of considerable resistance its temperature will rise; and, if the conductor be reduced in thickness to augment its resistance, will continue to rise until the conductor itself is either liquefied, volatilised or dissociated, when of necessity a practical limit is reached in the entire stoppage of the current. Again, with the discharges from induction coils and Leyden jars, which take place even across gases, there must be a limit, determined by the absorption of energy by the very molecules which are concerned in the discharge, and whose resistance to the electrical action will increase with their temperature. It is a point which may admit of some further discussion. But, on the whole, one is led to the conclusion that the dissociations we have shown to be theoretically possible are in a very large number of cases absolutely beyond the practical limits of experimental achievement.

One course yet remains open. We have not hitherto considered the connection between temperature and radiation in its bearings upon this question. It appears that every temperature, as defined above, corresponds to a definite kind of radiation. Every calorific oscillation of a particular rate is then associated with the propagation of a wave of disturbance in the surrounding ether; this wave having a particular frequency, or, what is the same thing, a particular wave-length. When these calorific waves in passing through space meet a body they tend to set its particles vibrating; and, what is more important, tend to set them vibrating in unison with the original vibrations of the radiating source. If it were not that the receiving body were subjected to external influences, it would acquire little by little exactly the same temperature as the body from which the radiations were emitted. In other words thermic equilibrium would be established between the two, quite irrespective of the distance between them. We know that the rays of the sun traverse space without any diminution in their frequency or wave-length. It follows, therefore that *the sun's rays are able to raise to a temperature equal to that of the sun's surface any body on the surface of the earth on which they can be concentrated*, provided only such a body could be preserved from losing heat by conduction or radiation. Although a certain quantity of the solar radiation is arrested by absorption in the imperfectly transparent atmosphere surrounding the earth, measurements made at places so widely apart as Cairo, Paris, and St. Petersburg agree in showing almost identical values for the amount of heat received from the sun, and which is about twelve calories, per square metre, per minute.

Now on the supposition that all the metalloids, with the exception, perhaps, of oxygen, are dissociated in the sun, thermal equilibrium, if thus experimentally obtained, ought to affect the dissociation of them upon our globe also.

M. Pictet therefore proposes that an enormous parabolic mirror should be constructed, in the focus of which the sun's rays should be concentrated upon the various metalloids which it is sought to decompose. All the data for calculating the requisite size of the mirror are known to a certain approximative value, with one exception. We know the quantitative intensity of solar radiation, and the reflecting power of polished metals, and hence can calculate how many units of heat a mirror of given size will hurl into its focus per minute. *We do not know* how much heat must be furnished to a given weight of any one of the hitherto undecomposed metalloids to dissociate it, but we are quite certain that this quantity must be much greater than that produced by the combustion of an equal weight of hydrogen and oxygen. Assuming that to dissociate bromine required *a hundred times* as much heat (at the temperature of its dissociation-point) as water vapour requires (at *its* dissociation-point) to split it up, M. Pictet calculates that a single gramme of bromine must have 350 calories expended upon it to resolve it into its elements. Further calculation leads him to consider that to dissociate one gramme of bromine per minute, would require that the solar rays should be concentrated by a mirror of *at least* 35 sq. metres of surface, measured normally to the rays, or of about ten metres' aperture. It would, he thinks, be best constructed in separate pieces of about a square metre in area, each ground and polished to a true curve and mounted in a special frame. The depth of the mirror should be equal to half its aperture, bringing the focus into the plane of the rim. At the focus would be a special *solar chamber*, or crucible, constructed of lime or zircon, or other refractory substance, into which the vapours to be operated upon would be led. To avoid loss of heat it would be kept hot from without by oxyhydrogen flames. The whole apparatus ought not, he thinks, to weigh as much as two tons. To catch and retain the dissociated substances, and to prevent their immediate recombination, he proposes to aspirate the vapours of the chamber through metal tubes containing metallic gauze, and cooled from without to a temperature perhaps as low as -50° by intense artificial refrigeration. The rapid cooling thus produced should hinder at least a considerable proportion of the constituents from recombining as fast as they were liberated from each other in the solar chamber.

There is much that is suggestive in the proposals of M. Pictet; so much, indeed, that any attempt at criticism or comment would outrun the limits of this article, which is therefore simply devoted to the exposition of M. Pictet's ideas in phrases as nearly identical as possible with those in which he has himself expressed them.

S. P. T.

THE DESTRUCTION OF INSECT PESTS, AN UNFORESEEN APPLICATION OF THE RESULTS OF BIOLOGICAL INVESTIGATION

"WHAT is the good of a knowledge of microscopic creatures? What is the good of prying into the anatomy of insects? It is all very well as an amusement, but serious persons can not be expected to assent to the devotion of endowments or state-funds to such trivial purposes. Chemistry, geology, electricity, if you please, have their solid commercial value, but biology is an amusement for children and old gentlemen." Such is the opinion of many a "practical man," ignorant and shortsighted as the genus invariably proves itself.

Already the practical man may be told in reply, that surgery is entirely reformed by our knowledge of the minuter fungi, that by avoiding the access of Bacteria to wounds, we avoid a large destruction of human life; already we see our way to avoiding some deadly diseases caused by these same Bacteria now that we know them to be the active cause of such disease. Already silk is cheaper in consequence of our knowledge of the Bacteria of the silk-worm disease; already better beer is brewed and better yeast supplied to the baker in consequence of Pasteur's discovery of the bacterian diseases of the yeast-plant; already vinegar-making, cheese-making, butter-making, wine-making, and other such manufacturing trades are on the way to benefit by like knowledge. Potato-disease and coffee-disease have been traced to their causes and means suggested by biologists for dealing with the parasitic plants causing those diseases, whereby not thousands but millions of pounds sterling a year may be saved to the community.

Insect pests which have depopulated whole provinces, such pests as the Phylloxera and the Colorado beetle, are about to receive a check at the hands of the same class of scientific students. The application of knowledge of natural facts is in this case a very remarkable one; for it is actually proposed to make use of our recently acquired knowledge of diseases due to Bacteria—not that we may arrest such diseases, but that we may promote them. Insect pests are to be destroyed by poisoning them not with acrid mineral poisons which damage plants as well as the insects, but by encouraging the spread of the disease-producing Bacteria which are known to be fatal to such insects. Prof. Hagen, of Cambridge, Mass., has called attention to the old practice of destroying greenhouse pests by the application of yeast. He conceives that this method may be applied to other insect-pests, such as Phylloxera, Colorado beetle, cotton worm, &c. He imagines that the yeast-fungus enters the body of the insect on which it is sprinkled and there produces a growth which is fatal to the insect's life. It is a well-known fact that insects are very subject to fungoid diseases and it is also ascertained that the application of yeast to the plants frequented by such insects favours their acquisition of such disease. Prof. Elias Metschnikoff, the celebrated embryologist, has however made some investigations on this subject and given an explanation of the possible value of yeast application (*Zool. Anzeiger*, No. 47), different and more satisfactory than that which Prof. Hagen appears to adopt.

The general result of the most accurate investigations of the beer-yeast fungus (*Saccharomyces cerevisiæ*), is entirely opposed to the notion that it can enter an insect's body and produce a disease. Beer-yeast is beer-yeast and appears always (or within experimental limits) to remain so. On the other hand De Bary has made known the life history of some simple fungi which destroy insects, and from Pasteur, Cohn, and others we know of diseases due to those simplest of fungi, the Bacteria, which produce the most deadly ravages amongst insects. Prof. Metschnikoff has examined some of these minute parasitic fungi and cultivated them by passing them from one insect to another, and has experimentally proved their very deadly character to the insects exposed to infection. The "green Muscardine" (*Isaria destructor*) is the name given by Metschnikoff to one of the minute fungi the effects of which he most successfully traced. Now it is perfectly evident that if green Muscardine spores could be produced in large quantity, or spores of similar disease-producing fungi, and applied to the ground and shrubs infested by insect-pests liable to harbour those fungi, we should have the best of all means for effecting the destruction of the insects, viz., a poison which once set at work would spontaneously multiply and spread its destroying agents around.

Accordingly Prof. Metschnikoff endeavoured to cultivate the "green Muscardine" apart from insects, so as to obtain its spores if possible in great quantity, in a liquid which might be applied to places attacked by injurious insects. He at last succeeded in effecting this cultivation by the use of beer-mash: in this decoction the green Muscardine produced a rich mycelium and finally spores.

It is exceedingly probable that we have here the true explanation of the value of the application of yeast to plants, &c., affected by insect pests. If there are a few spores only of such parasites as the "green Muscardine" about, the fluids of the yeast will serve them for nourishment and so cause the Muscardine to spread until it comes into contact with the insects. There is no reason to suppose that the beer-yeast plant itself is capable of generating a disease in any insects, at the same time we must remember that yeast as ordinarily used by the brewer is by no means pure; it contains in small quantities other minute fungi besides the *Saccharomyces cerevisiæ*, and it is quite possible that a given quantity of it, say a pint, *may*, if the brewery from which it came were not conducted on the most perfect system (such as that lately introduced by Pasteur), contain a few spores of such a disease-producing parasite as Muscardine. A diseased insect once in a way falling into the mash-tub would sufficiently keep up the supply, and thus it is possible that yeast may carry infection to insect-pests and destroy them.

At the same time Prof. Metschnikoff's suggestion of a deliberate cultivation of an insect's-disease-producing fungus, and the application of the cultivated fungus in quantity to places infested by these insects, is in the highest degree ingenious and likely to give results the value of which will be estimated in thousands of pounds, and so do something to persuade "practical" men that all science is deserving of their respect and encouragement.

E. RAY LANKESTER

THE CLASSIFICATION OF THE ENGLISH TERTIARIES

AT the last meeting of the Geological Society of London an animated discussion took place upon the question of the true correlation of the strata of the Hampshire Basin with those of France, the Netherlands, North Germany, Switzerland, and other parts of Europe. This discussion was raised by a memoir read by Prof. Judd, who showed that the accepted order of succession in the series of fluvio-marine strata of the Isle of Wight is not the true one, but that the formation in question is of much greater thickness and importance than had hitherto been supposed by geologists.

These fluvio-marine strata of the Hampshire Basin, which, as is well known, are quite unrepresented in the London area, have attracted much attention from British and foreign geologists. The order of their succession has been the subject of frequent controversies in the past, for, like all deposits formed in deltas, the beds are inconstant in character and thickness, and it is difficult to trace them at the surface by the art of the geological surveyor; furthermore, the districts of the New Forest and the northern half of the Isle of Wight, in which the strata in question are found, are covered with thick deposits of sand and gravel, so that the underlying strata are seldom exposed except in sea cliffs and in such artificial openings as railway-cuttings, brickyards, quarries, and wells.

The first classification which was proposed for these beds was the result of the long and careful study of the geology of the Isle of Wight by Thomas Webster. He believed that the fluvio-marine beds consist of a set of marine strata with fresh-water deposits above and below them. But the more careful study of the palæontology of the formation by Prestwich and Edward Forbes proved that Webster had confounded in his "marine series" several strata which are on very distinct geological horizons. In the memoir now laid before the Geological Society Prof. Judd carries the question one step further in the same direction, and demonstrates that strata exposed at Colwell Bay and at the base of Headon Hill are not, as was hitherto supposed, upon the same horizon, but that the latter underlie the former. The classification now proposed for these fluvio-marine strata, which are shown to have a thickness of from 800 to 900 feet, is as follows:—

Hempstead series (marine and estuarine) ...	100 feet.
Bembridge group (freshwater and estuarine)	300 ,,
Brockenhurst series (marine)	25 to 100 ,,
Headon group (freshwater and estuarine), including the Headon Hill sands	400 ,,

The Headon group is proved to be the exact representative of the *Zone of Cerithium concavum* which has been recognised at so many points upon the Continent.

Edward Forbes's division of the "Osborne and St. Helen's Series" it is shown must be abandoned, on the ground that it presents no good features, either mineralogical or palæontological, by which it can be distinguished, and its separation was founded on an error in working out the true order of succession of the beds. On the other hand, the marine strata seen about Lyndhurst and Brockenhurst in the New Forest, and at Colwell Bay and Whitecliff Bay in the Isle of Wight, are shown t constitute a division of very great importance for which the name of the *Brockenhurst Series* is proposed.

Since the date of Edward Forbes's study of these beds, much new light has been thrown upon their age and relations by the collection and study of the fossils which they contain; the number of species now known to us is probably, at least four times as great as those with which Forbes was acquainted, this result being mainly due to the labours of the late Mr. Frederick Edwards and other indefatigable collectors of tertiary fossils.

It is greatly to be desired that the rich stores of molluscan, reptilian, and mammalian fossils, which exist in the British and other museums, should be described by competent naturalists, as much new light would thereby be thrown on the life of the period when these beds were deposited.

Great difficulty has always been experienced by English geologists in referring the fluvio-marine beds of the Isle of Wight and the New Forest to their proper place among the great divisions of the Tertiary strata. Some authors place the whole of these beds in the Eocene, but this can only be done by unnaturally extending upwards the bounds of that division so as to include these Isle of Wight strata. In the paper just read to the Society, Prof. Judd shows that while the several marine Eocene faunas, those namely of the Barton, the Bracklesham, and the Bognor beds, are very closely related to one another, the Brockenhurst fauna has but little in common with them. Thus, out of nearly 200 species of marine shells found in the Brockenhurst series, not more than one-fifth occur in the Barton clay (Upper Eocene) below. The Hempstead marine fauna has still fewer species in common with the Eocene.

The late Sir Charles Lyell proposed to divide the fluvio-marine series into two portions, and to group one with the Eocene and the other with the Miocene. But the inconvenience of breaking up this homogeneous series of beds into two portions must be apparent to every one.

Under these circumstances it is felt by geologists that the fluvio-marine strata of the Hampshire basin must be referred to a division of the Tertiaries distinct alike from the Eocene and the Miocene, and this was admitted by almost every one who took part in the discussion last Wednesday, including Prof. Prestwich and Dr. Duncan.

In the year 1854, Prof. Beyrich, of Berlin, showed that under the great masses of gravels and drift that cover such large tracts in North Germany, and immediately overlying the great Brown-coal formation of the country, there exist marine beds which contain a fauna distinct alike from the fauna of the Miocene and from that of the Eocene; and strata containing the same fauna have since been discovered in the Netherlands, Switzerland, and other parts of Europe. For the division of the tertiary series which contains this fauna, Beyrich proposed the name of the *Oligocene*. Whether or not its author was happy in the choice of this name, no one can doubt that he has sufficiently demonstrated the distinct character of the great system of beds to which he applies it.

In 1867 von Koenen and Duncan, from a study of the molluscan and coral fauna of the Brockenhurst beds, respectively, proved that the fluvio-marine strata of the Hampshire basin represents the North German Oligocene; and the justice of this correlation is placed beyond doubt in the memoir by Prof. Judd which has just been read. He shows that the Headon group and the Brockenhurst series represent the lower Oligocene, while the Bembridge group and the Hempstead series are the equivalents of the lower part of the middle Oligocene, the upper Oligocene not being represented in this country.

That the Oligocene is a very important division of the geological series is shown by the fact that in Eastern Europe (Hungary and Transylvania) strata of this age attain a thickness of between 2,000 and 3,000 feet, and contain valuable beds of coal, while in the neighbourhood of the Alps they are from 10,000 to 12,000 feet thick. It is interesting to find that the lower portion at least of this great formation is represented in our own country, and by strata of such thickness and importance.

A NEW CLASS OF RHIZOPODA

AT a meeting of the Natural History Society of Jena the following note was read by Prof. Ernst Haeckel: "Upon the PHÆODARIA, a new Group of Marine Siliceous Rhizopods."

The Phæodaria are a group of large marine Rhizopods, rich in specific forms and remarkable in many respects, which have hitherto been included in the typical Radiolaria (Sphæridea, Discidea, Cyrtidea, Cricoidea), from which they differ as widely as do the Acanthometrina. Till lately very few forms of the Phæodaria were known; these were first observed by me at Messina in 1859, and described in my monograph of the Radiolaria in 1862, as representatives of three different families—

1. Aulacanthidæ (genus *Aulacantha*).
2. Aulosphæridæ (genus *Aulosphæra*).
3. Cœlodendridæ (genus *Cœlodendrum*).

Besides these, I had described two other forms belonging to this group, namely, *Thalassoplancta*, which I placed among the Thalassosphæridæ, and *Dictyocha*, which I placed among the Acanthodesmidæ.

Quite a new light has been thrown upon these interesting Rhizopods by the *Challenger* expedition, which discovered so many forms of the typical Radiolaria in the depths of the Pacific Ocean, that I have been able to define more than 2,000 new species. Besides these, the explorations of the *Challenger* have brought to light a number of deep-sea Phæodaria hitherto entirely unknown. The number of species of this group in the surface preparations in the *Challenger* collection which have been examined by me is not so considerable.

John Murray gave, in 1876, a short account of some of the most peculiar forms of these new deep-sea Phæodaria, under the name of Challengeridæ (*Proceedings* of the Royal Society, 1876, vol. xxiv. pp. 471, 535, 536, Pl. 24, Figs. 1–6). He draws particular attention, on the one hand, to the extremely delicate and finely-fenestrated structure of the large siliceous shells, and on the other hand to the constant appearance of masses of black-brown pigment which are scattered through the sarcode, outside the central capsule.

In the new arrangement of the Radiolaria given by me in 1878, in my article on the "Protista" (*Kosmos*, vol. iii.), I placed the hollow-spined siliceous Phæodaria already mentioned in a special order of Radiolaria, under the name of "Pansolenia": "The skeleton consists of single hollow tubes, loosely scattered, or connected in radial or concentric order" ("Protistenreich," p. 102).

This group was described in 1879 by Richard Hertwig, in his work on "The Organisation of the Radiolaria," as a special order of the class under the name of "Tripyleæ," with the following characters:—"Radiolaria Monozoa, with single nuclei; capsule-membrane double, with one principal and two lateral openings; skeleton siliceous, formed of tubes" (*l.c.*, p. 133, p. 87).

Neither the name "Tripyleæ," given by Hertwig, nor my name "Pansolenia" is applicable to all the Rhizopods which I have now placed in the group Phæodaria, as only a portion of these have the three openings in the double membrane of the central capsule, which ought to characterise the "*Tripyleæ*," and in a portion of them only the siliceous skeleton is formed of "hollow tubes" ("*Pansoleniæ*"). On the other hand, as Murray first showed, a striking character of all these Rhizopods is the constant presence of large dark-brown pigmented granules, scattered irregularly round the central-capsule, and covering the greater part of its outer surface. In brevity I call this extra-capsular mass of dark pigment the Phæodium (φαιός or φαιοίδης = dark brown, dusky). The Phæodella, or large brown granules of the Phæodium are not, as Murray supposed (*l.c.*, p. 536) true pigment cells, as a true cell nucleus cannot be observed in them; and the nature of the peculiar pigment of these pseudo-cells is not precisely known; but the quantity and constancy with which the Phæodium appears in all Phæodaria, while it is wanting in all the typical Radiolaria, gives the Phæodaria a high degree of systematic importance. It seems to me at present that the constant presence of the Phæodium and the peculiarly constructed membrane of the central-capsule are the only systematically reliable characters which separate all Phæodaria from all other Radiolaria.

The size of the Phæodaria is usually very striking in comparison with that of the other Radiolaria, which they greatly surpass in diameter. The greater number of the Phæodaria are visible to the naked eye, and many are from ½ 1 mm. or more in diameter. The conspicuous central capsule is usually round or spheroidal; it is, however, often egg-shaped or somewhat oval. In many cases it is monaxial, in others dipleuric. Its membrane is very firm and always double, the outer layer very thick, the inner thin. The opening through which the pseudopodia appear has the very peculiar structure accurately described by R. Hertwig (1878, *l.c.*). Many Phæodaria have only one such opening (*Monopyleæ*), others have two at the opposite poles of the central capsule (*Amphipyleæ*); many, perhaps the greater number, have three, one larger principal opening and two smaller lateral openings (*Tripyleæ*), while others have a larger number of openings regularly or irregularly disposed (*Sporopyleæ*). Notwithstanding its peculiar structure and conspicuous size, the central capsule of all Phæodaria, has merely the histological value of a single simple cell. This is shown by the microchemical condition of its protoplasmic contents and the nucleus inclosed within it. This cell-nucleus (described by me in 1862 as the "inner vesicle") is vesicular and of large size, being usually more than half the diameter of the central capsule. It sometimes includes one large nucleolus, sometimes several.

The extra-capsular soft substance of all Phæodaria is distinguished by two characteristic peculiarities—first, by the large quantity of the extra-capsular sarcode, which is more voluminous than the intra-capsular, and secondly by the mass of phæodella or "dark pigment granules" which it contains. The colour of the latter is usually dun-brown or black-brown, often greenish or dun-green. The layer which originates the pseudopodia is very thick and inclosed in a thick jelly, often traversed by spaces through which the ray-like pseudopodia protrude. The Phæodella or peculiar pigment-granules of which the large Phæodium is composed, are, like the Phæodium, of varying form and size. Sometimes the Phæodium envelopes the greater part of the capsule, sometimes only one side of it. The extra-capsular yellow cells which are found in all typical Radiolaria are entirely wanted in the Phæodaria.

The siliceous skeleton is extra-capsular in all Phæodaria and is very peculiar in form and structure. Although the principal types of this group have corresponding representatives among the typical Radiolaria, they are usually easily distinguished from the latter. In a small division only, corresponding to the Thalassicollidæ, the siliceous skeleton is entirely wanting (*Phæodinidæ*). All other Phæodaria have a characteristic siliceous skeleton, according to the structure of which I distinguish in the group four orders and ten families.

Order I. PHÆOCYSTIA.—The siliceous skeleton is either entirely wanting or it consists of hollow spines, arranged sometimes irregularly, sometimes regularly, outside the central capsule.

Family 1. PHÆODINIDÆ.—Siliceous skeleton entirely wanting. Genera: *Phæodina*, *Phæocolla*.

Family 2. CANNORHAPHIDÆ.—The siliceous skeleton consists of numerous separate hollow spines, or portions of hollow network, which, scattered round the periphery of the extra-capsular soft substance, are usually arranged tangentially. Genera: *Cannorhaphis*, *Thallassoplancta*, *Dictyocha*.

Family 3. AULACANTHIDÆ.—The siliceous skeleton consists of hollow radial spines, which spring from the outer surface of the central capsule, and traverse the extra-capsular jelly. The outer surface of the jelly is usually covered by a thick mantle of fine hollow siliceous needles, which are arranged tangentially and felted together. Genera: *Aulacantha*, *Aulancora*, *Aulographium*.

II. Order. PHÆOGROMIA.—The siliceous skeleton consists of a single fenestrated shell which is of different forms, sometimes round, sometimes egg-shaped, often dipleuric, but always furnished with a large principal opening or mouth (more rarely with several openings). Hollow spines with peculiar pore-areas at their bases are often present.

Family 4. CHALLENGERIDÆ.—The siliceous skelcton consists of a fenestrated shell, uniaxial or dipleuric, often laterally compressed and carinated, often egg-shaped or oval, and furnished with a wide opening at one end of the axis. This mouth is seldom simple, it is usually armed with a hollow tooth, or with one or more, often branched hollow tubes. The fenestrated structure of the siliceous shell resembles most closely that of the diatoms; there is a fine pore in the middle of each of the hexagonal facets (Comp. Murray, 1876, *l.c.*, Pl. 24, Figs. 1, 2, 4). Genera: *Challengeria*, *Tuscarora*, *Gazelletta*, *Porcupinia*, *Entocanula*, *Lithogromia*.

Family 5. CASTANELLIDÆ.—The siliceous skeleton consists of a simple round fenestrated shell, which has in one part of its upper surface a wide opening, often surrounded by peculiar processes. The fenestrated shell is usually ornamented with solid or hollow spines. Genera: *Castanella*, *Castanidium*, *Castanissa*, *Castanopsis*, *Castanura*.

Family 6. CIRCOPORIDÆ.—The siliceous skeleton consists of a sub-spherical or polyhedral siliceous shell, from which radiate in different directions hollow tubes (simple or branched, often provided with whorls of cilia). The shell has a large opening, as well as scattered pore-facets. The pores usually form circles round the bases of the spines. (Comp. Murray, 1876, *l.c.*, Pl. 24, Fig. 5-6). Genera: *Circoporus*, *Circospathis*, *Circostephanus*, *Porostephanus*, *Porospathis*.

Order III. PHÆOSPHÆRIA.—The siliceous skeleton consists of numerous hollow tubes which are combined in a peculiar manner into a large, usually round or polyhedral fenestrated body.

Family 7. AULOSPHÆRIDÆ.—The siliceous shell is a fenestrated ball or a fenestrated polyhedral body whose lattice work is formed of hollow tubes. Hollow spines usually radiate from the points of connection of the lattice-work (Comp. Haeckel, "Monogr. der Radiol.," 1862, p. 357, Taf. x. xi.). Genera: *Aulosphæra*, *Aulodictyum*, *Auloplegma*.

Family 8. CANNOSPHÆRIDÆ.—The siliceous skeleton consists of a uniaxial globular or oval simple bounding shell, which is connected by means of hollow radial rods with a composite outer encrusting shell. The outer shell consists of hollow tubes, which form a wide-meshed latticed sphere; hollow simple or branched radial spines spring from the junctions of the lattice (Comp. Hertwig, *l.c.*, 1879, p. 91, Pl. ix.). Genera: *Cannacantha*, *Cannosphæra*, *Cœlocantha*.

Order IV. PHÆOCONCHIA.—The siliceous skeleton consists of two separate fenestrated shells, like those of a bivalve mollusc. Simple or branched hollow tubes are often found at the junction of the valves.

Family 9. CONCHARIDÆ.—The siliceous skeleton consists of two semicircular or lenticular fenestrated shells turned each to each with the concavities inwards; the edges of the shells are usually set with rows of teeth, which lock together like the teeth of a bivalve (Comp. Murray, 1876, *l.c.*, Pl. 24, Fig. 3). Genera: *Concharium*, *Conchopsis*, *Conchidium*, *Conchocaras*.

Family 10. CÆLODENDRIDÆ.—The siliceous skeleton consists of two semicircular or lenticular fenestrated shells with the concave sides turned towards each other. Simple or tree-like branched hollow spines spring from the two opposite poles of the principal axis, or from the centre of the junction of the hemispheres. (Haeckel, "Monogr. d. Rad.," 1862, p. 360; Taf. xiii., Figs. 1-4; Taf. xxxii., Figs. 1-3.) Genera: *Cælodendrum*, *Cælothamnus*, *Cælodrymus*, *Cælothauma*.

Taking a comparative survey of the organisation of the known Phæodaria, we can define the characters of this group of Rhizopoda as follows:—

The Phæodaria are single-celled Rhizopods, whose larger cell-body (the central-capsule) incloses a large nucleus (or inner-vesicle). The cell-membrane is always double, pierced by one or more large openings, through which the intra-capsular protoplasm communicates with the much more abundant extra-capsular protoplasm. In the latter, towards the outside, lies the phæodium, a peculiar thick mass of dark pigment-granules (or phæodella). The whole body is inclosed in a thick gelatinous covering, which is often provided with spaces which the numerous pseudopodia traverse in order to rediate freely beyond its outer surface. With very few exceptions (Phæodinideæ) a well-developed, always extra-capsular siliceous skeleton is secreted, which forms, as in the different groups of the typical Radiolaria, very varied and delicate structures, usually radiating outwards in hollow siliceous tubes. N. M.

NOTES

THE German Chemical Society in entering upon its thirteenth year has elected as president Prof. H. Kopp, of Heidelberg, who for some time past has devoted himself almost exclusively to the chronicling of the history of chemistry. At the same time Prof. Roscoe, of Manchester, and Prof. Marignac, of Geneva, who was compelled a year since by advanced age to relinquish active professorial duties, were elected to honorary membership. The Society now numbers 2,086, of whom 14 are honorary members and about 200 resident at Berlin. The *Berichte* of the Society, now certainly the most important chemical periodical of the day, forms for the past year a volume of over 2,550 pages containing over 600 communications. An exhaustive index of the first ten years is now in the press, and will soon be ready. The already bulky dimensions of the *Berichte*, with its constant yearly increase in size, have forced the council of the Society to propose an increase in the membership fee, which instead of 15*s*. shall be raised to 20*s*. annually. The fact that the Society can cover its ordinary expenses and send post free to its members in all parts of the world a periodical of the size above mentioned for so modest an annual fee, affords an interesting glimpse into the comparative cost of scientific association and activity in Germany and in our own country, where the expenses of membership in most of the scientific societies often exclude those in limited circumstances.

DR. JOSEPH LEIDY, Professor of Anatomy in the University of Pennsylvania, at Philadelphia, has just been awarded by the Council of the Society of Natural History, Boston, Mass., the great Walker prize, for the value of his researches in natural history. This prize is given once in five years, at the discretion of the Council, to the naturalist whom it shall decide to have performed the most elaborate and original work during that time. This prize has been awarded but once previously—five years ago—to Prof. Alexander Agassiz, of Cambridge. It is usually the sum of $500, but on account of the extraordinary merit of Dr. Leidy's researches the Council increased the sum to $1,000. Dr. Leidy was for a long time connected with the Geological Survey of the Territories, and one of his most important memoirs, vol. xii. of the final Reports, has just been issued by the Government. In collecting the materials for the volume, Dr. Leidy spent two seasons in the Western Territories under the auspices of the Survey.

THE following arrangements have just been made at the Royal Institution for the lectures after Easter. Tuesdays:—Prof. Huxley—Two Lectures on Dogs, and the Problems connected with them; Mr. Robert H. Scott, F.R.S.—Four Lectures on Wind and Weather; Mr. John Fiske—Three Lectures on American Political Ideas from the Standpoint of Universal History. Thursdays:—Prof. Tyndall—Six Lectures on Light as a Mode of Motion; Mr. T. W. Rhys Davids—Three Lectures on the Sacred Books of the Early Buddhists. Saturdays:—Mr. James Sully—Three Lectures on Art and Vision; Prof. Henry Morley—Five Lectures on the Dramatists before Shakespeare, from the Origin of the English Drama, to the year of the Death of Marlowe (1593). The Friday Evening Meetings will be resumed on April 9—Prof. Huxley on the Coming of Age of the "Origin of Species." Succeeding discourses will probably be given by M. Ernest Renan, Mr. W. H. Pollock, Mr. W. Spottiswoode, Mr. G. J. Romanes, Lord Reay, Mr. H. H. Statham, and Mr. Francis Hueffer.

DR. C. W. SIEMENS was elected last month a Foreign Member of the Royal Academy of Sciences of Stockholm.

WE are glad to see that a movement has been set on foot for a testimonial to Dr. Farr as a mark of appreciation of the value of his statistical labours. The preliminary list of the committee is headed by the name of the Earl of Derby.

THE death is announced, on February 3, of Chintamanay Ragoonatha Charry, F.R.A.S., Head Assistant in the Madras Observatory for the last seventeen years. Attached to that institution for a period of over thirty-five years, he served in succession, in every grade, under the late Major W. S. Jacob, Col. W. K. Worster, Col. J. F. Tennant, R.E., and the present astronomer, and won the esteem and regard of each, by his intelligence, assiduity, and attachment to the pursuit he had adopted. His strict honesty and ready skill as an observer, combined with accuracy and speed in computation, and a fair and useful amount of self-acquired mathematical knowledge, rendered him, until disabled by impaired health, invaluable in the observatory; and the chief share in the Catalogue of Stars in hand, with the Transit Circle, since 1862, comprising already over 38,000 separate observations, is due to his personal exertions; besides many other special researches of a nature not often undertaken by ordinary assistants in observatories. He contributed several papers to the Royal Astronomical Society of London, and was elected a Fellow in January, 1872. He was twice successfully engaged in observations of total eclipses of the sun; on the first occasion in August, 1868, at Vunpurthy, in the Nizam's Dominions, in independent charge of a branch expedition for the purpose; and on the second, in December, 1871, at Avenashy, in the Coimbatore district. He was the first and only native of India who has yet entered the lists as a discoverer of new celestial objects, having detected two new variable stars, viz., R. Reticuli in 1867, and V. Cephei in 1878. He latterly took great interest in delivering public lectures on astronomy, with a view to enlighten his countrymen upon the subject, and to convince them of the absurdity of their notions in regard to celestial phenomena, by familiar explanations, in simple terms, of the true principles of the science, as opposed to the ignorant superstitions and rough predictions of Hindoo astrologers and empirics of the old school.

THE French papers, the *Gardeners' Chronicle* informs us, announce the death of Dr. Boisduval, to whose labours we owe one of the best treatises on the insects which affect garden plants. Dr. Boisduval was an ardent horticulturist, and a leading man for some time at the Central Horticultural Society of France. He died in his eighty-second year.

THE death is announced of Dr. Wilibald Artus, Professor of Philosophy at Jena, on February 7 last, aged seventy years. Also of Dr. Franz Xaver von Hlubek, Professor of Agriculture at the Graz Joanneum, on February 10, aged seventy eight years. In the third week of February also died Herr Adolf Müller, one of the directors of the well-known Geographical Institute of Justus Perthes at Gotha.

A MONUMENT to Dr. August Petermann, the well-known geographer, has just been erected at Gotha. The design, which is very tasteful, is by Herr Eelbo, and the work was executed by the eminent sculptor, Herr Deutschmann.

A NUMBER of former pupils of Bernhard von Cotta propose to erect a monument in memory of the deceased geologist, and invite subscriptions for this purpose. The Royal Berg-Academie at Freiberg will receive contributions.

DURING Napoleon's rule the number of French astronomical observatories was increased to four, viz., Paris, Toulouse, Marseilles, and the Meudon Physical Observatory of Astronomy. The present Government has created three new establishments—Lyons, Besançon, and Bordeaux, and M. Bischofsheim, the liberal banker, one at Nice. Among the high region meteorological observations Clermont-Ferrand could be used for astronomy if fitted with instruments and garrisoned by observers. The organisation of French astronomy has been completed by the creation of a school of astronomy at the Paris Observatory by Admiral Mouchez, who had already organised a school of astronomy for navy officers at Montsouris. The course of studies, whose duration is two years, was recently opened; the first year will be occupied in learning exclusively the meridian service, and the second the equatorial service, as well as general physics. The experiments connected with the physical department will take place at the Sorbonne, in the laboratories, as well as at the observatory. Four pupils have been selected by the director for the first promotion. They will have a salary of 1,800 francs a year, with lodgings in the buildings of the Observatory. After having successfully passed their examinations, they will be appointed assistant-astronomers in one of the government observatories. By a singular exception to the rules of the competition principles they are not appointed after an examination, but selected by the director of the public observatory from the Normal School, Polytechnic School, and Licenciés-es-Sciences mathématiques. They must not be more than twenty-five years of age when nominated. In addition to the Government pupils two more are trained at the expense of M. Bischofsheim, for his Nice observatory, and three others have been authorised to follow the course of lectures and applications after having proved their ability. Similar authorisations may be granted every year on application. Meridian service will be taught by Admiral Mouchez, M. Loewy, M. Perigaud, astronomer, and M. Gaillot, head of the Bureau des Calculs.

THE American Academy of Arts and Sciences intends to celebrate its 100th anniversary on May 26.

THE Easter Monday and Tuesday excursion of the Geologists' Association will be to South Hampshire, with Christchurch as a centre.

THE following statistics in connection with the termination of the St. Gothard tunnel will be of interest to our readers:—The total length of the tunnel is 14,920 metres, or 112 feet more than 9¼ miles. Its width is 6⅝ metres, or 21¾ feet. The undertaking has required for its execution seven years and five months—four and a half years less than the time taken to complete the Mont Cenis tunnel. The average daily progress was 5½ metres or 18 feet. The number of holes bored amounted to 320,000, and 490,000 kilogrammes of dynamite were used in blasting. 1,650,000 drills were consumed and 1,450,000 cartloads of *débris* were taken out from the bowels of the mountain.

THE phylloxera has appeared in Sicily in the province of Cultanisetta.

RADICAL remedies are now being adopted in France with a view of exterminating the phylloxera. The Government proposes to spend the sum of 2,400,000 francs (96,000*l.*) for inundating 7,000 hectares of vineyards in the Departments L'Aude and L'Hérault.

THE earthquakes in San Salvador, viz., in the capital and the cities in the vicinity of Lake Ilopango, seem to have lasted from December 21 until January 10. A violent shock on December 27 destroyed a number of villages near Lakes Ilopango and Zollapango, some fifteen miles from the capital. A violent shock was again felt on January 1, particularly in the port of La Libertad. The city of San Salvador is stated to be quite deserted by the population. News dated February 5 report earthquakes from Cuba and from various parts of Mexico, particularly from the districts of Cordoba, Orizaba, Tehuacan, and Veracruz. A violent earthquake occurred on February 9 at Kaposvar and other localities of the Somogy County (Hungary) shortly before midnight. A moderate shock of earthquake, proceeding in the direction from south to north, was felt in Lower Carniola in several places, such as Gradaz and Rudolfswerth, on February 12, at 5.15 p.m.

A FEW days since the *Bulletin* of the French Bureau Central of Meteorology published for the first time the daily telegrams sent from Briançon meteorological observatory, whose altitude is 1,300 metres, 300 more than the summit of Puy de Dôme. At present the French high region stations are three in number, Briançon, Puy de Dôme, and Pic du Midi. A fourth is being fitted on the new German frontier, which will complete the system.

DR. KIENITZ-GERLOFF, of Weilberg, writes to inform botanists that henceforth he is charged, in place of Herr Limpricht, with the account of bryology for the *Botanische Jahresbericht*, edited by Herr Just. He begs bryologists to favour him by transmitting their papers.

IN connection with the Commission which has been organised in Switzerland for the investigation of earthquakes, to which we referred in a recent article, Prof. Heim, of Zurich, publishes a little *brochure*, on "Les Tremblements de Terre et leur Étude scientifique," in which he reviews existing facts and theories, gives instructions for the observation of earthquakes, and describes the organisation of the Swiss Commission.

No. 3 of the *Proceedings* of the Birmingham Philosophical Society contains a number of papers of considerable interest. Dr. Richard Norris has an elaborate contribution, illustrated with many photographs, "On the Existence in Mammalian Blood of a New Morphological Element which explains the Origin of the Red Disk and the Formation of Fibrine"; Mr. Lawson Tait describes the researches on the Digestive Principles of Plants; and Prof. Bonney contributes a paper on the pre-Cambrian Rocks of Great Britain.

THE following papers were read yesterday at the half-yearly general meeting of the Scottish Meteorological Society:—1. Report from the Council of the Society. 2. The Velocity of the Wind at different Heights above the Ground, by Thomas Stevenson, Honorary Secretary. 3. The Storm of December 28, 1879, by Alexander Buchan, Secretary. 4. The Influence of the recent Fog on the Health of London, by Dr. Arthur Mitchell. 5. Thunderstorms in Scotland, their Diurnal Periods, by Alexander Buchan.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. S. M. Young; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, presented by Lady Dorothy Nevill; two Wild Boars (*Sus scrofa*) from India, presented by H.R.H. the Prince of Wales, K.G.; a Crab-eating Opossum (*Didelphys cancrivora*) from St. Vincent, W.I., presented by Mr. Geo. Dundas; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. J. Veale; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. T. Phillips; a Herring Gull (*Larus argentatus*), European, presented by Mr. H. D. Martin; a Macaque Monkey (*Macacus cynomolgus*) from India, a Crab-eating Raccoon (*Procyon cancrivorus*) from Baranquilla, two Wild Cats (*Felis catus*) from Spain, a Ring-tailed Coati (*Nasua rufa*), a Harpy Eagle (*Thrasaëtus harpyia*) from South America, deposited; a Harnessed Antelope (*Tragelaphus scriptus*) from West Africa, purchased; a Red Kangaroo (*Macropus rufus*), a Gaimard's Rat-Kangaroo (*Hypsiprymnus gaimardi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

An Astronomical Bibliography.—We are somewhat late in drawing attention to a prospectus of what must prove a very important work in astronomical literature, if it is carried out with the care and completeness of which there is every promise. MM. Houzeau and Lancaster, respectively the director and librarian of the Royal Observatory, Brussels, have projected a "Bibliographie générale de l'Astronomie, ou Catalogue méthodique des Ouvrages, des Mémoires et des Observations astronomiques publiés depuis l'Origine de l'Imprimerie jusqu'en 1880," and it is clear from the particulars furnished in the prospectus that the design has been thoroughly considered and formulated.

It is intended to divide the work into three sections:—(I.) *Ouvrages* or separate publications; (II.) Memoirs; (III.) Observations. For the first section there are available the astronomical bibliographies of Weidler, Scheibel, and Lalande referring to what may be termed the ancient period. For the modern the authors have made use of the catalogue (1860) of the splendid astronomical library of the Imperial Observatory of Pulkowa, and the catalogues of other observatories; more than a thousand journals and catalogues of different countries have been consulted for this division of the work. A list of the principal astronomical manuscripts, not yet published, which are found in the inventories of the various European libraries is added. Bibliographical notes, as, for instance, notes upon changes made in successive editions of a work are also appended, as well as a kind of analysis of works of an encyclopædic character. An alphabetical table of the authors and a methodical table of analysed matters accompanies this part of the work.

The second section, as forming a more immediate desideratum, it is intended shall be the first published, and the first fasciculus was about to be placed in the printer's hands, when the prospectus was issued, the others to follow rapidly. All the collections where astronomy could enter were consulted for this division, either directly or through the catalogue of scientific papers issued by the Royal Society or the *Repertorium Commentationum* of Reuss; it is mentioned that recourse has been had to the publications of nearly three hundred scientific societies, and more than a hundred and sixty reviews or journals. The authors have exercised great care in the classification of the contents, and in attributing each memoir to the sub-section to which it appertains; the collection where each memoir is found is indicated by a system of abbreviations. An alphabetical table of authors, briefly noting their different works for more ready reference, accompanies this second part also. In this division astronomical physics are included.

In the Section III., *Observations*, it has been proposed to arrange a kind of general table of observations, nearly upon the plan of the indexes to the *Astronomische Nachrichten*, but rather taking for a model the *Repertorium der Cometen-Astronomie* of Carl. In this section are mentioned the sources for observations of spots, faculæ, and protuberances of the sun, in chronological order from their respective discovery, observations of solar and lunar eclipses, each separately, monographs of the asteroids, bibliographical monographs of the comets, star catalogues, calculations relating to the compound stars, and individual descriptions of the variable stars and nebulæ. The authors claim to have analysed the publications of the different observatories with the most scrupulous attention in order to render this part of their work as complete and as useful as possible.

The entire work will form three large octavo volumes in double column, which will appear by fascicules of 300 to 400 pages; specimens of the form of execution of the three divisions of this laborious work are attached to the prospectus. It appears to be intended to issue it in sheets of sixteen pages, or thirty-two columns, at the price of three pence per sheet, payment to be made for each fascicule.

Every astronomer and astronomical student will applaud the zeal evinced by MM. Houzeau and Lancaster in undertaking to provide so valuable an addition to the literature of the science, and will cordially wish them success in every way in their self-imposed labours.

The Great Southern Comet.—A private letter from Mr. Gill, H.M. Astronomer at the Cape, furnishes some particulars of his observations of the great comet up to the evening of the 9th ult. Table Mountain interfering at first with the view from the Royal Observatory, Mr. Gill proceeded to Seapoint, on the west side of the mountain, where, from the garden of Mr. H. Solomon, in which Sir Thomas Maclear observed Donati's comet in 1858, he sketched the position of the tail amongst the stars on several evenings before the nucleus had withdrawn sufficiently from the sun's place to be visible. The nucleus was first seen on February 8, and then only for a few minutes through cloud; Mr. Gill thought it might have been visible the preceding evening, but haze near the sea horizon rendered it very difficult to say where the tail ended. He describes it as "a very poor affair, a faint nebulous thing not at all worthy of so fine a tail." Attempts were made to fix its position at the Royal Observatory on February 9, but only a glimpse with an opera-glass through cloud was obtained. The nucleus was "a little N. and E. of θ Sculptoris;" in a tracing accompanying the letter in question, however, the nucleus is shown a little *south* and east of the star, and midway between two stars, which from Gould's "Uranometria Argentina," appear to be Lacaille 6 and 34, so that the place referred to the epoch of the "Uranometria," 1875·0 would be in about right ascension 2° 20′ with 37° 50′ south declination, which is far from the position given by the elements telegraphed from Rio de Janeiro (to which reference was made last week) whether the heliocentric motion be assumed direct or retrograde; probably the orbit has been vitiated in transmission. On February 6 the tail appears to have been traceable nearly to Canopus.

BIOLOGICAL NOTES

On Certain Remarkable Phenomena presented by the Coloured Blood-Corpuscles of the Frog.—Repeated observations tend to show that the structure of the coloured blood-corpuscle is by no means so simple as is usually assumed: and from this point of view the observations made by J. Gaule in Prof. Ludwig's laboratory at Leipzig (*Archiv für Physiologie, v.* Du Bois-Reymond, 1880) are of singular interest. On diluting the fresh blood from a vigorous frog with 0·6 salt solution, and exposing it after rapid defibrination to a temperature of 32°–36° C. on the hot stage of the microscope, the escape of a peculiar body may be observed in many of the corpuscles. The bodies thus evolved simulate worms so closely by their form and wriggling movements, that Gaule styles them "Würmchen," which may be translated *vermicles*. However, he concludes from several reasons that they are simply protoplasmic portions of the corpuscles, which, under these special conditions, separate for a short independent life. He makes no reference to previous workers in the same field; but it would seem not improbable that his "Würmchen" correspond with the maculæ, which Prof. Roberts of Manchester revealed seventeen years ago by treating the corpuscles with tannin or magenta, reagents which would of course prevent any further signs of life in the objects. The "vermicles" are about half the length of the red corpuscle, pointed at either end, but more in front, and containing one or two vesicles or droplets. Their singular movements deserve a rather full description. After wriggling out of the corpuscle, in which it makes its appearance as a rod-like body beside the nucleus, the "vermicle" moves on, trailing the corpuscle behind by a long thread. On meeting a second corpuscle it bores into it, withdraws, pushes it aside, and goes on carrying this too in its train; and though the threads finally give way, "vermicles" may be seen dragging three, four, or more corpuscles after them. The corpuscles, quitted or attacked in this way, undergo in a short time changes of form and colour leading to complete disorganisation, which otherwise, under similar conditions, require hours for their accomplishment. Finally the "vermicle" also undergoes disorganisation. While the conditions given above are found on the whole most successful in bringing about these results, Gaule indicates limits of temperature and dilution within which they often occur, usually with slight modifications. It is this variation with the conditions of the experiment that supplies one of his strongest arguments against the previous individual existence of these bodies.

The Human Retina.—In a recent note to the Vienna Academy Herr Salzer offers an estimate (based on numeration) of the probable number of optic nerve-fibres and of retinal cones in a human eye. The number of the former he supposes to be about 438,000, that of the latter 3,360,000. This gives seven or eight cones for each nerve-fibre, supposing all fibres of the optic nerve to be connected with cones, and equally distributed among them.

URAL CRAYFISH.—Part 2, vol. v. of the *Bulletin de la Société Ouralienne d'Amateurs des Sciences naturelles à Ekathérinebourg* contains a very interesting memoir on the crayfish of the rivers of the Middle and Southern Ural, by M. Malakhoff. Prof. Kessler in his fine work in the memoirs of the Russian Society of Entomology, "On the Crayfish of the Rivers of Russia" points out that the data about the life of the fluviatile crayfish are still very incomplete, and in part even contradictory, and declares that it is very desirable that new researches should fill up the one and dissipate the other. Among the queries he starts is one as to how far the crayfish have spread into the rivers of Western Siberia? in which of its rivers is it to be found? and is it true that those fonnd are insipid as food? In this memoir, M. Malakhoff does his best to answer these, partly from personal observations, partly from those who had lived long in those parts of the country, such as fishermen, and partly from indications scattered through different works. He writes of the geographical distribution of the crayfish in the Middle and Southern Urals; giving a brief historical account of their successive propagation in the rivers of the watershed east of the Ural Mountains belonging to the basin of Western Siberia. Among the references here given, is one to a work, apparently not yet published, by J. S. Poliakoff entitled "Letters and Notices of a Journey in the Valley of the Obi." The species peculiar to this district would seem to be *Astacus leptodactylus*, Esch.; its northern limit would appear to be considerably to the north of the Ural; in the western region of the Ural it is found in many of the rivers and in considerable numbers: a detailed list of these is given. To the south it is found in the River Ural and most of its affluents. Facts seem to prove that the species is not indigenous to the eastern watershed of the Ural, nor in Northern Siberia. It would appear, however, under fitting circumstaoces to be very easily brought into cultivation. In the Middle and Western Ural it is to be met with from 100 to 175 mm. in length. A mountain variety possesses a cephalo-thorax, strongly serrated on the sides and angles; another, living in the River Ural, is remarkable for little asperities crowded together, which cover over the cephalo-thorax and chelæ. In the Ural the natives call the freshwater Unio Rak (*Ecrevisse*) and the true crayfish Rak-ryba (*l'Ecrevisse poisson*). Prof. Kessler's opinion as to their insipidity is declared to be wrong, as in general the crayfish are of excellent quality. In some districts they increase so much as fully to come up to the fisherman's description of "swarming;" in some rivers, owing to their number, they interfere with the capture of fish; not only will the nets be found filled with them, but what fish may be taken in these will be found spoiled and many are eaten. They will sometimes cross a good stretch of dry ground to get to a river with good feeding, though that this is a fact is denied by many. The people use the stones found in the crayfish stomachs as a remedy against struma. The distribution of *Mustela lutreola* in the Ural mountains seems to be dependent on the distribution of this crayfish, which would seem to be its principal food.—It ought to be mentioned that the memoirs of this Society are published in the original Russian, with a French translation in alternate columns.

DEVELOPMENT OF "AMBLYSTOMA PUNCTATUM."—Early in March of 1878 Dr. Samuel Clarke, of the Johns Hopkins University, obtained a mass of the eggs of the above batrachian. They were found clinging, in gelatinous, variously-sized masses, to aquatic plants, the masses containing from 4 to 200 eggs, and were partly composed of a milky, gelatinous matrix. Each egg is surrounded by two membranous shells, and the large space between these two is filled with a clear fluid. The eggs being laid by the female, the males, so far as the observations made on the animals in confinement went, then strewed the sperm-masses in the vicinity of, but not on, the ova, and not immediately on these latter being laid. Shortly afterwards, however, the eggs were found to be covered over with actively-moving spermatozoa, and though the e were never actually found within even the outer shell of the eggs, yet most of those which were laid during the night were found by nine o'clock the next morning to show the first segmentation-furrows. In Dr. Clarke's paper on the development of these eggs, very minute details are given as to the results of segmentation, which are illustrated by numerous figures. The following is his own *résumé*:—after segmentation an area made up of large cells appears around the lower pole of the egg, which, at first hemispherical, then oval, and finally circular, forms the vitelline plug of Ecker. This plug protrudes from the egg, then sinks into it, while from the diminishing area around the disappearing plug stretches away the anal portions of the medullary folds with the medullary groove midway between them. The two folds grow forwards and unite near the opposite pole. The medullary folds close in and unite, forming the neural tube. The body elongates, is covered with cilia, and rotates horizontally upon its axis. The head is marked off, and the optic vesicles appear. The branchial lobes and the lobes of the cephalic balancers appear, soon followed by those of the anterior limbs. The pericardial region is marked off, and the pulsations of the heart are visible. The nasal pits and the position of the mouth are indicated. The tail and the dorsal fin grow rapidly, and the branchial lobes are divided into three pairs of branchiæ; these give off processes. The eyes develop rapidly, and the mouth is moving forward. A constriction takes place across the ventral surface of the neck, and balancers, now fully developed become capitate. The branchiæ still further develop; the balancers become more and more slender as the anterior limbs increase in length, and the blood ceasing to circulate in them, they drop off. The anterior limbs now develop rapidly; first, the first and second digits, then the third, and finally the fourth. The first two digits on the posterior limbs are formed on the fourth digits on the anterior limbs, one budding out, then the third, fourth, and fifth in succession. Up to about the sixtieth day the external parts are being gradually formed; by this date it reaches a stage, after which it undergoes no further external change beyond a general growth, until the branchiæ begin to decrease in size as they are being absorbed. This change took place in reared specimens in about one hundred days from the commencement of segmentation. The process of resorption of the branchiæ begins at their distal ends; the outer processes become shorter and disappear, until nothing is left but three pairs of small rounded processes, which are very slowly indeed absorbed. The whole of this process lasts from three to five days; they then become air-breathers, and take up their abode in damp localities on the land. Some specimens developed much more slowly; one, hatched about the middle of May, retained its branchiæ until the end of the following October. In confinement the tadpoles were hard to keep supplied with food. When hard up they would bite each other's gills off, and then begin to eat the tips of each other's tails; and even when big enough they would swallow up bodily their smaller brethren. Although endowed with an immense power of reproduction of lost parts, it seems remarkable that, once a portion of a branchial tuft was bitten off, it never, at least in hundreds of cases tried, became reproduced. In a second memoir the author promises to treat in detail of the changes that take place in the development of the internal parts.

STIMULI IN SENSITIVE NERVES.—In experiments on the rate of propagation of stimuli in sensitive nerves it has been generally assumed that, under like conditions of experiment, and with an equal length of nerve-path from the point of stimulation to the centre, the reaction time is always the same. This, tested recently by Messrs. Hall and Kries (Du Bois-Reymond's *Archiv*, 1879, Supplement, p. 1), is found to be not confirmed. Stimulating with a slight induction shock the finger point and the middle of the outer side of the upper arm, the reaction in the latter case occurred with Mr. Hall later than that from the finger (on an average about 0·005 second). In Herr von Kries, the reaction time was shorter (about 0·003 sec.) from the upper arm than from the finger. Again, the reaction time was measured when light was made to strike different parts of the retina and even here (the lengths of nerve-path beirg equal) presented considerable differences. In Mr. Hall's case the difference between the outer and inner part of the retina was 0·018 sec., that between the upper and lower 0·028 sec.; in Herr von Kries's the differences were respectively 0·061 and 0·064 sec. In comparison with the place of direct vision still greater differences appeared. Experiments were also made in stimulating the forehead and the tongue, in which cases the paths were assumed to be nearly equal. In both observers the reaction-time from the tongue was somewhat longer than from the forehead, though, according to Weber, the sense of space at the tip of the tongue is about twenty times finer than on the forehead. The authors conclude that the reduced reaction times differ considerably according to the place of stimulation, that in the eye the differences are connected with differences of functional power, that the reaction method is not available for ascertaining the velocity of conduction in sensitive and motor nerves, and therefore the velocity in the spinal cord is still unknown.

GEOGRAPHICAL NOTES

AT the meeting of the Geographical Society on Monday evening, Sir H. Rawlinson read a letter just received from Mr. Thomson, the leader of the East African Expedition. Mr. Thomson wrote on November 9 from Pambete, at the south end of Lake Tanganyika, the shores of which he first reached on November 4, and he gives a brief account of his journey from the head of Lake Nyassa. After leaving the country of Konde, the party came on the steep face of the great African plateau, rising from 3,300 to 6,500 feet in the country of Nyika. At first they travelled over highlands at an elevation of 7,000 feet, the highest point reached being 8,180 feet on the Munboya range. The land then descends through a somewhat barren region to 3,300 feet, in about long. 32° 45'. On the west Nyika is bounded by the Chingambo Mountains, which have a precipitous eastern face, but a gradual slope away to the west. These mountains Mr. Thomson places in long 32° 45', lat. 9° 5'. The rivulets of the Nyika region drain down to the Lukuviro, a few south, and others north-west to Lake Hikwa, a lake now heard of for the first time. Mr. Thomson, on the other side of the Chingambo Mountains, entered the small country of Inyamwanga, which appears to be covered almost entirely with forests, and slopes west to its boundary, the Mkaliza, a stream flowing south in about long. 32° 20'. Here the country of Mambwe was reached, consisting alternately of pasture and forest land, and rising to a height of 5,000 feet at Kitimba's capital. The same elevation continues through the hilly Ulungu country to Lake Tanganyika. Mr. Thomson also furnishes some notes as to the hydrography of Mambwe, the northern part of which is a great water-shed for streams. He was to proceed northwards on November 10, along the west side of the lake, and a telegram has been received from Dr. Kirk, stating that he had left Ujiji, on the eastern shore, on January 16, on his return to Uguha. If he had not already done so, he would then, no doubt, carry out his intention of examing the Lukuga Creek for thirty miles, and afterwards striking south through the still unexplored region in that quarter. Mr. Thomson will next pass between the two lakes again and reach the coast at Kilwa. After this very interesting piece of new geography, Lieut. G. F. Temple, R.N., read a paper descriptive of a voyage on the coasts of Norway and Lapland, undertaken chiefly in the interests of hydrography, and which appears to have had useful results.

THE St. Petersburg Society of Naturalists proposes to send an important expedition for the exploration of the fishing on the Murmanian coast, and of the fauna of the western parts of the White Sea. Several professors will take part in this expedition, which will be under the direction of Prof. Wagner.

THE Rev. Father Carrie, Superior of the Roman Catholic Mission to the Congo, writing from Landana on December 3 last, gives some information regarding Mr. Stanley's Congo Expedition. The *personnel* of Mr. Stanley, the Father writes, is very numerous; besides Mr. Stanley, there is a superintendent, an engineer, a captain, several mechanics, carpenters, &c., in all twenty whites of different nations—Belgians, Americans, English, Italians, Danes. The expedition has recently been joined by a French naturalist, M. Protche. Many of the Europeans had already succumbed to fever and the hardships of the work involved. The following of blacks consisted of about 100 men, Arabs or natives of Sierra Leone and the Congo. There are five small steamers and several other boats, carts, and other machinery for land transport, wooden houses ready to erect, &c. Father Carrie was taken by steamer to Noki, the last European settlement on the river. Thence in a canoe the Father was taken further up, to Vivi, the first station of Mr. Stanley's expedition, on the right bank of the river, about 130 miles from the coast. Four or five miles further up the first of the Yellala Cataracts is met with. When the Father arrived Mr. Stanley was away among the mountains in the direction of the great village of Vivi. M. van Schandel told the Father that Mr. Stanley set out on his excursions and returned without giving notice to any one. The traveller soon returned, "exhausted by fatigue and covered with dust and perspiration." While waiting the end of the rainy season, Mr. Stanley is solidly establishing himself in his first station, the basis of all future operations, and maturing his plans for overcoming the difficulties to be met with. These difficulties are so great that the Father thinks it will take years before the termination of the terrible chain of mountains can be reached and the second station established at Stanley Pool, 200 miles distant. Mr. Stanley's intention, we are told, is to ascend the Congo to the Lualaba, where he hopes to find his Arab friend, Tibu Tib. Then he will explore the western part of the Congo, as well as the country on its two banks, attempting, at the same time, to attract the ivory trade to Mboma.

THE *Daily News* Lisbon correspondent telegraphs that Ivens and Capello, who have arrived at that city, have explored and studied a vast area and obtained important data for constructing a map of the province of Angola. They traversed the bush of Quioco, passed beyond the River Quango in the direction of Chicapa, and determined the roads to Muatay and Anvo, to the bush of Lobuco, Pesside, and Luba. They ascertained the sources of the rivers Quango, Cassai, and Loando, and descended the last-named to the seventh parallel. The Quango has extensive rapids. The sources of these rivers are contiguous. The explorers bring many observations—geographical, meteorological, and magnetic, and also on the African fauna and flora—and they will publish these observations.

WURSTER AND CO., of Zurich, the publishers of Kaltbrunner's "Manuel du Voyageur," noticed by us on its publication, request all interested in scientific geography, both societies and individuals, to forward a statement of any desiderata whereby the work would be improved as a manual of scientific instruction for travellers of all nationalities. Communications should be addressed to M. Kaltbrunner, Bureau International des Postes, Zurich.

MR. J. H. RILEY, one of the agents of the China Inland Mission at Chungking, in Szechuen, in company with Mr. Mollman, of the British and Foreign Bible Society, at the end of last July, paid a visit to Ngo-mi-Shan and the borders of the Lolo country. The mountain in question is one of the loftiest in the province, and is remarkable for its Buddhist temples; the travellers spent some days on it, and experienced a notable decrease in temperature, for, though they were there in mid-August, they found a fire necessary. From Ngo-mi they went westward to Ngo-pien-ting, about three or four miles from Tsuan-chi-kow, a small town on the boundary of the Lolo country, into which they were unable to penetrate owing to the opposition of the officials. They succeeded, however, in getting a Lolo to return with them, so that something will be learned about these people. The men are described as fine, stalwart fellows; they wear cloaks, some made of coarse woollen, with a fringe round the bottom, and some of a kind of felt. Mr. Riley returned to Chunking, by way of Kia-ting-fu, at the end of September.

IN the voluminous blue book on Central Asia, which has recently been published, will be found some information respecting the Akhal-Tekkes, drawn up by M. Kuropatkine. The Tekkes, as is known, are divided into two parts, the one, the Akhal-Tekke, inhabiting the oasis at the foot of the Kurendagh, and the other the oasis of Merv. The former oasis is 150 versts in length, and 20 versts in breadth, containing about 30,000 *Kibitkas*, half of which are at Geok-Tépé, practically the capital of the race. The tribe is sub-divided into Takhtamystschis and Utemystchis, the former being three times the more numerous, as well as the more peaceable. The eastern villages, from Yarodji to Hiaurs, are governed by four Khans Beurm, where the Utemystchis live, is on the west, and is ruled by a Tykma-Sirdar. The Takhtamystchi settlements are under the authority of Berdi Muvgad Khan, son of the powerful Nura Verdi Khan.

THE March number of *Petermann's Mittheilungen* contains the conclusion of Dr. Junker's account of his fruitful travels to the west of the White Nile. This is followed by a paper by Dr. Lehmann, of Halle, on the recent Danish attempts to penetrate into the interior of Greenland, to which we have referred; maps accompany both these papers. The "Geographical Necrology" of 1879 is a long list, and is followed by an interesting memoir of the late J. E. Wappaeus, by Prof. H. Wagner, of Königsberg. The monthly notes contain, as usual, many valuable items of geographical information.

THE German *savant*, Herr Karl Bock, who was commissioned by the Dutch Government to investigate the southern and eastern districts of Borneo, has just completed his first tour in the eastern part of Koti.

NEWS just received announces the arrival at Kassala of the two German African travellers, Dr. Mook and Baron Holzhausen. They crossed the desert from Suakin to Kassala in fourteen days. Kassala, the residence of a pacha, is the centre of the German dealers in wild beasts. Many German travellers originally started from here on their tours, such as Florian, Werner, Cohn, Dr. Schweinfurth, Heuglin. Dr. Mook and Baron Holzhausen intend to move in a south-easterly direction towards the Rahat and Diuder.

THE German Government has supported African research with the sums of 100,000 marks (5,000*l.*) during 1878, and 70,000 marks (3,500*l.*) during 1879. For the present year it is proposed to devote another sum of 70,000 marks to this purpose, besides a sum of 5,000 marks (250*l.*) for the furtherance of independent private research in the Dark Continent.

THE Paris Municipal Council has held a secret sitting to deliberate upon the organisation of a great banquet to Prof. Nordenskjöld. It has been decided that a gold medal be presented to the explorer in the Salle des États.

THE municipal authorities of Gossensass, on the Brenner Railway, have re-christened the Hünerspiel peak, famous for the magnificent view which is obtained from its summit, and which lies within their district. The peak will henceforth be called Amthorpeak, in honour of Dr. E. Amthor, of Gera, an eminent "Alpine" writer.

ON THE INFLUENCE OF ELECTRIC LIGHT UPON VEGETATION AND ON CERTAIN PHYSICAL PRINCIPLES INVOLVED[1]

THE vast development of vegetation proves that dissociation is accomplished freely within the leaf-cells of plants, in which both water and carbonic acid are broken up in order that chlorophyll, starch, and cellulose may be formed. It is well known that this reaction depends upon solar radiation; but the question may fairly be asked whether it is confined to that agency, or whether other sources of light and heat, which, in common with the sun, exceed the temperature of dissociation, may not be called into requisition, in order to continue the action of growth, when that great luminary has set or is hidden behind clouds?

About two years ago I mentioned to Sir Joseph Hooker, then President of the Royal Society, that I thought the electric arc might be found sufficiently powerful to promote vegetation and that I should be willing to undertake some experiments on the subject if he could give me any hope of confirmative results. Sir Joseph Hooker gave me sufficient encouragement to induce me to follow up the subject, and I have since that time gradually matured a plan for conducting the experiment.

The apparatus which has been put up at Sherwood consists—1. Of a vertical Siemens dynamo-machine, weighing 50 kilos, with a wire resistance of 0·717 unit on the electro-magnets. This machine makes 1,000 revolutions a minute, it takes 2 horse-power to drive it, and develops a current of 25 to 27 webers of an intensity of 70 volts. 2. A regulator or lamp, constructed for continuous currents, with two carbon electrodes of 12 millims. and 10 millims. diameter respectively. The light produced is equal to 1,400 candles measured photometrically. 3. A motor, which at present is a 3 horse-power Otto gas-engine, but which it is intended to supersede by a turbine to be worked by a natural supply of water, at a distance of about half a mile from the house.

My object in making these experiments was to ascertain whether electric light exercised any decided effect upon the growth of plants. For this purpose I placed the regulator in a lamp with a metallic reflector, in the open air, about two metres above the glass of a sunk melon house. A considerable number of pots were provided, sown and planted with quick-growing seeds and plants, such as mustard, carrots, swedes, beans, cucumbers, and melons. The plants could then be brought at suitable intervals under the influence of daylight and electric light, without moving them, both falling upon them approximately at the same angle. The pots were divided into four groups.

1. One pot of each group was kept entirely in the dark.
2. One was exposed to the influence of the electric light only.
3. One was exposed to the influence of daylight only.
4. One was exposed successively to both day and electric light.

The electric light was supplied for six hours, from 5 to 11 each evening, all the plants being left in darkness during the remainder of the night.

In all cases the differences of effect were unmistakable. The plants kept in the dark were pale yellow, thin in the stalk, and soon died. Those exposed to electric light only showed a light-green leaf, and had sufficient vigour to survive. Those exposed to daylight only were of a darker green and greater vigour. Those exposed to both sources of light showed a decided superiority in vigour over all the others, and the green of the leaf was of a dark rich hue.

It must be remembered that, in this contest of electric against solar light, the time of exposure was in favour of the latter in the proportion of nearly two to one, but all allowance made, daylight appeared to be about twice as effective as electric light. It was evident, however, that the electric light was not well placed for giving out its power advantageously. The nights being cold, and the plants under experiment for the most part of a character to require a hot moist atmosphere, the glass was covered very thickly with moisture, which greatly obstructed the action of the light, besides which, the electric light had to pass through the glass of its own lamp.[2] Notwithstanding these drawbacks, electric light was clearly sufficiently powerful to form chlorophyll and its derivatives in the plants.

These preliminary trials go to prove that electric light can be utilised in aid of solar light by placing it over greenhouses, but the loss of effect in such cases must be considerable. I, therefore, directed my observations, in the next place, to the effect of electric light upon plants, when both were placed in the same apartment. The plants under experiment were divided into three groups; one group was exposed to daylight alone, a second similar group was exposed to electric light during eleven hours of the night, and were kept in the dark chamber during the day time, and the third similar group was exposed to eleven hours' day and eleven hours' electric light. These experiments were continued during four days and nights consecutively, and the results observed are of a very striking and decisive character, as regards the behaviour of such quick-growing plants as mustard, carrots, &c. The plants that had been exposed to daylight alone (comprising a fair proportion of sunlight) presented their usually healthy green appearance; those exposed to electric light alone were, in most instances, of a somewhat lighter, but, in one instance, of a somewhat darker hue than those exposed to daylight; and all the plants that had the double benefit of day and electric light far surpassed the others in darkness of green and vigorous appearance generally. A pot of tulip buds was placed in this electric stove, and the flowers were observed to open completely after two hours' exposure.

Although the access of stove heat was virtually stopped, the temperature of the house was maintained throughout the night at 72° F., proving that the electric lamp furnished not only a supply of effective light, but of stove heat also. No hurtful effect was, moreover, observed on the plants from the want of ventilation, and it would appear probable that the supply of pure carbonic acid resulting from the complete combustion of the carbonic electrodes at high temperature, and under the influence of an excess of oxygen, sufficed to sustain their vital functions. If the nitrogenous compounds which Prof. Dewar has shown to be developed in the electric arc were produced in large quantities, injurious effects upon the plants must undoubtedly ensue, but it can be shown that in a well-conditioned electric lamp, with a free circulation of air round the carbon electrodes, the amount of these products is exceedingly small, and of a different nature than is produced in a confined space.

These experiments are not only instructive in proving the sufficiency of electric light alone to promote vegetation, but they also go to prove the important fact that diurnal repose is not necessary for the life of plants, although the duration of the experiments is too limited perhaps to furnish that proof in an absolute manner. It may, however, be argued from analogy, that such repose is not necessary, seeing that crops grow and ripen in a wonderfully short space of time in the northern regions of Sweden and Norway, and Finland, where the summer does not exceed two months, during which period the sun scarcely sets.

The next step in the course of these experiments was to remove the electric lamp into a palm house, constructed of framed glass, which was 28 feet 3 in. long, 14 feet 6 in. wide, and averaging

[1] Abstract of a paper read at the Royal Society on March 4, by C. William Siemens, D.C.L., F.R.S.

[2] Prof. Stokes has shown, in 1857, that the electric arc is particularly rich in highly refrangible invisible rays, a circumstance which seems to point to a great loss on passing those rays through glass.

14 feet 6 in. (8·62 m. × 14·42 m. × 4·42) in height. In the centre of this house a banana palm and a few other small palm-trees are planted, the sides of the house all round being occupied with a considerable variety of flowering plants. The electric light was fixed as high as practicable at the south corner of the house, in order that its rays might fall upon the plants from a direction and at an angle coincident with those of the sun during the middle of the day. The temperature of the house was maintained at 65° F., and the electric lamp was kept alight from 5 P.M. to 6 A.M., for one week, from February 18 to February 24, excepting Sunday night. The time was hardly sufficient to produce very striking effects, but all the plants continued to present a healthy appearance. Of three Alicante vines, the one nearest the electric light made most progress, and the same could be said of the nectarines and roses. It was observed that other plants, such as geraniums, continued to exhibit a vigorous appearance, notwithstanding the heat of the place. This experiment is of importance in showing that the electric light, if put into conservatories or greenhouses, does not injure the plants, but rather improves their appearance and growth. The leaves assume a darker and more vigorous appearance, and it seems that the colouring of the flowers becomes more vivid, but a further period of time is necessary to establish this observation absolutely.

I decided to try the effect of electric light as a means of promoting growth in the open air and under glass at the same time. The regulator was put back into its first position, 2 metres above the ground, with a sunken melon house on one side, and a sunken house containing roses, lilies, strawberries, and a variety of other plants on the other. The space of ground between these, about 1 metre broad and 7 metres long, was covered with boxes sown with early vegetables, including mustard, peas, beans, and potatoes, and in order to prevent cold winds from injuring the plants, low protecting walls were put up across the openings of the passage between the two houses.

Some weeks must elapse before any absolute results can be given, but growth is evidently promoted under all these various circumstances. In order to test this clearly, a portion of the plants both under glass and in the open air are shaded from the electric light without removing them from their position of equal temperature and exposed to solar light during daytime. The effect upon the flowering plants is very striking, electric light being apparently more efficacious to bring them on than daylight. Although the amount of heat given off from the electric arc is not great compared with a gas flame (giving off its products of combustion), yet the rays of intense heat of the arc counteract that loss of heat by radiation from the leaves into space, which during a clear night causes hoar frost. For this reason I expect that electric light may be usefully employed in front of fruit walls, in orchards, and in kitchen gardens, to save the fruit-bud at the time of setting; and in this application electric light will probably be found a useful agent not only to promote rapid growth, but to insure a better yield of fruit.

The experiments seem to lead to the following conclusions :—

1. That electric light is efficacious in producing chlorophyll in the leaves of plants, and in promoting growth.

2. That an electric centre of light, equal to 1,400 candles, placed at a distance of 2 metres from growing plants, appeared to be equal in effect to average daylight at this season of the year, but that more economical effects can be attained by more powerful light centres.

3. That the carbonic acid and nitrogenous compounds generated in diminutive quantities in the electric arc, produce no sensible deleterious effects upon plants inclosed in the same space.

4. That plants do not appear to require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight and during the night to electric light.

5. That the radiation of heat from powerful electric arcs can be made available to counteract the effect of night frost, and is likely to promote the setting and ripening of fruit in the open air.

6. That while under the influence of electric light plants can sustain increased stove heat without collapsing, a circumstance favourable to forcing by electric light.

7. That the expense of electro-horticulture depends mainly upon the cost of mechanical energy, and is very moderate where natural forces of such energy, such as waterfalls, can be made available.

Since writing the above my attention has been drawn to an article in NATURE, vol. xxi. p. 311, giving interesting observations by Dr. Schübeler, of Christiania, on "The Effect of Uninterrupted Sunlight on Plants in the Arctic Regions." These observations fully confirm the conclusion indicated by my experiments with electric light. Not only are plants able to grow continuously, according to Dr. Schübeler, but when under the influence of continuous light, they develop more brilliant flowers and larger and more aromatic fruit than under the alternating influence of light and darkness, whereas the formation of sugar appears to be dependent chiefly upon temperature.

It would follow from these observations, that with the aid of stoves and electric light, fruit, excelling both in sweetness and aroma, and flowers of great brightness, may be grown without solar aid. Dr. Schübeler mentions that in removing an acacia plant from the dark, and placing it under the influence of the Arctic midnight sun, the leaves opened slowly, and it is interesting to observe that the same effect took place when an Acacia Lophantha was placed (in the open air) under the influence of my midnight lamp.

PREHISTORIC ANTIQUITIES OF THE AUSTRIAN EMPIRE[1]

1. *CAVES.*—The cave of Vypustek, near Brünn, in Moravia, was systematically explored, from April to end of October, 1879, under the superintendence of the Committee, appointed by the Imperial Academy of Sciences at Vienna, for Prehistoric Investigations. The ossiferous layer, four to five metres thick, and covered with a thin stalagmite, is a non-stratified breccia of sand, loam, pebbles, and angular stones, with bones of "diluvial" mammals abundantly, but irregularly, dispersed. Most of the bones are fragmentary; many of the pieces are rolled, and even polished, by friction. Bones of *Ursus spelæus* predominate. Eight to ten per cent. belong to thirty other mammalian species. Some bones have evidently been gnawed by porcupines. In a side cave, layers of charcoal and ashes, with fragments of rudely-worked stone implements and bones of domestic animals, showed it to have been once resorted to by human beings.

The Kreuzberg Cave in Carniola has further enriched the Academy's museum with numerous remains of *Ursus spelæus.* Skeletons of individuals of all ages lie together, but only in the uppermost loam in the highest part of the cave. Thus the animals inhabiting the cave may be supposed to have retired before an irruption of water, and have perished by a flood in in their place of retreat. In a side cave the stalagmitic floor near the entrance contains some charred corn.

A cave near Fiume, on the Adriatic coast, opened by railway-works, appears to have been used as a burial-place in the stone period, as human skeletons, bones of animals, stone implements, and fragments of rude earthenware, were discovered in it.

2. *Tumuli.*—A tumulus opened in Lower Austria was found to contain only a few worked stones, layers of charcoal, and bones of animals. The skeleton of a woman, executed and buried about seventy years ago, lay in its uppermost portion. In the same province several low barrows were found to contain stones placed in a circle, in the middle of which, on a stone slab, lay the skeleton (not burnt), with many bronze weapons and ornaments. Some larger barrows, probably of later date, are reported to have contained urns and charred bones, a few objects of bronze and iron, and coins of Domitian.

Of more than a hundred tumuli near St. Margareth, Lower Carniola, twenty have been opened. A great many antiquities were obtained: earthen vases of peculiar shape, articles in bronze, iron, glass, and amber, and even gold ornaments.

The tumuli near Jagnenza were found to contain skeletons within elliptical rows of stones, and those near Unter-Erkenstein had urns with burnt human bones. Another large barrow contained a circle of stones, a human skeleton, burnt bones, charcoal, iron objects, and bronze ornaments.

[1] Report of the Committee, &c., Imperial Academy of Vienna. Report of Meeting, December 18, 1879.

NOTES FROM ITALY AND SICILY

THE following notes, although necessarily of a desultory character, may interest some of our readers :—

Climate.—The climate of Southern Europe during the last month, from the middle of December to January 20, has been more severe than we ever remember it before. Long icicles depended from the platform of the engine which conveyed us to Italy; the basin of the fountain in the Piazza Barberini in Rome was thickly fringed with icicles, and the ground within the Colosseum, and elsewhere in shady places, remained frozen all day long. Eight inches of snow fell in one night in Athens. Etna was thickly coated with snow, which extended even on the eastern seaboard to the lower limits of the Val del Bove, that is to say, to within 4,000 feet of the sea. The effect of this was to render Catania bitterly cold whenever a wind blew off the mountain. Messina, being protected by a range of hills, suffered less, but the Messinese complained loudly of the severity of the winter. On the 13th of this month (January) a furious tramontana blew over Naples. Its intensity was such that we could only ascend Vesuvius on the south-west side under the lea of the great cone, and when, having reached the summit, we were exposed to the full force of the fitful blasts, we had difficulty in standing against them. The temperature of the wind was $-3°$ C. ($26°\cdot4$ F.). The following day was bright, warm, and sunny, while on the morning of the 15th Vesuvius was completely hidden in mist, and a scirocco was blowing. Torrential rain fell somewhat later. When the mist lifted, about 11 A.M., Vesuvius was seen to be covered with snow, which reached nearly as low as the observatory (2,218 feet), on the side facing the sea, and to a still lower level on the sides of Monte Somma remote from the sea. The weather in Lipari, however was quite summer-like. During the middle of the day we found it necessary to hold an umbrella over our heads to protect us from the sun, and the nights were warm and balmy. The sea for several days was perfectly smooth, and there was not a breath of wind. We were obliged to row the whole distance from Lipari to Stromboli in a small open boat (nine hours), and the very gentle wind which prevailed in returning only shortened the voyage to seven hours.

The late Eruption of Etna.—Prof. Silvestri, of Catania, has just published a second and enlarged edition of his report entitled "Sulla doppia eruzione e i terremoti dell' Etna." Another valuable contribution to the history of the eruption is the "Relazione degli ingegneri del R. Corpo delle Miniere addetti al rilevamento geologico della zona solfifera di Sicilia sulla eruzione dell' Etna avvenuta nei mesi di maggio e giugno, 1879." This is published by the "R. Comitato Geologico d'Italia," and is accompanied by an admirable coloured map of the parts affected by the last eruption, drawn to a scale of 1 in 50,000. Prof. Silvestri has a very extensive collection of the products of the last eruption, in which we noticed many specimens of sulphate and chloride of copper, and chlorides of sodium, and ammonium, but no rare substances. The new Etna observatory (NATURE, vol. xix. p. 557), is partially constructed, and the work will be continued as soon as the snow disappears. It will certainly be ready for work in the autumn. The last eruption has been studied more fully than any previous display of volcanic energy, thanks to the wisdom of the Italian Government, which numbers among its Senators some of the most eminent scientific men in Italy, and to the untiring perseverance and activity of Prof. Silvestri.

Science Teaching in Rome.—A large number of students are attending the science lectures in the Sapienza, and its adjunct, the Istituto Chimico in the Via di Panisperna, and a considerable scientific literature is making its appearance. On the large plot of ground on which the Istituto Chimico stands, there is a botanic garden, and a fine range of physical schools is nearly completed. Prof. Canizzaro's laboratory finds a very convenient home in the long cool corridors of the convent, and his lecture theatre is now completed, and is fitted with all the newest appliances. The lectures are open to the public, and we were glad to see among the numerous students several ladies. The lecture which we heard was on Iodine, and among the experiments was one which we have not seen in England, although undoubtedly it is sometimes shown, as it is too effective to be omitted from a long course. A tall cylinder of hydriodic acid gas is inverted over a cylinder of chlorine; on withdrawing the glass plates which cover the mouth of the cylinders, the gases combine with the production of flame, hydrochloric acid being of course formed and iodine deposited.

Reale Comitato Geologico d'Italia.—We do not think that the admirable work now being carried out by the Comitato Geologico of Italy, under the direction of the Minister of the Interior, is sufficiently recognised in this country. Steadily, and not slowly, geological maps of the whole Italian peninsula are being prepared. We may mention as a specially interesting map and report, the monograph of the engineer, F. Giordano, on the "Condizioni Topografiche e Fisiche di Roma e Campagna Romana." This includes the whole of that excessively interesting volcanic region around Albano, Frascati, and Rocca di Papa.

The New Element, Vesbium.—Prof. Archangelo Scacchi, of the University of Naples, well known for his researches in connection with Vesuvian minerals, thinks that he has discovered a new element in a yellow incrustation on the lava of 1631. At present the subject requires further investigation, and his belief is not shared by some of his colleagues. A full account of his researches on the subject will immediately be given in these pages, and we therefore defer any further comment.

The Club, "Alpino Italiano."—The Italian Alpine Club, which has its centre in Turin, has many representatives in every part of Italy, and is flourishing. Prof. Silvestri is the president in Catania, and has recently prepared for the use of the members a very concise and admirable book entitled "Un Viaggio all' Etna," which is so completely a type of what such a book should be that we shall shortly notice it more fully in these pages.

Italian Scientific Literature.—It is much to be regretted that Italian scientific literature is not better known in this country, especially the numerous original memoirs which constantly appear in the important scientific societies of Bologna, Milan, Rome, Naples, and Catania. If our principal societies would put themselves in correspondence with the Italian academies, and would exchange Transactions, it would be a decided gain both to them and to us.

G. F. RODWELL

SCIENTIFIC SERIALS

THE *American Journal of Science and Arts*, February.—Contributions to meteorology (twelfth paper), by E. Loomis.—Colour correction of achromatic telescopes, by W. Harkness.—Pinite in Eastern Massachusetts, its origin and geological relations, by W. O. Crosby.—Lintonite and other forms of Thomsonite, by S. F. Peckham and C. W. Hall.—Elements of the planet Dido, by C. H. F. Peters.—Analysis of some American tantalates, by W. J. Comstock.—Method of studying the reflection of sound-waves, by O. N. Rood.—Newton's use of the term indigo, with reference to a colour of the spectrum, by O. N. Rood.—Notice of recent additions to the marine fauna of the eastern coast of North America, by A. E. Verrill.—The electric light, by F. E. Nipher.—The limbs of Sauranodon, by O. C. Marsh.

THE *Journal of the Franklin Institute*, February.—Shearing strength of some American woods, by S. C. Trautwine.—Report of the Committee on Science and Arts on the steam injector and ejector of J. H. Irwin.—Mineralogical notes, by W. H. Wahl.—Silk culture, by S. Chamberlaine.—A statement concerning the relation of the lawful standards of measure of the United States to those of Great Britain and France, by J. E. Hilgard.

THE *American Naturalist*, February.—Henry J. Rice, observations upon the habits, structure, and development of *Amphioxus lanceolatus* (concluded).—C. S. Minot, a sketch of comparative embryology. No. 1. The history of the genoblasts and the theory of sex.—Thomas S. Roberts, on the convolution of the trachea in the sandhill and whooping cranes (with illustrations).—J. S. Kingsley, on the development of moina (a short abstract with illustrations of Dr. Carl Grobben's paper).—The Editor's Table.—A note on the present position of affairs in the Academy of Natural Sciences, Philadelphia.—Recent literature (the Naturalists' Diary for 1879 has just been published; it relates only to the United States).—Scientific news; proceedings of scientific societies.

THE *Rivista Scientifico Industriale* (Nos. 19 and 20, October, 1879), contains the following papers:—On a peculiar green substance generated by the contact of coffee with albumen, by Prof. G. Pasqualis.—On the work which can be performed by the beams of certain aquatic motors (second part), by Cesare Modigliano.—On a new and simple form of Sprengel's mercury pump, by Prof. D. Macaluso. On the transformation of glycerine into glucose, by Prof. S. Zinno.—On the swimming bladder of fishes, by Prof. C. Marangoni.—On the electric phenomena of Canton's glass balls, by Prof. A. Righi.—On ottrélite, by A. Renard.—Account of the second meeting of the International Geological Congress.—"On the Depth of the Water below Niagara Falls," is the title of one of various notes of minor interest.

THE *Revue d'Anthropologie*, fasc. i.—M. F. Ameghino gives drawings of the various objects belonging, as he believes, to the tertiary age, found by him, together with human remains, in the Pampas near Buenos-Ayres. M. Broca adds a brief description of the human bones.—Mdme. Royer, under the title "Le Système pileux," treats of the different character of hair in man and the lower animals, and the different line of direction presented in the two, which under all other variations remains constant and invariable. The author especially considers the questions how far the hairless condition of the human body may be due to sexual selection, and how far man's progressive mental development may have resulted from the necessity of counteracting the inconveniences due to the absence of this means of protection.—Dr. Beuzengue gives a report of the Arnold School for deaf-mutes at Moscow. The writer's object is to prove that *surdo-mutism* is, in the majority of cases, the immediate result of cerebral lesions, and not due to consanguinity of the parents. The limited number of cases (110) observed, and the short time in which the establishment has been in existence, render the classification in accordance with rank and nationality, of comparatively little value, but the indications of the condition of health, intelligence, &c., of the children, are interesting as bearing out the writer's views.—A paper by C. S. Wake on the beard, as characteristic of race, is translated.—M. Przyborowski has published the result of his explorations in Volhynia, where he has discovered traces of pile dwellings, and obtained flint knives and animal remains.—M. Zawisza has continued his examination of the fauna of the caverns of Poland, and M. Ossowski, following the investigations of Przyborowski, has explored burial mounds in Volhynia, belonging presumably to the latest prehistoric times, while M. Loski has brought to light a large number of cinerary urns from Terespol on the Bug.

THE *Archives des Sciences Physiques et Naturelles*, vol. iii., January 15.—On dichrote seiches, by M. F. A. Forel and M. J.-L. Soret.—Proceedings of The Chemical Society of Geneva.—On the constitution of the dibromic ethylene, by M. E. Demole.—On isophtalophenone or diphenieizophtalide, by M. E. Ador.—On metallotherapy, by M. M. Schiff.—On several applications of centrifugal force, by M. Thiery.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, February 19.—W. Carruthers, vice-president, in the chair.—Mr. J. Britten exhibited stems of *Myrmecodia echinata* and *M. glabra*, recently sent from Borneo by Mr. H. O. Forbes, showing the remarkable tunnelled galleries formed by a species of ant allied to, if not identical with, *Pheidole javana*, Mayr. Specimens of very young plants were also shown, all of which had been attacked by the ants. Beccari, who had studied *Myrmecodia* in its native localities, asserts that the presence of the ants is essential to the plant's existence, for unless the young plants are thus attacked by the ants, they soon perish.—Dr. Maxwell Masters also brought forward an example of a pitcher plant (*Nepenthes bicalcarata*) from Borneo, and he read a note thereon from Mr. Burbidge. It seems these pitchers are perfect traps to creeping insects, by reason of the incurved ridges round the throat of the pitcher. To get safely at the prisoners a certain species of black ant ingeniously perforates the stalk, and, tunneling upwards, thus provides an inroad and exit to the sumptuous fare of dead and decaying insects contained in the reservoir. The remarkable Lemuroid *Tarsius spectrum*, likewise visits the pitcher plants for the sake of the entrapped insects. These it can easily obtain from the *N. Rafflesiana*, but not so from *N. bicalcarata*, where the sharp spurs severely prick, if the animal dares to trifle with the urn lid.—Dr. J. E. T. Aitcheson next read a contribution on the flora of the Kurum Valley, Afghanistan. Of 15,000 specimens or 950 species collected, the material shows a meeting of floras, European, Persian, Afghanistan, Tibetan, and Himalayan in character. In the Kurum and Hariab valleys the Deodar, our finest Himalayan timber tree, forms dense forests, many of which will be found easily worked and hereafter valuable for exportation. The pine and the oak forests descend and recede much according to the nature of the hill range, its exposure, dryness, or moisture. The walnut and amlok (*Diospyros lotus*) produce excellent fruit. *Chamærops Ritchiana*, a branching palm, 20 feet high when uninjured, forms but an aloe-like scrub on the plateau west to the Darwaza Gar Pass. Of new species and varieties the genera *Acantholmion, Astragalus, Oxytropis, Cousinia, Nepeta, Sedum, Saxifraga, Pleurospermum, Cotyledon, Eremurus, Rosa, Rhododendron, Clematis*, and *Polygonum* yield noteworthy examples. Ferns were not plentiful, though over a dozen species were found, and *Nephrodium rigidum*, most characteristic, now for the first time found Afghan. Most of the European edible fruits are found in the orchards. Tobacco is occasionally grown, but plants used in kitchen gardening are rarely cultivated. The climate of the Hariab district is much colder and dryer than Kurum, and the rigour of the winter, accordingly, reacts on the vegetation. Dr. Aitcheson, *en passant*, gave interesting information relative to the native uses of the plants, and also mentioned that nearly every house keeps bees, so that a large trade is done in barter for honey. On his approaching return to Afghanistan, Dr. Aitcheson hopes still further to work out the flora of the districts traversed by our army.—Mr. Edwin Simpson-Baikie was elected a Fellow of the Society.

Chemical Society, March 4.—Mr. Warren De la Rue, president, in the chair.—Prof. T. E. Thorpe delivered a lecture on the relation between the molecular weights of substances, and their specific gravities when in the liquid state. The lecturer gave the results of some elaborate investigations with which he had been engaged during the last four or five years. He gave a *résumé* of Kopp's conclusions on the above subject, and pointed out the interesting evidence which could thus be gained as to the atomicity of elements in various compounds. He has determined the specific volumes of fifty-two liquids, inorganic and organic, on the principle adopted by Kopp, *i.e.*, determining the specific gravity, the boiling-point, and rate of expansion. A description of the apparatus used in these determinations was given. He has in the main confirmed Kopp's results, and has arrived at the following conclusions:—1. A difference of CH_2 in a homologous series corresponds to a difference of 22 in the specific volume. 2. Carbon has a specific volume of 11, hydrogen of 5·53. 3. There is no reason for accepting Buff's hypothesis that the specific volume is a function of the atomic value of an element. 4. The inference of Kopp that members of the same family have the same specific volume does not appear to be well founded. 5. The specific volume appears to be a periodic function of the atomic weight.

Geological Society, February 25.—Robert Etheridge, F.R.S., president, in the chair.—Joseph H. Cowham, William Alexander Forbes, M. H. Gray, and Charles Thomas Whitmell were elected Fellows of the Society.—The President announced that a communication had been received from the American Academy of Arts and Sciences, stating that the Academy proposed to celebrate its 100th anniversary on May 26, 1880, on which occasion the Academy hoped that one or more delegates from the Geological Society of London might be present.—The following communication was read:—On the geology of Anglesey, by Prof. T. McKenny Hughes, M.A. The author brought forward evidence to show that, resting on the central gneissic axis of Anglesey, there was a series of conglomerates which he referred to the base of the Cambrian; that the Lingula-flags had not yet been recognised; that the conglomerates were followed by the brown sandstones hitherto referred to Caradoc, but which he identified by the included fossils with Tremadoc; that the lower part of the black-shale group was arenig, as shown by the graptolites; while he thought that the higher parts of the black-shale group might turn out to be Lower Bala; that the black shales pass under the gnarled schists. He then adduced evidence to show that these gnarled schists were not foliated or in any way true metamorphic rocks, but only crumpled laminated beds in which all the alteration that had taken place was of the nature of vein-structure, and a kind of universal slickenside, consequent upon the crushing of a rock consisting of thin laminæ of different texture; and suggested that the whole might be, like the green slates, &c., of Chapel-le-dale, in Yorkshire, the water-sorted outlying equivalents of volcanic rocks elsewhere, and be contemporaneous with the Snowdon volcanic series.—Notes on the strata exposed in laying out the Oxford Sewage Farm at Sandford-on-Thames, by E. S. Cobbold, F.G.S., Assoc.M. Inst. C.E. The beds noticed in this paper belong to the Kimmeridge clay and the upper and middle part of the Oxford oolite.—A review and description of the various species of British upper Silurian Fenestellidæ, by G. W. Shrubsole, F.G.S.

Anthropological Institute, February 24.—Edward B. Tylor, F.R.S., president, in the chair.—The election of J. Hall Gladstone, Ph.D., F.R.S., as a new Member was announced.—Dr. Tylor read a paper on the origin of the plough and the wheeled carriage. The first agricultural implement seems to have been a pointed stick four or five feet long, such as many savage tribes still carry for the purpose of digging roots, knocking down fruits, and unearthing animals; at a later date the stick was bent and used hoe-fashion, the point being hardened by fire; the Indians of North America still use it in this form. In south Sweden large tracts of land give evidence of early cultivation, which is attributed by the natives to a prehistoric people called by them "the hackers," whose rude hoe was a fir pole with a short projecting branch, pointed, and who are always associated with the giants of mythology. There came into use afterwards a larger instrument of the same kind, which was not used like the hoe, but dragged by men or oxen. Instances of this are to be found in old Egyptian pictures, and among the bas reliefs, and it is evidently the primitive idea of the plough. The plough is in its origin prehistoric, evidences of its early use being found amongst the Greeks, Egyptians, and Chinese, and it had from the earliest times a religious sanction, one proof of which is found in the fact that the name of Brahma's wife—Sita—signifies a furrow. A wooden hook shod with iron was the next improvement, and in the time of Virgil we find a wheeled plough in use, which differed little from the best in Europe a century ago. Some people assert that the plough was the earliest vehicle, but it seems more probable that the sled was first used, then rollers were placed underneath, and shifted forward when necessary, as seen in one of Raphael's pictures in the Vatican, and then the middle part of the rollers was shaved away in order to reduce friction. In some carts of the Scythians the solid drum wheel is fixed to the axle, so that wheel and axle revolve together; and in Italy and Portugal, at the present day, the carts are very generally built with large block drum wheels, and in many cases the bearings are not locked below, but merely rest on the axle like forks. The original mode of harnessing was the yoke, attached to the horns or withers of oxen; in the time of Homer no traces were used, but the Egyptians used one trace, which shows that they were one stage advanced in civilisation. The Gauls and Britons evidence a still further advance in the employment of chariots, some being even furnished with scythes, like those mentioned in the Maccabees.—Dr. Dally exhibited a fine collection of ethnological objects from British Columbia. On some of the hats which were shown, Dr. Dally pointed out marks similar to the tattoo marks with which the natives adorn their bodies, and which, he said, all have a definite meaning, being, in fact, a record of events which have taken place in the life of the wearer. Some of the specimens of native workmanship were remarkably good, particularly some silver bracelets which had been made and engraved specially for Dr. Dally. The natives appear to have a knowledge of working iron and brass as well as the softer metals.

CAMBRIDGE

Philosophical Society, February 9.—Prof. Newton, president, in the chair.—Mr. W. J. Lewis was elected a Fellow of the Society.—The following communications were made to the Society:—A theorem in elementary trigonometry, by Mr. J. W. L. Glaisher. The theorem in question is that—

$$\cos a \cos b \cos c \cos d + \sin a \sin b \sin c \sin d$$
$$= \cos a' \cos b' \cos c' \cos d' + \sin a' \sin b' \sin c' \sin d',$$

where $a' = \frac{1}{2}(-a + b + c + d)$,
$b' = \frac{1}{2}(a - b + c + a)$, &c.
so that $a' = \sigma - a$, $b' = \sigma - b$, &c.
where $\sigma = \frac{1}{2}(a + b + c + a)$.

—Note on the reflection and refraction of light, by Mr. R. T. Glazebrook. In his paper on the reflection and refraction of light at the bounding surface of two isotropic media Green assumes that no external forces act on the ether in either medium, and that its elasticity is the same in the two. He further assumes that the velocity of propagation of the normal vibrations is very great compared with that of the transverse. Kirchhoff, in a paper read before the Berlin Academy, replaces Green's assumptions by the supposition that external forces act over the common surface of the two media of such a nature as to prevent the propagation of the normal waves. In addition he supposes that these forces produce neither loss nor gain of energy, and discusses the case of two crystalline media. These principles are applied in the paper to the problem for two isotropic media, and expressions for the intensity of the reflected and refracted waves are deduced. For the reflected wave the intensity of the wave in which the vibrations are in the plane of incidence agrees with that given by Fresnel for vibration perpendicular to that plane, and *vice versâ*. The intensities of the refracted waves are slightly different from Fresnel's expressions. The results agree with those given by MacCullagh, *Irish Transactions*, 1848. His expression for the intensity of the strained medium is, however, inconsistent with the conservation of energy. The change of phase produced by total reflection is also investigated. It follows, too, from the equations, that the density of the ether is the same in all isotropic transparent bodies.

BOSTON, U.S.A.

American Academy of Arts and Sciences, January 14.—Hon. Charles Francis Adams in the chair.—Mr. S. W. Holman, of the Mass. Institute of Technology, considered the bearing of Chappuis's recent study of surface-condensation upon the determination of the coefficient of expansion of gases, and shows that the effect of introducing a correction for condensation is in general to bring the results obtained by different experimenters into closer accordance.—Mr. W. H. Pickering has investigated the relative amount of light of four different refrangibilities in various artificial lights and in moonlight and sunlight, using as standard a portion of the flame from an argand gas-burner. He also discussed the question of the sun's temperature, showing from the intrinsic brilliancy of the sun and from the relative amount of yellow and violet light in its rays the temperature lies between 270,000° C. and 22,000° C. as probable limits. An additional method, based upon other measurements discussed in a different manner gives 80,000° C. as the probable upper limit and 8,000° as the lowest possible limit.

VIENNA

Imperial Academy of Sciences, January 8.—On perfect inscribed polygons, by Prof. Weyr.—Researches on picrotoxin, by Prof. v. Barth.—Researches on the rainfall of Austria-Hungary (second part), by Herr Hann.—On the number of optic nerve fibres and retinal cones in the human eye, by Prof. von Brücke.—On heliotropic phenomena in the plant-kingdom, by Prof. Wiesner.

January 15.—On the theory of gaseous friction, by Prof. Boltzmann.—On a relation between the singular elements of cubic involutions, by Prof. Le Paige.—On the carrying power of magnets, by Prof. Stefan.—On the principal reducing properties of ferro-oxalate of potassium and some reactions produced by them, by Dr. Eder.—Histological researches on traumatic inflammation of the brain, by Dr. Unger.—Researches on the formation of the ground substance of cartilage, by Dr. Spina.—New method for quantitative determination of ferrous and ferric oxide in presence of organic acids and also cane-sugar, by Dr. Eder and Herr Meyer.

CONTENTS

THURSDAY, MARCH 18, 1880

DISSOCIATION OF CHLORINE, BROMINE AND IODINE

IN NATURE, vol. xx. p. 357, I gave an account of Prof. V. and Herr C. Meyer's remarkable observations on the density of chlorine at high temperatures, which showed that the chlorine evolved from platinous chloride at temperatures of 1,200° and above had a density only two-thirds of that corresponding to the molecular formula Cl_2. I also mentioned that the Meyers had stated that iodine exhibited a similar behaviour.

These observations, tending as they did to show that chlorine was not the simple substance it had hitherto been supposed to be, naturally excited great interest among chemists, and further information has been most anxiously looked for; it must be admitted, however, that they were received with considerable scepticism, more especially because the statement relating to iodine was in direct contradiction with a most careful series of experiments on the comparative behaviour of air and this substance made by Deville and Troost, who, after assuring themselves that iodine vapour underwent a normal expansion, made use of iodine as a pyrometer in many determinations in the course of their celebrated investigation of the density of a variety of inorganic bodies at furnace temperatures.

This scepticism was considerably strengthened by the appearance, in a recent number of the *Comptes Rendus*, of a paper by a well-known American chemist, Prof. Crafts, describing a quasi-repetition of the Meyers' experiment with chlorine. The method adopted by Crafts was a slight modification of that introduced by V. Meyer. Two graduated and calibrated U-tubes, maintained at constant temperature by a bath of cold water, were connected with V. Meyer's apparatus in such a manner that a known volume of gas could be transferred from the one to the heated bulb of the density apparatus through a very fine tube, the volume of gas displaced by it being collected and measured in the second U-tube. In two experiments made in this manner at the highest temperature of the furnace, the density apparatus being filled with air, 10 c.c. of chlorine displaced 10·37 c.c. and 10·24 c.c. of air; the apparatus being filled with chlorine, 10 c.c. of air were found to displace 9·98 and 10 c.c. of this gas. These experiments were made with a porcelain apparatus; using a platinum apparatus, 10 c.c. of chlorine were found to displace 10·43 c.c. and 10·50 c.c. of air. If the expansion observed by the Meyers had taken place, the quantities of air and of chlorine collected should have been 15 c.c. and 6·6 c.c. respectively, so that operating with free chlorine, Crafts failed to verify the observation of the German chemists.

With iodine, however, he obtained results confirmatory of their statement, the observed density being 6·01 and 5·93, instead or 8·79, the theoretical number corresponding to the formula I_2. Bromine was found to be intermediate in its behaviour, the numbers obtained being 4·39 and 4·48, instead of 5·57, indicating a reduction in density of one-fifth in place of the reduction of one-third observed in the case of iodine. Hydrogen chloride and carbon dioxide gave normal results, showing that there was no fault inherent in the method; Crafts, however, noticed that the glaze of the Bayeux porcelain vessels used was much attacked by the coal-gas flame, and that at the high temperatures employed they were slightly porous to hydrogen and water gas, but not to other gases, although not to an extent to vitiate the experiments, only ·001—·002 gramme of water passing through in the course of an hour.

The announcement of these results has led Meyer to give an account of experiments he has made in conjunction with Herr Züblin since the publication of the paper by C. Meyer and himself, but prior to the publication of the paper of Crafts. Meyer and Züblin confirm the accuracy of Crafts's observations. Using chlorine gas prepared in the ordinary way, and carefully purified and dried by passing it through water and sulphuric acid and over phosphoric anhydride, they found in three experiments at a yellow heat, 2·57, 2·63, 2·64; in mean 2·61, instead of 2·45, which is the density corresponding to the formula Cl_2.

We have then the astonishing result that whereas ready prepared free chlorine is stable at high temperatures, nascent chlorine, *i.e.*, chlorine at the moment of liberation from the compound platinous chloride, is unstable, and undergoes dissociation: for there can now be little doubt that such is the nature of the phenomenon involved in the reduction of its density observed by the Meyers, the argument that this may be due to a great difference in the rate of expansion of chlorine as compared with gases such as oxygen and nitrogen at high temperatures being disposed of by the fact that free chlorine does exhibit a normal behaviour in this respect.

Meyer also publishes the results of a long series of experiments on the density of iodine. In all of these, purified solid iodine was employed and not an iodine compound. The first series of observations, made in a porcelain vessel, are summarised in the following table:—

Temperature.	Observed density.				Theoretical density.
253°	8·89	8·83			$8{\cdot}78 = I_2$
About 450	8·84	8·85			
„ 586	8·73	8·71	8·71		
„ 842	6·68	6·80	6·80		
„ 1,027	5·75	5·74			
„ 1,570	5·67	5·60	5·71	5·81	$5{\cdot}83 = \frac{2}{3} I_2$

On comparing these results with those for chlorine from platinous chloride, it will be observed that the dissociation of iodine is complete at a considerably lower temperature (about 1,000°) than that of chlorine (at about 1,200°).

These results being so at variance with those obtained by Deville and Troost at a temperature of 1,040°, Meyer subsequently made further experiments with entirely new apparatus and fresh iodine, but without observing any departure from them. A determination at about 1,052° in a porcelain apparatus gave 5·88; and the density of mercury at the same temperature being simultaneously determined to control this result, the number 6·98 was obtained in place of the theoretical number, 6·91. Two experiments with iodine in a platinum vessel at about 1,567° gave 5·71 and 5·81 as the density.

The only explanation which can at present be advanced to account for the difference between the observations of Deville and Troost on the one hand, and Meyer and Crafts on the other, is that in the experiments of the former the iodine was gradually converted into vapour, whereas the method adopted by the latter involves the almost instantaneous volatilisation of the iodine; in the case of some organic compounds a difference of this kind in the mode of heating is known to exercise a considerable and in many respects similar influence on the result, so that this explanation is not unsupported by analogy.

Great difficulty was experienced in determining the density of free bromine in consequence of the explosive rapidity with which it is converted into gas when introduced into the intensely-heated bulb of the density apparatus. The results obtained are not accordant, but all lie between the number corresponding to the molecular formula Br_2 and that required on the assumption that dissociation takes place to the same extent as in the case of iodine. Using platinic bromide, $PtBr_4$, however, instead of free bromine, Meyer and Züblin find that a reduction in density takes place precisely of the character of that observed for chlorine from platinous chloride and for iodine. Thus at a temperature of about 1,570° the observed density in two experiments was 3·78 and 3·64, 3·64 being exactly two-thirds of the density corresponding to the molecular formula Br_2.

As yet Meyer has told us nothing of the nature of the dissociation products of the three halogens; their determination and separation will probably be attended with great experimental difficulties, but the problem could not well be placed in abler hands, and we trust that ere long we may be able to congratulate him on the accomplishment of this the crowning triumph of his labours.

HENRY E. ARMSTRONG

GLAISHER'S FACTOR TABLES

Factor Table for the Fourth Million. By James Glaisher, F.R.S. (London: Taylor and Francis, 1880.)

THERE is no general method of ascertaining whether one number is divisible, without remainder, by another specified number (less than its half) except by actual trial, or by the knowledge, otherwise acquired, of all the divisors of the first number. If then the second is not among these, it is also known that it is not a divisor of the first number. The knowledge of whether a specified number has any divisors at all, and if so what they are, is only to be obtained in general by trying it with all possible divisors less than its square root. The process can be shortened, but only to a limited extent, and, speaking generally, it would require hundreds of division sums, to ascertain by trial that 3,979,769 had 1979 for a divisor, and was consequently the product of 1979 and 2011.

It is, however, frequently important to mathematicians to know how to split up any given number into its divisors or factors, and this without the enormous labour which *may* be involved in actually trying for its divisors, especially as there is no general mathematical principle which enables us to dispense with the trial, or even to shorten it so as to bring it within practicable limits. The alternative is to tabulate numbers up to a given limit, and to indicate, for each, whether it has divisors, and what they are. It is not necessary, or usual, to include in such tables *every* number without exception; for an inspection of the last figure of any number tells us whether it is divisible by *two* or by *five*; and the old rule of "casting out the nines" tells us whether it is divisible by *three*. These considerations greatly reduce the number which it is necessary to tabulate; for, among the first 300 numbers, 150 are even, that is to say, divisible by 2; and of the remaining 150, 50 are divisible by 3; while of the 100 left after that, 20 are divisible by 5. The exclusion of the numbers divisible by 2, 3, or 5 thus reduces the number of tabular entries required, from 300 to 80, and this proportion holds all through the table, as well as for the first 300 numbers. It will be observed that the last two figures of these 80 numbers remain the same for every batch of 300. This facilitates the tabulation, and advantage has been taken of this facility in printing the Tables.

The first extensive tables of this kind were those published by the Austrian General, Baron von Vega, at the close of the last century. These extended from 1 to 108,000, and thus give all the divisors of the numbers not divisible by 2, 3, and 5 within those limits. The next table was that of Chernac, a Polish Professor of Mathematics at Deventer, in Over-yssel, which was published in 1811. It contained all the divisors of all numbers, not divisible by 2, 3, and 5 up to 1,012,000. It forms a very thick quarto volume of over 1,000 pages.

The next extension was made by Burckhardt (1814-17), who published a series of three volumes, giving, not *all* the divisors, but the least prime divisor, of all numbers (except those divisible by 2, 3, and 5) up to 3,036,000. This is not quite so convenient, as a matter of immediate reference, as giving all the divisors; but it answers every necessary purpose. For example, when we know that 3,999,589 has 11 for its least divisor, we can find by actual division that the quotient is 363,599. We "look out" this number in the earlier part of the table, being sure of finding it there, seeing that 11 was the *least* divisor of its multiple; we find its least divisor to be 31. Performing the division by 31, we obtain the quotient 11,729. We "look out" this again in the earlier part of the table, and we find that 37 is the least divisor. Performing this division, we obtain 317 as the quotient. Since this is less than 37×37, we know that it can have no divisors except unity and itself, or that it is prime. If, instead of the least prime divisor, all the divisors had been given, we should at once have found from the table

$$3,999,589 = 11 \times 31 \times 37 \times 317.$$

There is an obvious advantage in the more complete table. Unfortunately it is balanced by the practical inconvenience of size, and "a great book is a great evil." What this practically comes to may be judged of from the remark that Chernac's table, which gives all the prime factors from 1 to 1,019,000, takes 1020 quarto pages; while Burckhardt's, which gives only the least prime divisor, contains the numbers from 1 to 3,036,000 in 336 quarto pages. It is true that Burckhardt's table is more closely printed than Chernac's, with somewhat smaller type, and a slightly larger form; but, making all allowances, the condensation obtained by giving the least prime divisors instead of all the divisors, cannot be put at less than three to one. It must be observed also, that the processes of division, which have to be performed when the least divisors only are given, are definite divisions with a known divisor, and do not involve the tentative process of finding what the divisor is; it is just this tentative process which it is the object of all such tables to avoid.

Burckhardt's tables extend, as has already been stated, to 3,036,000. They consequently tabulate no divisor exceeding 1741, which is the prime number next below the square root of 3,036,000, which lies between 1742 and 1743.

The celebrated German computer, Zacharias Dase, began the task of extending this table to nine or ten millions. There was then a prospect of the fourth, fifth, and sixth millions being printed from a manuscript by Crelle, so that Dase, instead of taking the fourth million, began with the seventh. His task was interrupted by his death, but was resumed by his friend Dr. Rosenberg. The seventh, eighth, and ninth millions were published by a Society called the Dase-Verein, and printed in Hamburg, and the tenth million exists in manuscript. These publications, however, were of little practical value to science, so long as the gap between 3,036,000 (Burckhardt's final limit), and 7,000,000 (Dase's initial limit) remained a blank, and it was found that Crelle's manuscript, which had fallen into the possession of the Berlin Academy, was not sufficiently reliable, in respect of accuracy, to supply this gap.

This blank Mr. Glaisher has undertaken to fill up, and the first instalment, the fourth million, is now before us. With the assistance, towards the expenses of computation and printing, of grants from the British Association, and of the Government grants administered by the Royal Society, but without any requital of his own toil, except such as all good workers find in the satisfactory completion of their labour, he has secured for England a share in the performance of this work. The fourth million, added to Burckhardt's three millions, makes perfect work as far as it goes. The fifth million is now going through the press, and the manuscript of the sixth million is nearly complete. When these are printed, the work of Dase and Rosenberg will couple on, and we shall have, in a shape available for immediate reference, a complete knowledge of the divisors of all numbers up to nine millions. To test a number nearly equal to nine millions might involve our trying, as divisors, all the prime numbers from 7 to 2,999 inclusive.

It would be premature to discuss the question of accuracy of performance until much more trial has been made of the work than has been possible in the few days which have elapsed since its appearance. Very good guarantees, however, are afforded by the systematic method in which the process of calculation has been performed, as well as by the great experience which Mr. Glaisher has had in accurate computation, and again by the numerical tests of comparing the number of primes actually counted, within given limits, with the approximate numbers indicated by theory.

It is well known that the frequency of the occurrence of prime numbers in the neighbourhood of any large number, x, is expressed by the reciprocal of the hyperbolic logarithm of x. Soldners' integral, $\int_0^x \frac{dx}{\log x}$, should therefore express, with a high degree of approximation when x is large, the number of primes below a certain number. One difficulty of the application of this is, that the function integrated becomes infinite between the limits. Nevertheless a highly approximate formula for the number of primes below a high number x is given by the expression (due to Legendre)—

$$\frac{x}{\log x - 1{\cdot}08366}.$$

A serious practical difficulty in attributing exactness to any such formula, or in determining its constants to any high approximation, lies in the irregular distribution of the prime numbers. It not unfrequently happens that two consecutive odd numbers are primes; that is so with 3,999,311 and 3,999,313. On the other hand there is no prime number at all between 3,826,019 and 3,826,157, which differ by 138. This variation of frequency effectually throws out any minute comparison between actual counting, and analytical expressions for the number of primes, founded on the assumption of regular continuity. A discussion of this part of the subject is given in Mr. Glaisher's introduction.

For a full development of this and of the cognate theorems, and of their limits, we must refer to the extremely valuable preface which Mr. Glaisher has prefixed to his work. To that also we must refer for an account of the ingenious methods used in abridging the enormous labour of computation, and at the same time of seizing the advantages of the most systematic arrangement possible, in order to secure accurate work in the first instance, and then the detection of error, if accidentally committed. The amount of accuracy which it is possible to obtain may be inferred from the fact, that after many years' use, only two errors have yet been pointed out in Burckhardt's extensive table, and that Chernac is nearly as good. We have no reason to doubt that this high standard of accuracy has been maintained by Mr. Glaisher.

Our review would hardly be complete without some remarks on the utility of this work. We have already pointed out the utter impossibility, as a practical question to practical men, of ascertaining whether a given number has divisors, and what they are, without the help of such tables. One of the most obvious applications is to the calculation of high logarithms. The larger logarithmic tables, to a great number of figures, only extend from 1 to 20,000 in the case of common logarithms, and from 1 to 10,000 in the case of Napierian logarithms. When, therefore, such a logarithm is required for an incommensurable number (as is commonly the case), it becomes necessary to split it, either absolutely or approximately, into factors. Now this series of tables, when complete, will give us at sight the breaking up of the first seven figures of any number, and by a little adjustment, turning upon the formula $a^2 - (b \pm c)^2$, suggested by Burckhardt, to a far higher extent. For instance, Burckhardt himself gives as an approximate value of π, $256 . 19 . 173 . 229 . 509 . 3203$, which (neglecting cyphers) is good for the first ten figures; and in the same way it has been found that

$$\log_e 10 = 64 . 5 . 13 . 13 . 103 . 109 . 541 . 701 + 24844$$

up to the fourteenth decimal place.

Again, the tables virtually furnish lists of primes to their full extent. We need not remind mathematical readers how often it is important to know, concerning certain results of calculation, whether a number is prime or not, this being the necessary preliminary to further inferences from the processes which give rise to it. As an easy example of the consequence of knowing how a number splits up into prime factors, we may mention the elementary theorem, that any recurring decimal whose period consists of five figures *must* have one or more of the numbers 3, 41, or 271, as factors of its divisor. This is simply a consequence of the numerical identity—

$$99999 = 3 \cdot 3 \cdot 41 \cdot 271.$$

Now, as to relative utility: We are inclined to think that the utility of such tables is measured by the index of the power of 10, to which they extend—that this rule represents the advantage of Vega's table, up to 108,000, over Barlow's, up to 10,000; of Chernac's, up to 1,012,000, over Vega's; and of this set of tables, when completed up to ten millions, over Chernac's. We think this estimate holds for theoretical questions relating to the enumeration and distribution of primes, and cognate questions relating to the theory of numbers, as well as for the practical command they give us over the numbers themselves. Nevertheless, it would not be right to underestimate the important point that this work *does* give us a command over numerical magnitude such as we did not possess before. In that view he would be a bold man who should say that the money cost of the production and printing of these tables was a bad investment for science, especially when the directing labour was gratuitously given. What that directing labour involves can be understood by those alone who have worked upon millions. None others know what an awful factor a million is, when applied to the multiplication of the simplest process. We shall heartily congratulate Mr. Glaisher on the termination of his labours, and we no less heartily congratulate our mathematical friends upon their good fortune in having found such a man to undertake such a task.

We conclude by reminding our mathematical readers that all the processes by which these tables have been formed are but skilful adaptations of the well-known CRIBRUM ERATOSTHENIS, of which the analytical expression was first given by Euler (*introductio in analysin infinitorum*) in his remark that the harmonic series—

$$1 + \tfrac{1}{2} + \tfrac{1}{3} + \tfrac{1}{4} + \tfrac{1}{5} + \tfrac{1}{6} + \ldots \text{ to infinity}$$

is the reciprocal of the continued product—

$$(1 - \tfrac{1}{2})(1 - \tfrac{1}{3})(1 - \tfrac{1}{5})(1 - \tfrac{1}{7}) \ldots,$$

in which the primes only enter.

C. W. M.

WHO ARE THE IRISH?

Who are the Irish? By James Bonwick, F.R.G.S. (London: David Bogue, 1880.)

THIS little work is issued as the first of a series on "Our Nationalities," to be followed by three others on the Scotch, Welsh, and English. It does not appear from the prospectus whether the rest of the series is to be entrusted to Mr. Bonwick; but if they are it is to be hoped that he will qualify himself for the task by a preliminary study of at least the first principles of ethnology. The present volume, with all its good intentions and praiseworthy industry, must be regarded as a hopeless failure, owing entirely to the neglect of this necessary precaution. For many years ethnology, anthropology, and philology were subjects which any one seemed competent to deal with, who had got hold of a few lists of words in some obscure African or Polynesian dialects (the obscurer the better), or who had desecrated a sufficient number of ancient barrows, or posed to admiring circles under the shadow of some Druid's altar in Cornwall or Brittany. But those halcyon days of the amateur ethnologist are no more, though the writer, unfortunately, seems scarcely alive to the fact. Almost every page of his little tractate betrays solecisms and crudities, such as one naturally looks for in the writings of the Pinkertons, Vallanceys, Vans Kennedys, Bethams, and other obsolete writers of the old Keltic school, but which have become anachronisms since Keltic studies have been placed on a solid basis by the labours of Pritchard, Pictet, Zeuss, Ebel, Lottner, Diefenbach, Whitley Stokes, and Dr. W. K. Sullivan.

A great many authorities are quoted, some, it may be, at first hand, but most of them vicariously, some good, some of no account, some utterly worthless. But all are treated with equal deference, and nowhere is there betrayed the least sense of discrimination as to their respective merits. Thus at p. 27 we have "Betham makes them Teutons, and Wilde, Celts," as if the opinion of a keltomaniac like Sir William Betham could matter a straw one way or the other, and as if in the writer's view it commanded as much weight as that of the distinguished member of the Royal Irish Academy, with whom he is here strangely associated. This vice pervades the entire work, and of itself alone reveals the utter incapacity of the author to deal with such a theme as that of the affinities of the Irish race. Hence it is not perhaps surprising to find ethnical terms treated quite as wildly as ethnological authorities. At p. 19 occurs the following passage, which is quite a curiosity in its way:—"The Basques are believed to be of Turanian origin, while the Celts are Aryans, like most of the Europeans, as well as Persians, Hindoos, &c. Some Turkish and Finnish tribes, with ancient races in Greece, Italy, and Assyria, have been deemed Turanian with Tartar (*sic*) sympathies. The Etruscans of Tuscany were leaning to the Iberian." For wild incoherence and confusion this will surely hold its own with anything to be found in the lucubrations of the most popular exponents of Keltic ethnology in the present or past generation. Frequent use is naturally made of the convenient but dangerous term "Turanian," but its meaning is nowhere defined. Careful writers, if they use it at all, at least restrict it to the Finno-Tataric or Ural-Altaic family. But it is here apparently separated from that connection, so far at least as regards the Tatars, while the Tatars themselves are spoken of as something distinct from the "Turkish" (read Tûrki) tribes, with whom they are nevertheless identical. Why or when "the Etruscans of Tuscany were leaning to the Iberian" we are not informed, nor are we told by whom "the Basques are believed to be of Turanian origin." Meantime it may be well to remind the author that, though linguistically standing quite apart, the Basques belong ethnically to the same great Mediterranean or Caucasian stock as do the Aryans themselves, and that they can therefore have nothing in common with the "Turanians." He should also try to realise the fact that Aryan is much more a linguistic than an ethnical term; hence that though there may have been non-Aryan speaking peoples in the British Isles, they need not necessarily have belonged to a different ethnical type from the Aryan-speaking tribes, who afterwards arrived in successive waves of migration, and practically absorbed the previous elements. In a word, apart from the question of quaternary man typified on the Continent by the fossil remains discovered at Canstadt, Cromagnon, Furfooz, Nagy-Sap, and elsewhere, there is nothing to show that in the present geological epoch these islands have been occupied by any races typically distinct from the Mediterranean, least of all that "the primitive Irish were . . . of a kindred more like Finns, Lapps, and Siberians" (p. 9). The Finns have been proved to be comparatively recent arrivals in Eastern Europe, and certainly never have reached the west. Who the "Siberians" are it is impossible to say, for the term is unknown to anthropology as a distinct racial appellation, being in fact a purely political or geographical expression.

A good deal is said about "the dark stock" prevailing in the west and south-west of Ireland. But one of the chief sources of that element is entirely overlooked, probably because too recent and too obvious to arrest the attention of the palæolithic and neolithic ethnologists. The source in question is the Spanish, due to the close commercial and even social intimacy maintained by Spain with the west coast of Ireland down to quite recent times. There were important Spanish trading stations at Dingle, Valentia, Cahirciveen, Bantry, Timoleague, Galway, and elsewhere. Many of the old houses in these places are built in the Spanish style, and it may not be generally known that Valentia Island was actually held by the Spaniards until expelled during the vigorous administration of Cromwell. Many of the peasantry in Kerry and Galway bear an unmistakable Spanish expression, and this factor ought certainly to be taken into account in dealing with the complicated problem of Irish ethnology.

Verbal resemblances are appealed to or at least quoted in the most reckless manner. One instance must suffice: "The *Lettmanni*, or Leathmannice, are said to have given name to the Avene Liff or Liffey; some trace the tribe to *Livonia* of the Baltic" (p. 20). Why to "Livonia of the Baltic" any more than to Livadia of Greece, or Livno of Herzegovina, or Livorno of Italy, or Livuma of East Africa, or Livny of Russia, or Lippai of Styria, or Liffa of the Moluccas? It is the old story of a river in Macedon and a river at Monmouth, so that "the situation, look you, is both alike," and Fluellen's ethnology quite as good as that of many here appealed to as authorities.

On the subject of the Round Towers the writer has some sensible remarks, and we are glad to see that he has had the courage to reject the Christian theory of their origin. Referring to those overthrown by the earthquake of 448 A.D., he well remarks that "it was very unlikely they had been erected as belfries, since the churches of the period were *all* of wood, and continued to be of wood for six hundred years after. The oldest stone churches are extremely rude and of imperfect masonry. It is strange, therefore, that the belfries, supposed to have been raised in the twelfth or thirteenth century, when churches were either of wood or clay, or of miserable stone-work, should have a finish and delicacy of work rivalling anything of modern times. . . . . If Christian, how is it that only two out of one hundred and twenty-five should bear the least symbol of a Christian character, and while those evidently show such marks to be novel alterations?"

The writer's style and grammar are peculiar. On the very first page we have "lots of discussions;" "we might, it is true, track backward on the track of new-comers;" "we could thus pass by English, Scotch . . . . without ever *getting across* the original men." Farther on, "The cup-marks are being still reverenced," p. 10; "inroading peoples," p. 17. "They brought with them *there* fifty maidens," p. 21. "They reappear on Irish *sods*," p. 23. "The Danes made Dublin, Wexford, Cork, and Waterford the commercial ports they are, whose people are now lighter than the others," p. 59. "Silver was once abundantly ornamenting it, besides precious stones," p. 80. Elsewhere the uncial style of penmanship is spoken of as a "corrupt Latin;" the famous "Book of Kells" is referred to as "the Book of Kelly;" the abolition of clan war-shouts is said to have removed "one cause for shillelahing;" the tendency of the English to become assimilated to the natives is described as "the habit of English to turn Irishy (*sic*) there;" hence the king hesitates "about the expediency of allowing decent Englishmen *mixing up* with Irish," p. 120. There is a good deal of this flippant tone, which cannot fail to give as much offence to the sensitive Irish as the extraordinary grammar certainly will to the sensitive English reader.

A. H. KEANE

OUR BOOK SHELF

Zoology for Students and General Readers. By A. S. Packard, Jun., M.D., Professor of Zoology and Geology in Brown University. With numerous Illustrations. (New York: Henry Holt and Co. London: Trübner and Co., 1879.)

THIS neatly printed and well illustrated volume forms one of the American Science Series, the principal object of which is to supply the lack, in some subjects very great, of authoritative books whose principles are, so far as practicable, illustrated by familiar American facts, while they should at the same time at least not contradict the very latest generalisations of science. Prof. Packard's "Zoology" is one of the first published of the series; it is designed to be used quite as much in the laboratory or with specimens in hand as in the class-room. It is an expansion of a course of lectures for college students, though prepared to meet the wants of the general reader. Most of the anatomical descriptions and drawings have been made expressly for this book, and special portions have had the benefit of being supervised by Professors Hyatt, Gill, Cope, and Dr. E. Coues; the illustrations are to a large extent original, though some of them have appeared before in the pages of the *American Naturalist*, or in Dr. Coues's "Key to the Birds of North America."

The classification adopted is described as a provisional one; in it the animal kingdom is divided into eight branches—Protozoa, Porifera, Cœlenterata, Echinodermata, Vermes (flat and round worms, Polyzoa, Brachiopods, Annelids, Tunicates), Mollusca, Arthropoda, and Vertebrata. It is hinted that the Tunicates might even form a ninth branch, to stand next below the Vertebrates. The evident aim and object of the writer has been to write in the smallest possible compass a clear and intelligent account of the animal kingdom, one that would give a fair idea to the reader of what is already known about it, and that would at the same time suggest where new work might be done and how to do it. In this effort it is our opinion that the author has in a very great measure succeeded; but the subject is so large a one that with all the help he has received he still sometimes falls short of his aim. Some of the shortcomings are strange; thus Fig. 33 is a copy of Lovén's *Hyalonema boreale*, a species having nothing to do with the vitreous sponges and yet referred to as typical. On p. 85 we read, "In Tubipora the polyps are compound and secrete solid, calcareous, bright red tubes arranged side by side"; and yet in the next paragraph but one it is stated that Heliopora differs from Tubipora "in that the hard tissue of its corallium shows no sign of being composed of fused spicules." To call attention to all such instances as have caught our eye as we looked carefully over this book would serve no useful purpose. We could easily on the other band call attention to many new facts here recorded, not to be found perhaps in any other manual, and we feel sure that this handbook deserves a successful career. It is brought out in a style in every way worthy of its publishers.

Principles of Agriculture. Questions, Answers, Notes, &c. By S. Tomlinson, Stud. Inst. C.E. (Bradford: T. Brear, 1880.)

THE object of this book is, we presume, the instruction of students about to be examined in subject xxiv. of the Science and Art Department. It mainly consists of such answers as Mr. S. Tomlinson would have given to the questions asked in the examination papers set by Mr. H. Tanner in the years 1876-9. It is difficult to characterise this incoherent pamphlet as it deserves. It is not merely inadequate; it is something worse than feeble; in fact it abounds in the errors, direct and implied, which a mere beginner in the study of agricultural chemistry would be most likely to make. We quote such statements as the following in support of our adverse criticism. "Some guanos contain phosphates," p. 20. Where is the guano free from them? "The general composition of cows' milk is:—Water 858, casein 68, butter 38, sugar 30, salts 6;" p. 22. It is needless to remark that the figure representing butter in this analysis is the only one which approaches the truth. "Fibrin in wheat; albumen in corn," p. 30. What is the distinction implied here between wheat and corn? "The use of soils depends upon their place amongst other rocks," p. 39. Even if soils were species of the genus rock, their agricultural value could not be fairly stated to depend upon their geological horizon. On page 46 phosphorus is given as an element essential to the constitution of albumen and fibrin. But we will say no more, having already probably said too much. A. H. C.

The Cotton-Worm. By Chas. V. Riley, M.A., Ph.D. *Bulletin* No. 3 of the United States Entomological Commission. 8vo, pp. 1–144. (Washington: Government Printing Office, 1880.)

WE think this monograph exceeds in value all others of Prof. Riley's well-known writings on North American injurious insects. The cotton-worm is the larva of a moth of the family *Noctuidæ*, and belongs to that section of it in which the caterpillars form what is termed a "half-loop" in walking, owing to one pair of pro-legs being absent. It is calculated that in a year of severe visitation it occasions damage to the amount of 30,000,000 dollars, or 15½ per cent. annual average loss since the war. No wonder it has become a subject of governmental solicitude. The first forty-seven pages are occupied by an exhaustive natural history of the pest, illustrated by numerous very excellent original woodcuts, and a few (not original) that are indifferent, and also by a fine plate, admirably executed in colours, by what is termed the lithocaustic process. This portion consists not only of a complete history of the moth itself, but also of every imaginable kind of parasite and external enemy, so that it is of the greatest service to the scientific, as well as to the economic entomologist. The formidable nature of the subject may be readily imagined, when it is stated that in the hot districts the number of broods is almost continuous, and that in summer the whole life-cycle may be completed in less than three weeks. As to whether the perfect insect hibernates or not, there appears to be considerable difference of opinion, but Prof. Riley believes it does so in the southern districts, but not otherwise. This biological portion is succeeded by an extended examination of the remedies proved or tried, and an illustrated description of the various implements and appliances used to distribute these remedies, reminding one of the illustrated catalogues of some of our large agricultural implement makers, only in these one looks in vain for any parallel to the "brushers," "distributors," "atomisers," "sprinklers," &c., that here figure. Considerations of the advantages of light and saccharine matters for attracting the moths are not lost sight of, neither is the new idea of infecting the larvæ by means of the yeast fungus, although this is reported upon somewhat disparagingly. Our author, while admitting the efficacy, in greater or lesser degrees, of other insecticides, appears to fall back upon "Paris green" as the most effective, as he has done in former cases, when treating upon the Colorado beetle, &c.

Not the least interesting and amusing part of the book is the appendix of answers by correspondents to a circular of questions addressed to them. These answers display that same amount of great knowledge and gross ignorance combined as one finds amongst agriculturists at home on similar subjects. Biologists inclined to favour the theory of abiogenesis will find enthusiastic advocates amongst cotton-planters, even in connection with an animal so high in the scale as a moth; one planter expresses his decided opinion that "the atmosphere created the germ right there;" others strongly deny that any pairing of the sexes takes place; another bold theorist states as his belief that "it is a peculiar parasite of the cotton-plant, and as such, that the cryptic germ of the insect is to be found with the germ of the plant itself, and, like all parasites, only requires favourable circumstances to develop it." Some, again, assert that the moths are brought from the south by strong breezes; others, that the larvæ are not especially attached to the cotton-plant, but feed upon anything on which the eggs were deposited, only then they differ from those on the cotton. Even supposing all Prof. Riley's time and trouble in investigating the matter to be thrown away—and there is no reason to imagine it will be—so far as arresting the damage, or lessening it, is concerned, he will have done good service in explaining to the planters the true state of things regarding the natural history of the insect; but we must not suppose all will believe him.

The moth is *Aletia argillacea* of systematists, *Aletia* being a genus closely allied to *Anomis*, Hübner. It has also been described as *Anomis bipunctina* by Guenée (if we mistake not), originally from a figure in Abbot's beautiful work, though our author makes no mention of this.

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.*]

C. F. Gauss

In August of last year the editor of NATURE forwarded to me a letter he had received from Mr. Robert Gauss, of the firm of McDearman and Gauss, attorneys at law, St. Charles, Missouri, U.S.A. The object of this letter was to obtain, if possible, a copy of the *Proceedings* of the Royal Society (vol. vii.), referred to in my centenary notice of Gauss (NATURE, vol. xv. p. 533). I have not succeeded in obtaining this volume, and I learn from Mr. Walter White that there is no copy available from the Royal Society. In the course of a subsequent correspondence I have learnt several family particulars which, as I have Mr. Gauss's permission, I should like to give to supplement my former notice referred to above. I am the more disposed to do so as the notice of Gauss in the *Encycl. Brit.* (vol. x.) gives but scanty details, and, I observe, gives the erroneous date of April 23 (for April 30) as his birthday (vol. xv. p. 533), and further, all reference to Gauss's married life was omitted in my notice. Gauss, it is well known, was twice married. By his first wife he had two sons, Joseph and Louis, and one daughter, Minna; Joseph died in Europe four or five years ago, Louis died in infancy, and Minna, wife of Prof. Ewald, of Göttingen, died about ten years before her father. The second wife was Minna Waldeck (there is a letter from her mother to Olbers, in Dr. Bruhns's "Briefe zwischen A. v. Humboldt und Gauss," No. vi.); by her Gauss had also two sons and a daughter. This daughter, Theresa, died in Europe. The second son, William, settled in Missouri, and died August 23, 1879, at St. Louis. My informant says he died rich, and his sons are very well circumstanced in business: one son is a Presbyterian minister. Eugene Gauss, the eldest son by the second marriage, is the only living child of C. F. Gauss, and is in his sixty-seventh year (almost entirely blind with cataract in his eyes); he is Mr. R. Gauss's father; he left Europe about 1831, and has not since left his adopted country. The family propose to publish a translation of the several memoirs of Gauss in book form, and are very desirous of procuring copies of his letters to scientific men, more especially such as would be illustrative of his character and thoughts on general subjects. I have an extract before me of a letter from the daughter Theresa (date December 6, 1850), in which she says: "I cannot tell you much out of our quiet, simple life; one day and one year resembles very much the other, although they are peaceful days and years, for father, even now in his advanced years, retains his health unimpaired, and an always cheerful and happy frame of mind;" and then follows an account of the celebration in July, 1849, of his "semi-centennial doctors'-jubilee." Brunswick and Göttingen heaped honours upon him, and the "King sent him autograph congratulations and bestowed on him the degree of a higher order; of letters and addresses there was no end" . . . "then father delivered an address in the University hall, which was filled to overflowing with spectators and auditors, and which was so decorated with flowers as to look like a fairy palace. Even the houses in the streets through which he passed were decorated, and the city swarmed with well-dressed people as on a holiday. When at last, at seven o'clock, he returned home from the dinner, he was indeed very much exhausted, and it was well that the torch-light procession, which the students had thought of getting up in his honour, was, at his wish, omitted." It was a matter of regret to the old man that not one of his sons was able to be present.

A subsequent letter (November 16, 1855) describes the closing scene: "Gradually his life ebbed away, while his sufferings ('from an organic heart trouble') increased. He bore it all though with constant cheerfulness, and with a uniform patience and submission. He did not altogether lose hope, and he retained his consciousness until the last. His physician Bauer remained with him during the day previous to, and during the night of, his death. At 1 o'clock in the morning he took hold of his pulse, and said: 'It is moving quietly and full as in his best days, death may linger a long time yet.' Ten minutes later all was over! He died sitting up in his chair; and it was thus that his son Joseph found him enjoying, apparently, a quiet peaceful sleep." It is granted to few mathematicians to be so honoured in life.

R. TUCKER

Trans-Atlantic Longitudes

In an admirable article by M. Perier on telegraphic differences of longitude, published in the *Bulletin de la Société de Géographie* for September, 1879, he refers to the cables across the Atlantic, and their use for the above-mentioned purpose.

As a matter of historical interest, I beg to forward you the following memoranda of the work of this class executed by this country.

By officers of this Survey:—

In 1866: Between Cambridge, Mass., and Greenwich, *viâ* Newfoundland and Ireland.

In 1870: Between Cambridge, Mass., and Brest, France.

In 1872: Between Cambridge, Mass., and Greenwich, *viâ* St. Pierre, Brest, and Paris.

The results of these observations are shown in our paper, written by Prof. J. E. Hilgard, on these longitudes, a copy of which is forwarded herewith.

By officers of the U.S. Navy:—

In 1874 and 1875: Key West to Havana, Havana to Santiago de Cuba, Santiago to Kingston, Jamaica, and Kingston to Panama.

In 1875 and 1876: Kingston to St. Thomas, to Port Spain, to Barbadoes.

In 1878 and 1879: Greenwich to Lisbon, to Funchal, to Porto Grande, to Pernambuco, to Bahia, to Rio de Janeiro, to Monte Video, to Buenos Ayres.

The cable between Para and Port Spain having been broken, the complete grand circuit cannot at present be effected.

C. P. PATTERSON

U.S. Coast and Geodetic Survey Office, Washington, March 1

The "Zoological Record"

In acknowledging with thanks the kindly notice of the last volume of this publication given in NATURE, vol. xxi. p. 392, I trust I am not out of order in referring to one or two sentences in it that require explanation. If the reviewer knew the difficulty of getting competent recorders at the slight remuneration we can offer, he would also appreciate the impossibility of enforcing uniformity in treatment of the separate subjects: the work is almost done as a favour, and each writer has his own idea as to the method most likely to be useful, and would probably desire all the others to conform to his standard.

The scheme of separate pagination referred to as a convenience to the printer is, on the contrary, a source of considerable additional trouble mechanically both to the printers and myself: it was adopted in deference to the expressed wishes of some working zoologists, who naturally desired to have as soon as possible the portions of the work devoted to their special branches, and who indeed very probably care for no other part of the publication. The query affecting myself as editor as to the accent always given on the *a* of *infrâ*, scarcely needs the answer that *infra* without the accent is a preposition requiring the accusative, and with the accent, as used here, is an adverb (see any large Latin dictionary, such as the old Ainsworth). It is also perhaps unnecessary to refer to the remark as to reproduction of the Greek "κ" by the English *c*, beyond observing that generic words, such as *Kallispongia*, Wright, are supposed to be in Latin, not English; discretion is scarcely allowable when uniformity is desirable.

The identification of the author, H. W. Mackintosh, has evidently escaped Dr. Lütken, who has been puzzled by the form "Mr. Mackintosh" used in *Quart. Jour. Micr. Sci.*, xvii. p. 104.

In "Cœl. 13," *Cylicozoa* is not a misprint for *Calycozoa*, as is readily seen by referring to Taschenberg's paper itself.

Mr. Ross's paper on the muscles of a specimen of the Cheetah which he dissected, was possibly considered by the recorder as purely medical, with no attempt at deduction (the number of *Proceedings* of the Royal Irish Academy containing it did not arrive to my hands in London until October, 1878, long after the mammalian part was written).

The omission of a second reference to *Ceratella labyrinthica* shall be supplied in the next volume; those who take the trouble to note such *omissa* are the truest friends we have.

1, Savile Row, W. E. C. RYE

[The writer of the review claims to know something of the difficulties the editor of the *Zoological Record* refers to, with which "haud ignar*us* mali" he sympathises, and still he clings to the idea that it might be expedient for the editor to keep his young team in hand, but in thus suggesting a uniformity in practice, nothing was further from his thoughts than an unfriendly criticism. As to the accentuation of the *ā* in *infra*, he quite agrees with the editor that he would find the fact he mentions in an "old Ainsworth," but no modern writer now ever thinks of using an accent on Latin words under any circumstances, and hence the query. As to *Kalispongia*, Wright, being spelt with a *K* and not a *C*, though the subject is a tempting one for comment, yet a controversy on it would hardly be suited for the columns of NATURE, but surely the editor will draw a distinction between an attempt to preserve a uniformity in the style of the several records, and an insistance on authors being uniform in their spelling of generic names.]

A Museum Conference

MR. PATON'S suggestion about a museum conference is an admirable one, although I think that it should not be confined to officials only. The time has come when an Association for the Promotion and Systematic Arrangement of Museums must be formed. I trust, therefore, that those competent to do it will take the matter up and produce some practical result.

J. ROMILLY ALLEN

The Tay Bridge Storm

IN his interesting letter on the above subject (NATURE, vol. xxi. p. 443) Sir Ralph Abercromby remarks that "there is a good deal of evidence to show that where the velocity of the [cyclone] centre is very great, the strength of the wind for any given gradients is increased, or at all events becomes more squally and gusty;" and again (p. 444) that the Tay Bridge storm "was exceptionally squally and gusty, doubtless owing to the unusually rapid rate of its motion." I am far from wishing to be understood to impugn the accuracy of these remarks, but I would say that the law which is indicated in them has, if I mistake not, escaped general observation, and I believe that meteorologists will be grateful to Sir R. Abercromby, than whom no one can be found better able to do so, if he will point out the evidence on which it rests.

It is, I think, generally admitted that in traversing the continents both of Europe and of North America storms have on some occasions a greater velocity of propagation than has been recorded in the British Isles; and it seems possible that an increment in the quality of "gustiness" may be produced in an air current by its passage over a very extensive surface whose friction coefficient is large. But this scarcely seems to throw light upon the relation, mentioned by Sir R. Abercromby, between the gustiness of the wind for a given gradient over a particular and very limited area, and the velocity of propagation of the wind-system across that area.

The relation between the strength of the wind and the steepness of barometrical gradient is somewhat complex, and has not even yet received complete study. The relation between the strength of the wind and the velocity of propagation, or rate of progress of a storm, is a more intricate and obscure subject, and I believe that any facts which tend to elucidate it will be of considerable value, especially if this second relation can be shown to be independent of the first. W. CLEMENT LEY

March 12

Strange Arithmetic

IN the March number of the *Contemporary Review* is an article by Dr. C. B. Radcliffe, entitled "A Sequel to the Pedigree of Man," in which some most startling theories are propounded. As an appendix to this article, he gives several tables intended to prove that the mean time of high spring-tide throughout the world is about six o'clock (morning and evening). For this purpose he gives the time at a considerable number of stations, and the very large discrepancies led me to inquire how he arrived at his results. This he does by adding the times together, and dividing by the number of places! It is surely clear that any miscellaneous selection of times treated in this manner *must* give a result somewhere near six.

His first table shows a result of 6h. 9m., but if you take his figures, and number the hours from morning to evening, instead of noon to midnight (that is, call six twelve, and twelve six), the result is 6h. 27m., or on our hypothesis 27 minutes past noon! The proper way of treating the figures would be to show at how many places the tide is high during each hour, and the annexed table shows that it is utterly impossible to fix any mean time. If all Dr. Radcliffe's theories rest on such hollow proofs as this, they are certainly worthy of little attention.

Hour.	Table I.	Table II.
1[1]	3	0
2	3	3
3	4	2
4	9	2
5	1	3
6	4	3
7	7	1
8	5	1
9	0	7
10	2	2
11	2	6
12	2	2
No. of places	42	32

Chester, March 6 E. S.

[1] That is, 1.0 to 1.59 (morning or evening).

Fertilisation of the Grape Vine

THE season is favourable for an examination of the floral development of the vine, and I recommend an inspection of the flower of that plant to all who are curious. For my own part I shall be glad if any one who has remarked more than is obvious will tell us something about it, for the flower is certainly remarkable. On examination it is seen that each little knob, which at first sight seems to be the young grape, is, in fact, a little green *cap*, which, when lifted off, discloses a group of stamens closely surrounding the pistil. To all appearance this cap—which is all that represents the flower (in the common acceptation of the word)—must effectually prevent anything like cross-fertilisation. Apparently it becomes detached below and is thrown off as soon as the stamens, which continue to support it, lose their vitality, and not before. It is, indeed, not easy to conceive any other so simple an arrangement, by which, whatever of fertilisation is necessary, can be ensured being done at home. It seems as if by this arrangement every flower *must* fertilise, though there were not another within miles, and *cannot* be fertilised by any other but itself, though it be one among thousands.

Collingwood, March 14 J. HERSCHEL

EXPLORATION IN BORNEO

HERR CARL BOCK has successfully accomplished his journey across Borneo—from Koetei to Bandjermassing—arriving at the latter place on the last day of 1879. The journey was commenced on November 21, from Tangeroeng, the residence of the Sultan of Koetei, who promised to accompany Herr Bock, but did all in his power to dissuade him from going. From hence the route was up the Mahakkan River, to the village of Moara-Kaman, where the mosquitoes were so troublesome that a retreat was almost determined on. On the 24th the largest Malay village in the interior was reached—Kotta Bangoen, containing more than a thousand inhabitants. The whole of the lower part of the Mahakkan is occupied by the Malays, the Dyaks dwelling only on the smaller tributaries, or towards the source of the main river. In this neighbourhood there is abundance of rattang gutta, or edible birds' nests, and bees' wax, to obtain which the Malays go in parties of twenty or thirty into the forests for fear of the Dyaks. Owing to the great drought of last year in this district, the whole forest is leafless, a very unaccustomed sight in the tropics, and as a result the birds had all deserted it, or at least none were to be seen. At this village, as well as at

Tangaroeng and Moara Kaman, Herr Bock has found traces of a former Hindoo race, and a Dyak had lately dug up a beautifully formed bronze Hindoo goddess. From this point Herr Bock diverged from the Mahakkan, in order to visit the lake district and observe the Dyak inhabitants. He has made a number of sketches of these savages, many of whom are cannibals. The most dreaded tribe are the Tring Dyaks, whose chief, by name Sibau Mobang, Herr Bock summoned to meet him in the name of the Sultan. This man is most villanous in looks, and told our traveller that he frequently cut off the heads of either sex for the sake of eating the brain, which was sweet, as were also the palms of the hands, but the shoulder was bitter; and he presented him with his shield, covered all over with tufts of human hair. At the last village in the Malay part of his dominions, Moara Pahou, the Sultan summoned a large number of the Dyaks to accompany him and accumulated a body of some 600 in all, of whom 75 accompanied Herr Bock one or two days' journey in advance. The Dyak tribes are constantly at war with each other in order to obtain heads, and the Malays look down on them as savages, and by this means the terror of their name is increased. The upper part of the Moara Pahou branch of the Mahakkan is broken by rapids, over which the praus had to be dragged by rattang ropes. The last village on this river, Moara Anar, was reached on December 20, and then the march through the forest over the water-shed commenced. One of the advanced party was here killed, but no further loss was sustained. A Dyak road has been made through the forest with narrow bamboo bridges over the numerous small streams; these, however, were at the time mostly under water, owing to the recent floods. The journey on foot occupied four days of twelve hours, during two of which Herr Bock had to feed on the wild fruits, his provisions having been left behind. Perfect silence here reigns, broken only by the occasional note of a bird, though none are to be seen. No attempt at molestation appears to have been made by the more savage tribes of the Dyaks, although at one village the chief pressed his visitors to partake of rice and fruit, which they had been forewarned was poisoned, and therefore declined. The end of this march brought our traveller to the river Benangau, a tributary of the Tewé, down which he passed till he arrived on Dutch territory, where the Dyaks are altogether comparatively civilised, and very different to those of Koetei.

Very little that is new in zoology appears to have been obtained in this journey, which lay across a rather barren district; but Herr Bock has had splendid opportunities for making ethnological observations and these have been turned to good account. Many attempts were made to find the family which were said to have tails—but though several Dyaks were spoken to who had seen them, their whereabouts was not discovered.

The journey was undertaken at the desire of the Dutch government, who will doubtless take care that its successful accomplishment is duly honoured.

THE AUDIPHONE

THE instrument which is now being introduced into this country under the name of the audiphone, is the invention of Mr. R. G. Rhodes of Chicago. It is intended, as its name attempts to indicate, to provide the deaf with the means of hearing, and is for some persons undoubtedly a more efficient aid than the hearing-trumpet. The figures appended show the original form of the instrument, and the modification of it suggested by Prof. Colladon of Geneva. The American audiphone consists of a thin elastic plate or sheet of hard ebonite rubber, furnished with a handle, and about the size and shape of an ordinary palm-leaf fan. The strings attached to the upper edge serve to bend it into a curving form, and a small clamp fixes the string at the handle. When thus strained into shape, the instrument is pressed against the upper front teeth by the deaf operator, the convex side being turned outwards. The sounds received upon the thin sheet cause it to vibrate, and the vibrations are thus conveyed through the teeth and bones of the skull to the auditory nerves. Its use is therefore confined to the

FIG. 1.—Rhodes's Audiphone.

partially deaf, or at least to those in whom the auditory sense is not entirely absent, or the nerve atrophied.

The ebonite of which the audiphone is made being costly, Prof. Colladon has suggested a cheap and efficient substitute in the form of a strip of elastic cardboard of the peculiar kind known to the trade as satin-board or shalloon-board, and which may be described as a fine kind of yellow mill-board with a very smooth, glazed surface.

FIG. 2.—Colladon's Audiphone.

A sheet of this material, about eighteen inches long by ten broad, and varnished at the edge where it is placed in contact with the teeth, yields results quite equal, if not superior, to those afforded by the ebonite article of fifty times the cost. Prof. Colladon has made a number of experiments in conjunction with M. Louis Sager, upon the hearing of deaf-mutes Not all who tried the instrument could succeed in hearing with it, but all with whom the experiment was successful preferred the card audiphone to that of ebonite.

A number of deaf mutes under the care of M. Sager, were blindfolded and provided with audiphones; the distances from a grand piano, at which they began to hear the sounds, indicated their different degrees of deafness. They could distinguish at once between the high and the low notes of the instrument, and between its tones and those of a violoncello. The shrillest tones of the violin produced little effect. Similar experiments were made by M. Colladon in another establishment for deaf-mutes, near Geneva, under the care of M. Forestier.

Mr. Thomas Fletcher, of Warrington, has communicated to us a further improvement. After a long series of experiments he has found the best material of which the audiphone can be made is birch-wood veneer. If cut to an oval about 12 inches by 8½, and steamed and bent to a curve, it does not require the cords of the Rhodes' pattern, and is more convenient for use than Colladon's form. Mr. Fletcher states that a disk of half the above size suffices for a musician who may, in consequence of partial deafness, require such aid, and who cannot use a bearing trumpet on account of the inconvenience of holding it while playing his instrument. The disk of veneer is so light that it may be held between the teeth without effort and almost without consciousness of its presence. If stained black it is less visible.

THE ELASMOPODA (HJALMAR THÉEL) A NEW ORDER OF HOLOTHURIDEA

ALTHOUGH the Holothuridea show a greater tendency to a bilateral arrangement of their internal organs than any other group of the Echinodermata, most of them are fusiform or cylindrical in shape, and the radiate symmetry prevails so far externally that the five radial ambulacral vessels and their appendages are similar, that they run symmetrically at equal distances from one another from the oral to the apical pole, and that they are used indifferently for the purposes of progression. In all Holothuridea, however, two ambulacra, those of the *bivium*, are essentially dorsal, while the three ambulacra of the *trivium* are ventral; and in one little group of the ordinary Dendrochirota, which includes the well-known genus *Psolus*, a very distinct ambulatory tract is defined

FIG. 1.—*Elpidia glacialis*, Théel. Side view.

on the ventral surface of the body, and the pedicels of the rest of the ambulacral system are either absent or greatly modified. From the form of the ambulatory disk and the position of the mouth and apex, a *Cuvieria*, with its tentacles expanded, has a very striking resemblance to a large *Doris*.

In the year 1875 Dr. Hjalmar Théel, attached as naturalist to Nordenskjöld's expedition to the Yenisei, dredged in the western portion of the Kara Sea at a depth of 150 fathoms, fourteen specimens of a small Holothurian, which he was at first inclined to take for a nudibranchiate mollusc. *Elpidia glacialis*, Théel, is about 20 mm. long and 8 mm. broad. The anterior portion is abruptly contracted, so as to give the appearance of a head, and the mouth, surrounded by a ring of ten tentacles, simple with the exception of two terminal papillæ, is turned downwards. A transverse section of the body is semicircular, the dorsal surface being strongly arched, while the ventral (trivial) surface is flat, and forms an ambulatory disk. The skin, which has the usual structure of the skin in the Holothuridea, is strengthened by a thick layer of felted calcareous spicules of different forms, with delicate branches which project through the skin, roughening it slightly. Very sparsely scattered, just below the epidermis, there are a few large wheels much like those of *Myriotrochus*, and a large number of very minute wheels are found in the outer layers of the skin. *Elpidia* has eight very prominent partially retractile pedicels or water-feet, placed in two opposite rows of four, on the lateral ambulacra of the trivium, along the edges of the ventral disk. Radial vessels are developed in two ambulacra only, the vessels of the ambulacra of the bivium and the central ambulacrum of the trivium being entirely suppressed. The nervous system is radially symmetrical, five cords running back symmetrically from the oral nerve ring along the five ambulacral lines. Otocysts of peculiar structure are placed at intervals along the course of the nerves.

On the back there are two rows of paired foot-like appendages much in the position of the bivial ambulacra; the appendages of the anterior group bend forwards, and those of the posterior backwards. From the absence of the bivial water-vessels these appendages are not in connection with the water-vascular system; they receive twigs, however, from the radial nerves.

Elpidia is unisexual; the small genital opening is placed in the dorsal middle-lines about mid-way between the crown of tentacles and the anterior group of dorsal appendages; the so-called "respiratory tree" and the Cuvierian glands are absent.

Elpidia is very remarkable both in external form and in internal structure, and differs widely both from the typical Pedata and from the Apoda, in many respects taking an intermediate place between these groups.

Since the appearance of Dr. Théel's paper Messrs. Koren and Danielssen have described in the *Nyt Magazin for Naturvidenskaberne*, two new genera procured by the Norwegian North-Sea Expedition, whose close relation to *Elpidia* is manifest. The characters of these genera will be given in their place in the systematic list.

On looking over the Holothuridea of the *Challenger* Expedition, I at once recognised the resemblance of a large number of the deep-sea species to the form which Dr. Théel had worked out with much care and skill, and acting under the advice of my friend, Prof. Lovén, I asked Dr. Théel to be good enough to undertake the description of the *Challenger* material belonging to the class, Prof. Lovén kindly offering his advice and assistance. Dr. Théel was over last summer and examined the collection. He recognised over 200 species, half of which are new to science, and of these the greater number from the deep-sea are related to *Elpidia*. The group enlarged to such an extent, and presenting so many marked peculiarities quite revolutionised the *facies* of the Holothuridea, and asserted itself as an order of value equal at all events to that of the PEDATA and APODA. For this order Dr. Théel proposes the name ELASMOPODA

Dr. Théel selected all the forms belonging to the new order in the *Challenger* collection, and carried them with him to Sweden, and a few weeks ago he published, with the permission of the Treasury, in the *K. Sv. Vet.-Akad. Handl.*, Band 5, No. 19, the first part of a preliminary report on the Holothuridea of the *Challenger* Expedition, in which seven new genera and seventeen new species of Elasmopoda are defined.

The following are the genera established by Dr. Théel, and I add the definitions of the two others described by

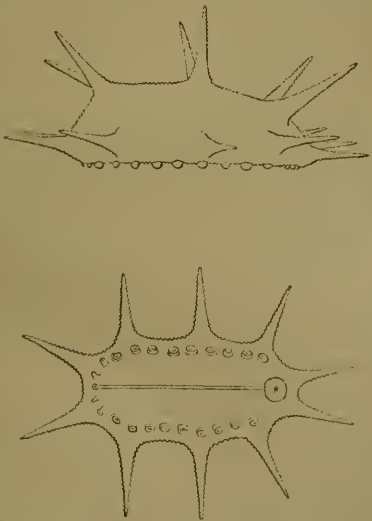
Koren and Danielssen to complete the sketch of the order according to our present knowledge.

Order : ELASMOPODA (ἐλαύνω, to move).

Body distinctly bilateral. Ambulacra well defined. The lateral ambulacra of the trivium bearing large, slightly retractile pedicels, disposed either in a single row, or sometimes in two rows, along each side of the ventral surface, and sometimes with another series of larger highly elongated not retractile processes placed externally and above the pedicels; pedicels of the two lateral ambulacra symmetrically arranged, being more or less distinctly opposed across the ventral surface. The odd ambulacrum naked or very seldom with a few rudimental pedicels. Bivium provided with very long not retractile processes, often disposed in one or more rows along each of its ambulacra and more or less distinctly opposed across the dorsal surface, or with only a few rudimental ones in its anterior part, or with a single very large one, resembling a broad, branched or unbranched lobe, and near to it some small papillæ. No respiratory trees. Integument naked, spiculous, or plated.

Deima, n.g., Figs. 2, 3 (δεῖμα, a fright).

Back highly convex; ventral surface flat. Mouth anterior, ventral; anus posterior, ventral. Tentacles small, perfectly retractile, about twenty (?). The lateral ambulacra of the trivium with large pedicels, slightly retractile at their ends alone, disposed in a single row all along each side of the ventral surface, and with another series of highly elongated, conical, rigid, not retractile



FIGS. 2, 3.—*Deima fastorum*, Théel. Lateral and ventral views.

processes, placed externally and above the pedicels all along each side of the body and directed straight outwards. The odd ambulacrum naked. Bivium with processes, resembling those of the trivium, disposed in a single row all along each of its ambulacra. Processes forming transverse rows, more or less distinct. Integument with crowded, irregularly rounded, perforated plates.

D. validum, n.sp. *D. fastorum.*

Oneirophanta, n.g., Fig. 4 (ὀνειρόφαντα, a vision).

Back highly convex; ventral surface flat. Mouth anterior, subventral; anus posterior, ventral. Tentacles twenty, large and retractile at their ends alone. The lateral ambulacra of the trivium with large pedicels, slightly retractile at their ends, disposed in a double row all along each side of the ventral surface, and with another series of highly elongated, conical, more or less flexible, not retractile processes, placed externally and above the pedicels all along each side of the body. The

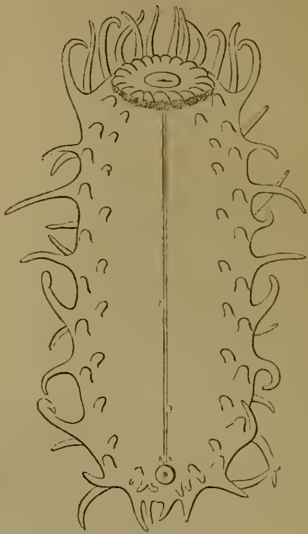


FIG. 4.—*Oneirophanta mutabilis*, Théel. Ventral surface.

odd ambulacrum, with a few more or less rudimental pedicels. Bivium with processes, resembling those of the trivium, disposed in a single row all along each of its ambulacra. Processes not forming transverse rows or very indistinct ones. Integument with crowded, irregularly rounded, perforated plates, often provided with minute processes.

O. mutabilis, n.sp.

Orphnurgus, n.g. (ὄρφνη, darkness).

Back convex; ventral surface almost flat. Mouth anterior, terminal, subventral; anus posterior, terminal, slightly dorsal. Tentacles twenty. The lateral ambulacra of the trivium with very large, not retractile pedicels, disposed in a single row all along each side of the ventral surface, and with another series of slender, very flexible, for the most part apparently retractile processes, placed above the pedicels all along each side of the body. The odd ambulacrum naked. Bivium with a crowded series of numerous processes, resembling those of the trivium, apparently disposed in two rows all along each of its ambulacra. Integument with spicula of various forms, but destitute of wheels.

O. asper, n.sp.

Cryodora, n.g. Fig. 5 (κρύος, cold).

Back highly convex; ventral surface almost flat. Mouth anterior, subventral; anus posterior, terminal, subdorsal. Tentacles fifteen. The lateral ambulacra of the trivium with large, slightly retractile pedicels, disposed in a single row all along each side of the ventral surface. The odd ambulacrum naked. Bivium with slender, flexible, not retractile processes, disposed in a single row all along

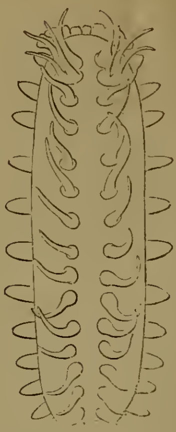


FIG. 5.—*Cryodora spongiosa*, Théel. Dorsal surface.

each of its ambulacra. Integument spongy without calcareous deposits.

C. spongiosa, n.sp.

Lætmogone n.g. (Fig. 6) (λαῖτμα, depths of the sea).

Back highly convex; ventral surface slightly so. Mouth anterior, terminal, subventral; anus posterior, terminal, slightly dorsal. Tentacles fifteen. The lateral ambulacra of the trivium with large, not retractile, only a little contractile pedicels, disposed in a single row all along each side of the ventral surface. The odd ambulacrum

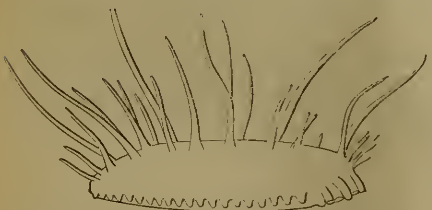


FIG. 6.—*Lætmogone wyville-thomsoni*, Théel. Side view.

naked. Bivium with highly elongated, flexible, cylindrical, not retractile processes, disposed in a single row all along each of its ambulacra. Integument with numerous wheel-shaped plates and other calcareous secretions.

L. wyville-thomsoni, n.sp.; *L. violacea*, n.sp.

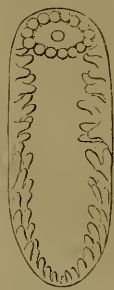
Ilyodæmon (Fig. 7), n.g. (ἰλύς, ooze, δαίμων, spirit).

Back highly convex; ventral surface nearly flat. Mouth anterior, almost ventral; anus posterior, terminal, subdorsal. Tentacles fifteen. The lateral ambulacra of the trivium with large, not retractile pedicels, apparently disposed in a double row all along each side of the ventral surface. The odd ambulacrum naked. Bivium with a crowded series of very numerous, completely retractile, slender, rather long processes, disposed in three or four irregular close-set rows all along each of its ambulacra. Integument with numerous wheel-shaped plates and dichotomously branched bodies.

I. maculatus, n.sp.

Achlyonice n.g. (Fig. 8) (ἀχλύς, darkness).

Back highly convex; ventral surface flat or almost concave. Mouth anterior, ventral; anus posterior, dorsal. Tentacles twelve. The lateral ambulacra of the trivium with more or less retractile pedicels, disposed in



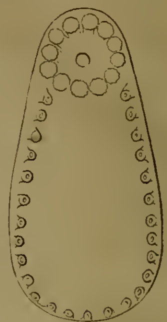


FIG. 7. FIG. 8.

FIG. 7.—*Ilyodæmon maculatus*, Théel. Ventral surface. FIG. 8.—*Achlyonice ecalcarea*, Théel. Ventral surface.

a single row all along each side of the ventral surface. The odd ambulacrum naked. Bivium with a few very soft and flexible processes in its anterior part alone. Integument thick, spongy, destitute of calcareous deposits.

A. ecalcarea, n.sp.

Elpidia, Théel (Fig. 9) (ἐλπίς, hope).

"Mémoire sur l'Elpidia," *K. Sv. Vet.-Akad. Handl.*, Bd. 14, No. 8, 1877.

Body ovate, more or less elongated, sometimes cylindrical. Mouth anterior, terminal, or subventral, anus posterior, terminal, subventral, or subdorsal. Tentacles ten. The lateral ambulacra of the trivium with large, slightly retractile pedicels, disposed in a single row along

FIG. 9.—*Elpidia globosa*, Théel. Side view.

each side of the ventral surface. The odd ambulacrum naked. Bivium with one or a few pairs of often very elongated, not retractile processes on each of its ambulacra, or with only a few more or less rudimental ones in its anterior part. Integument with spicula of various shapes.

E. glacialis, Théel. *E. mollis*, n.sp.
E. verrucosa, n.sp. *E. nana*, n.sp.
E. murrayi, n.sp. *E. papillosa*, n.sp. *E. elongata*, n.sp.

Irpa, K. and D. (Fig. 10) (from the Norse mythology).

Body nearly cylindrical, bilateral. Mouth nearly central, anal opening terminal. Ten short, thick, digitate tentacles. Along the sides of the body nine pairs of long stiff, non-retractile pedicels, and six round the posterior end of the body. On the back two rows of papillæ, and

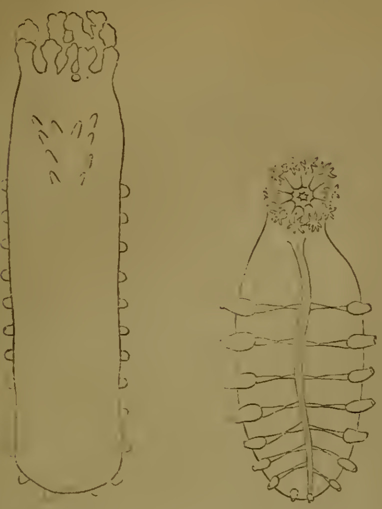


FIG. 10. FIG. 11.
FIG. 10.—*Irpa abyssicola*, K. and D. Dorsal surface. FIG. 11.—*Kolga hyalina*, K. and D. Ventral surface.

two standing separate between them. Calcareous spicules in the skin.

L. abyssicola, K. and D.

Kolga, K. and D. (Fig. 11) (from the Norse mythology).

Body bilateral; oral disk furnished with ten tentacles, turned towards the ventral surface. On the anterior portion of the back there is a prominent collar furnished with papillæ, and right in front of it two openings, a genital opening and the opening of the sand canal. Pedicels on both sides of the body and round the posterior end. Sexes separate. No "respiratory tree."

K. hyalina, K. and D.

These are all abyssal forms, eight of the seventeen species having been dredged from depths of more than 2,000 fathoms. They are very extravagant in shape—the names which Dr. Théel has given them shows that their appearance suggests such stuff as dreams are made on—and they are of large size, some over a foot in length.

One group is very gelatinous, and of a rich purple colour; others are gelatinous, grey, and semi-transparent; while another series, and among these the most fantastic of the whole, are yellowish and have a test crustaceous with a thick layer of calcareous plates, often running out into strangely shaped processes. A peculiar little group from the Antarctic Sea are little more than a gelatinous membrane, covering an enormously distended intestine, filled with diatom ooze. From the number of species and individuals which came up in our scattered and infrequent hauls of the trawl, the *Elasmopoda* must form quite a prominent feature of the abyssal fauna.

C. WYVILLE THOMSON

NOTES

A HIGH and well-deserved compliment has been paid to the United States Signal Service, of whose services to meteorology our readers are so well aware. The German Government recently addressed through the German Minister at Washington, a letter requesting to be exactly informed as to the processes by which the Signal Service Bureau so promptly collects at the War Department the meteorological reports from all parts of the United States—an extent of territory greater than Europe—and so rapidly drafts and publishes them upon the printed daily weather map. These maps are issued three hours after the records are read at the distant stations. When it is remembered that the request comes from a government noted for its skilled chartographers, and standing first in Europe, the value of the compliment will be appreciated. It is understood that the German Government proposes an advance in meteorological work. The information sought has been minutely prepared by the Chief Signal Officer, Gen. Myer, with the approval of the Secretary of War.

THE death is announced of Mr. Thomas Bell, F.R.S., F.L.S., &c., of the Wakes, Selborne, Hampshire, on Saturday, at the advanced age of eighty-seven. Mr. Bell had a large practice as a dentist, and his name was well known in the scientific world. He was for a long period Professor of Zoology in King's College, and his histories of "British Quadrupeds" and of "British Reptiles," though published more than forty years ago, are still much esteemed. When he was over eighty-four years old he brought out his edition of Gilbert White's "Natural History of Selborne." Mr Bell was Corresponding Member of several foreign scientific societies. About eighteen years ago he gave up practice and retired to The Wakes at Selborne, Gilbert White's house, which he purchased from the great-nieces of the naturalist. Here he collected every memorial he could find of White, and the house and grounds were ever open to the admirers of "The Selborne."

THE Paris Academy of Sciences has received information of the death of M. Zinin, the eminent chemist, of St. Petersburg. He was the discoverer of the production of aniline colours by hydro-carburets.

THE University of Königsberg lost towards the close of last month one of the oldest members of its professorial staff, in the person of Dr. Ludwig Moser, Professor of Physics. Long before photography had become a practical art, Dr. Moser had acquired considerable reputation by his systematic and successful experiments in this department. He was in his seventy-fifth year.

THE following epigram on Dr. Siemens's recent paper has been sent us as by "a well-known scientific man." It is entit'ed Electric Chlorophyll:—

"Quis veterum vidit plantas sine sole virentes
Germinat en semen Siementis lumine claro."

THE Ancient Monuments' Bill has been read a second time in the House of Lords and been referred to a Select Committee.

HER MAJESTY has been graciously pleased to command that the Agricultural College, Cirencester, be styled the "Royal Agricultural College."

M. MASCART, the head of the French Central Bureau of Meteorology, has sent out a circular to his several rural correspondents, with forms for the purpose of collecting information on a number of natural phenomena relating to animal and plant life.

IT appears that the Berlin Municipal Corporation has granted to Dr. W. Siemens the concession of one electrical railway which will connect Wedding-Platz with Belle Alliance-Platz. The rails will be supported by iron columns, which will not be an obstruction for the circulation of carriages and passengers in the streets. There will be no intermediate station between the two termini.

ENGELMANN of Leipzig announces the appearance in April of a new botanical serial, *Botanische Jahrbücher für systematik Pflanzengeschichte und Pflanzengeographie*, edited by Prof. A. Engler of Kiel. The journal will appear at intervals of from three to six months, in numbers of from four to six sheets. The first part will contain papers by Oswald Heer, Alph. de Candolle, E. Warming, O. Beccari, and Prof. Engler.

THE first ordinary meeting of the Epping Forest and County of Essex Naturalists' Field Club was held at the head-quarters, 3, St. John's Terrace, Buckhurst Hill, Essex, on February 28, the president, Mr. Raphael Meldola, F.R.A.S., F.C.S., &c., presiding. Nearly seventy Members were present. The minutes of the Foundation Meeting having been read and confirmed, the President proceeded to deliver an inaugural address on the objects and work of the club. He said their Society, in general terms, might be said to have for its scope the study of nature in the field. Although not quite two months old, it already numbered more than 160 original Members. It was unnecessary, he thought, for them to plead any excuse for their *raison d'être*, it only remained for them to show those who had so readily extended the hand of encouragement, by the future work of the Members, that the sympathy had not been given in vain. They now looked forward, he might add, with confidence to receiving from their Members substantial support in the way of contributions to their publications, exhibitions of specimens at their meetings, and the discussion of problems in natural science in that amicable spirit which was most conducive to the real advancement of knowledge. In forming a Society such as the Epping Forest Club, their primary object was, of course, the furthering of science; the annual addition of something, however humble, to the general stock of human knowledge. Their chief object—the advancement of natural science—would be best effected by the publication of *original papers*, notes, and discussions; but they must likewise bear in mind that science will also be indirectly promoted by mutual intercourse and instruction, and, above all, by fostering and educating the scientific faculty in their younger members. He impressed upon the members that their most useful work would first be the observation and recording of the phenomena of that district which they had fixed upon as the field for their studies. With this alone they had a large and pleasant task in hand. In the course of time, and as their society continued to increase—as it surely would if it only fulfilled the promises of its early youth—they should hope to establish permanent collections in a museum, and any contributions of specimens to form the nucleus of such a public collection would at any time be welcome. Mr. Meldola suggested that a "Museum Fund" be started for that purpose. He pointed out the obvious advantages of having in one building their collections, library and meeting room, and suggested that it would be best for the members to endeavour to furnish the museum as far as possible from specimens collected by themselves in the county. The secretary then read a paper communicated to the club by Mr. R. M. Christy, of Chignal, near Chelmsford, on the occurrence of the great bustard (*Otis tarda*, L.), and the rough-legged buzzard (*Buteo lagopus*), near Chelmsford, during the winter of 1879. The meeting then resolved itself into a *conversazione*.

PROF. BORLINETTO, of the University of Padua, suggested some time ago the employment of cardboard covered with a film of collodion in the construction of the electrophorus. The instrument yielded excellent results, the sparks obtained from it being sensibly longer than those derived from an ordinary electrophorus of resin and shellac of the same size. Collodion is an extremely electrical substance, and becomes negatively electrified when rubbed with all other known substances. An electrical paper was also employed by Schönbein in the construction of an electrical machine.

THE report of a committee of the Franklin Institute, which recently spent five days in examining the action of Irwin's steam injector and ejector, appears in the Journal for February. They consider Mr. Irwin has contributed a valuable improvement in injectors, increasing their power of augmentation to above twice that of the pressure of steam used for practical working without waste, and about four times with waste at the overflow. It seems to be a general law that the lower the steam employed, the higher could the proportional augmentation of pressure be carried. Among the peculiarities of Irwin's apparatus is that of the water-supply pipe and overflow being set at an angle of 45° to the axis of the instrument; also the permitting of free entrance of atmospheric air at and through the overflow; both of them, it is claimed, increasing materially the power of augmentation.

PROF. THURY, of Geneva, contributes to the *Archives des Sciences* (February 15) a curious paper on the time required to make a survey of the heavens with different magnifying powers of telescope. Such estimates, he points out, do not admit of great exactness, but nevertheless are of interest with regard to forming a plan of observation, and also with a view to answering the question: What are the chances that an object of determinate visibility, existing in the heavens, should have hitherto remained unperceived? and what chances are there of discovering new objects with an instrument of given power?

A MELBOURNE paper states that arrangements are being made there to work a copper mine near Dotswood, Queensland, where an extensive and rich lode of copper is known to exist. The ore is described as being of the richest kind known, viz., virgin copper and red oxide, and specimens examined have yielded 58·2 per cent. of copper and 5 dwt. of gold and 4 oz. of silver per ton of ore.

THE students of the Institution of Civil Engineers have been recently invited to take part in a series of supplemental meetings of members of their body to take place on the undermentioned dates, when the following papers will be read and discussed:—March 12—"Storage Reservoirs," by Walter Cradoc Davies, Stud. Inst. C.E. March 19—"The Manufacture of Bessemer Steel Rails," by Horace Allen, Stud. Inst. C.E.—April 2—"The Construction of Brick and Concrete Egg-shaped Sewers," by Ernest van Putten, Stud. Inst. C.E. April 9—"Small Motive Power," by H. S. Hele Shaw, Stud. Inst. C.E. April 16—"Railway Tyres and Tyre Fastenings," by Robert Read, Stud. Inst. C.E. The chair will be taken at seven o'clock on each evening, and successively by Mr. Giles, M.P., Mr. C. Wm. Siemens, F.R.S., Mr. R. Rawlinson, C.B., Dr. Pole, F.R.S., and Mr. Berkley, Members of Council.

A DEPLORABLE accident has taken place at the Grenoble Lycée. The professor of chemistry was lecturing on salts of mercury, and had by his side a glass full of a mercurial solution. In a moment of distraction he emptied it, believing he was drinking a glass of *eau sucrée*. The unfortunate lecturer died almost immediately.

MERCURY was seen at Paris on May 10 and 11 with the naked eye, owing to the transparency of the atmosphere and the great elongation of the planet. It had the brightness of a 1st class star, and was of a yellowish colour. The observation was made by MM. Henry brothers, at the Paris Observatory.

ETNA is again tranquil, its summit is once more covered with snow, and an ascent is contemplated, with a view to examine the alterations caused in the crater by the recent eruptions.

WE have received the first number of the *Bulletin* of the Algerian Scientific Association, the object of which is to popularise and develop scientific studies in Algeria, and to facilitate in every possible way the work of its members. This firs number contains some papers worthy of attention, among others, "A Critical Study of the Fevers of Algiers," by Dr. Angel Murraud; "Considerations on the Herbaceous Plants of the Summer Flora of Algiers," by M. J. A. Ballandito; and a lecture on "The General Phenomena of Reproduction among Vegetables," by M. F. Trabut.

THE post of *astronome titulaire* to the Paris Observatory having been declared vacant, the Minister of Public Instruction has decided upon following for the first time the prescriptions of an old decree of 1852, declaring that the Minister should only have the faculty to appoint one of the persons whose name should have been inscribed on either of two lists, written one by the Academy of Sciences and the other by the Astronomical Board of the Observatory. The list of the Board has been sent to the Minister with the name of M. Perrigault in the first line and Leveau in the second. The Section of Astronomy has submitted to the Academy a list containing Perrigault in the first line and Leveau and Perrotin in the second. The Academy will vote at its next sitting on these conclusions.

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseo-viridis*) from North-East Africa, presented by Mr. H. E. Laver; a Common Marmoset (*Hapale jacchus*) from South-East Brazil, presented by Madame Sparagnapane; a Persian Gazelle (*Gazella subgutturosa*) from Persia, presented by Mr. W. Dunt; a Golden Eagle (*Aquila chrysaëtos*), European, presented by the Viscount Hill; a Horrid Rattlesnake (*Crotalus horridus*) from Aracati, Brazil, presented by Mr. Karl J. Schmettan; a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, W.I., eight Golden Plovers (*Charadrius pluvialis*), European, purchased; four Wild Swine (*Sus scrofa*) born in the Gardens.

OUR ASTRONOMICAL COLUMN

MINOR PLANETS.—The circulars of the *Berliner astronomisches Jahrbuch* prove that Prof. Tietjen is using great exertion to keep pace in calculations with the rapid discoveries of small planets; the latest circular contains elements and an ephemeris of No. 212 detected at Pola on February 6. The actual number is now 214, the last having been discovered also by M. Palisa at Pola on March 1.

THE SOUTHERN COMET.—Approximate positions of the large comet first remarked in South Africa on February 1, deduced from observations at the Royal Observatory at the Cape on each evening from February 10-15 inclusive, were received from Mr. Gill by last mail. The right ascensions were given to minutes of time only, the corresponding north polar distances to minutes of arc, but the motion of the comet in R.A. being pretty rapid it has been possible to found elements upon the Cape places, which will afford an idea of the true orbit, and indeed which represent the observations on the six evenings as nearly as could be expected under the circumstances. The elements are as follow:—

Perihelion passage, 1880, January 26·4559 G.M.T.

	° ′
Longitude of the perihelion ...	255 47·2
,, ascending node ...	332 25 0
Inclination ...	46 38·6
Logarithm of the perihelion distance ...	8·59917

Heliocentric motion—retrograde.

This orbit represents the observed places with the following differences:—

	R.A.	N.P.D.
	′	′
February 10	0·0	0·0
11	− 4·7	+ 0·4
12	+ 1·6	+ 0·1
13	+ 2·4	+ 1·4
14	+ 10·7	+ 1·1
15	0·0	0·0

Calculating for 8h. 30m. mean time at the Cape Observatory we have the subjoined positions, during the period that the comet, so far at least as regards its lengthy train, appears to have attracted so much attention in the other hemisphere:—

	R.A.	N.P.D.	Distance from the Sun.	Distance from the Earth.	Intensity of light.
	° ′	° ′			
Jan. 30	314 3	113 40	0·237	0·768	30·3
Feb. 1	320 59	116 55	0·322	0·709	19·2
3	329 2	119 42	0·399	0·671	14·0
5	337 54	121 51	0·469	0·649	10·8
7	347 12	123 13	0·535	0·641	8·5
9	356 25	123 44	0·597	0·647	6·7

The above orbit will barely suffice to indicate the comet's actual positions within narrow limits; for March 19, at 8 P.M., the computed right ascension is 4h. 16m., and the north polar distance 104°, which places the comet above our horizon after sunset, but the intensity of light has diminished to 0·2, which, with the presence of the moon, seems to allow but little chance of observations.

With the elements we have given the comet would be north of the ecliptic less than two days, or from about January 25d. 20h. to 27d. 17h. Greenwich time. The orbit telegraphed from Brazil, apparently on the authority of a note of M. Liais's, differs very widely except in the perihelion distance.

GEOLOGICAL NOTES

GEOLOGICAL SURVEY OF SAXONY.—This well-appointed and well-led body of geologists continues to produce a series of excellent maps, which are issued as chromolithographed sheets, at the price of 2*s*. Each sheet is accompanied by an explanatory pamphlet, price 1*s*., in which the geological structure of the ground is made clear to the reader. The contents of the pamphlet are conspicuously printed on the back of the cover. Eight of these sheets and pamphlets have recently been issued, embracing the sections of Colditz, Leisnig, Döbeln, Penig, Waldheim, Burkhardtsdorf, Marienberg, and Elterlein. The area embraced by these publications includes large tracts of gneiss, schist, and other azoic rocks, which are described in great detail in the text. There can be no doubt that this thorough investigation of the Archæan rocks of Saxony will be of great service in future discussions regarding the age and genesis of the crystalline schists.

GEOLOGICAL SURVEY OF INDIA.—Mr. Medlicott, superintendent of this survey, has issued his Annual Report for 1879, from which we learn that in the Peninsular area there were five parties in the field during the past year, while in the extra-peninsular area there were two parties. The map accompanying the report shows that a large area of the Carnatic has been recently mapped and published, and that a wide tract is in progress between Hyderabad and the Bay of Bengal. The maps and reports of another large district in the lower part of the Indus Valley were last year published, as well as several detached areas in the Peshawur and Kashmir regions. The areas completed by some of the surveyors are of wide extent. Thus Mr. Feddes completed the survey of some 1,900 square miles in continuation of his previous season's work, besides making preliminary traverses of adjoining territory. This large piece of ground is almost wholly occupied by eruptive igneous rocks. Mr. Hacket, however, succeeded in adding more than 10,000 square miles to his previous survey of the Arvali region. This region is described as a wide waste of sand with only scattered outcrops of rock. Mr. Medlicott makes in his report an important statement as to the nature and conditions of publication in the office under his charge. He points out that were the issue of the work of his subordinates postponed until it could be thoroughly tested and brought up to the best standard of the time, it would often be indefinitely postponed. He states that such postponement, previous to his appointment, had been the rule, and he cites the case of the description of the Rájmahál hills as an example, this work having actually been delayed for fifteen years, though even at last it is in no important respect better than it would have been had it appeared at once. He considers that the chief duty of the Geological Survey is to the general public, which requires, first of all, an intelligible map and description of areas hitherto geologically unknown. He claims that the least finished work of the Survey fulfils that duty, however imperfectly, and that on the whole it is better, even at the risk of publishing crude material, to give the results forth to the world than to withhold them for an indefinite period until they can be completed and perfected. This immediate publication likewise removes any cause for discontent on the part of the officers whose labours might be withheld from the public, while at the same time the consciousness that their work will at once be exposed to criticism must naturally act as a stimulus to care and accuracy. Mr. Medlicott adds: "I see no compromise but the one I adopted, and to which I adhere. The risk it obviously implies—the exposure of faulty work—falls upon our own heads. The minor evils it involves are no greater than those it removes, and the smart of public criticism is more wholesome than the heart-burning of official suppression." His efforts at conciliation and usefulness, however, have landed him in another dilemma. Of course he is compelled to make corrections of the publications of the Survey; but the wielding of his editorial pen seems to be now and then resented by some over whose lucubrations it has been displayed. And thus the injured writers, proud of their flowery periods or of their inaccurate geology, rush off to newspaper editors and pour forth their complaints in angry letters! Would it not sometimes be the most fitting punishment to publish the lucubrations just as they are put into the superintendent's hands? One or two glaring cases of this kind would possibly cure the evil, unless the burning sun of India makes a geologist's hide thicker than is usual in our colder clime.

American Geological Surveys.—Though the various independent geological surveys under different departments of the United States administration were abolished by Act of Congress in June of last year, certain provision was made for the publication of their results. Among the corps embraced in the demolition was that which, under Capt. George Wheeler of the Engineers, had done much good work. From a document just issued, and forming part of the Annual Report of the Chief of Engineers for 1879, we learn that Capt. Wheeler's geologists stuck to their ground almost up to the very day when their appropriations expired. They took the field on May 20 of last year in Colorado and New Mexico, and after a month of hard work the party was disbanded on June 24, six days before the end of the financial year. Prof. J. J. Stevenson of New York, who has been in charge of the Engineer geological explorations in that area, has published a preliminary report in anticipation of the final memoir. It shows that he has accomplished much interesting detail, particularly in regard to the succession of the coal-bearing Laramie series. We trust that he will be able to give satisfactory sections of the Sangre de Christo range, particularly with reference to the structure and age of its metamorphic rocks. He alludes to them in this preliminary report as "archæan." In Hayden's Report of the United States Geological and Geographical Survey of the Territories for 1875 (p. 208) Dr. Endlich concludes that these rocks are metamorphosed Silurian strata; and in the Report of the same Survey for the previous year he presents a similar conclusion with regard to the granite of the San Juan country. Detailed and accurate information on the true stratigraphical relations of the so-called "archæan" rocks of the Rocky Mountains and western ranges of North America are much needed. While referring to American official geological publications we would point out the absolute necessity of reference to the labours of previous explorers. We could pick out not a few otherwise excellent reports which are disgraced by an utter obliviousness of the existence of any earlier writings on the areas described. Without warning or explanation new names are given to formations which had already been named and described. If the original names and descriptions are defective or inaccurate let that be stated. But in common fairness to fellow-labourers, not to speak of duty to the reading public, let us know distinctly whether we are perusing an account of ground that has never been described before, or whether we are merely getting a new rendering of facts already familiar to us. When the history of geological exploration in Colorado comes to be written how many different and rival expeditions will have to be enumerated, and in how many cases will it be found that they have recognised each other's existence!

Imperfection of the "Geological Record."—Geologists and those who take interest in the literature of Evolution will find some curious papers by Th. Fuchs in recent numbers of the *Verhandlungen* of the Geologische Reichsanstalt of Vienna—apparently the first of a series in which he proposes to demolish Darwinism by accurately compiled statistics. He contends that the assertion of the imperfection of the "Geological Record" rests for the most part on gross exaggeration of the facts. He holds that instead of being, as Darwin and his followers maintain, full of gaps, the record of the older faunas and floras of the earth is extraordinarily perfect. He contends that Palæontology as it now stands is able, with a properly directed criticism, to afford a perfectly satisfactory basis on which to discuss with confidence the biological questions involved in Darwinism. He points out that in such a discussion it is needful to keep clearly in view a twofold series of animal remains. 1. Those which on account of their fragility, habitat, or habits can only be exceptionally preserved, such as medusæ, ascidians, insects, birds, small mammals, and tender plants. 2. Those with enduring hard parts, which, in consequence of their habitat and habits, are necessarily, in the regular progress of sedimentation, inclosed in new formations, such as corals, echinoderms, molluscs, &c. Admitting the exceptional preservation of the first series as fossils, he maintains that the entombment of those of the second series, so far from being exceptional, is now, and always has been, part of the daily and necessary *régime* in the formation of sedimentary accumulations, and that in this way the geological record of the past is remarkably complete. To prove or illustrate this contention, he gives a few examples of the kind of "statistical data" on which he relies. For example, in an up-raised bed of marine clay near Messina about 100 species of organisms were found, nearly all still living in the adjoining sea, but including a few that were not known in the existing fauna. Further search of the sea-bottom, however, detected these forms also. "In this case, therefore," says Herr Fuchs, "the fauna of Messina Harbour was more completely known from the fossil than from the living fauna." Again the Tyrrhenian Sea has yielded 337 species of conchiferous shells; of these 300 are found in the quaternary deposits of Leghorn; therefore the fauna of that sea could be with great completeness made out from fossil forms! In a subsequent number of the same journal Herr R. Hoernes has shown the fallacy of this reasoning; but Herr Fuchs has evidently laid in his store of ammunition, and does not mean to be disturbed until he has fired it all off. He continues his broadside in the number of the *Verhandlungen* just received, where he has a paper "On some Fundamental Phenomena in the Geological Development of the Organic World."

GEOGRAPHICAL NOTES

According to the last news received from M. Prjevalsky, he reached, on September 12, the boundary of Southern Tsaïdam, and thus entered the great highway which leads from China to Tibet. Detailed information as to his journey of last year from Kami to Sha-jeu, appears now in the *Izvestia* of the Russian Geographical Society. Khami is at the extremity of the sandy steppe described as the Mouschoun Gobi; it is a desert, nearly quite deprived of vegetation. For fifty miles are seen only immense spaces of clay covered with gravel; the temperature at the beginning of June reached as high as 38° Cels., and the soil had sometimes a temperature of 68° Cels. Journeying must be done in the night. No large animals, except the antelope and the wild camel, which comes from the deserts of Lob-nor, were seen. M. Prjevalsky crossed this desert in a south-eastern direction for 232 miles, and reached the oasis of Sha-jeu, a very fertile one, being the best tract of Central Asia, after Kulja. A high ridge of mountains covered with snow, the Altyn-tagh of Lob-nor, here joins the Nian-shan of Koko-nor. Thus the question as to the junction of these two systems of mountains is solved definitely. M. Prjevalsky stayed for a month in Sha-jeu, seeking for guides to Tsaidam, and finally he found in the mountains three Mongols who agreed to serve as guides, so that he could reach Tsaïdam, going first south-west to Lake Serten and thence to Lake Koko-nor.

The last number of the Russian *Izvestia* contains an interesting paper, by M. Oshanin, on the upper parts of the Muk-su River, a tributary of Surkhab. These tracts were not previously visited, only one point in the valley of Muk-sou being known to Russian travellers, namely, the grave of Altyn-mazar, situated at the confluence of the Sel-su, Suk-su, and Kainda Rivers. Very high peaks inclose this deep valley, the bottom of which is no less than 8,000 feet above the sea-level. The Sandal peak, which is in the middle of the chain, reaches to no less a height than 25,000 feet, and two other peaks, Shelveli and Muz-jilga, are situated beside it. They are covered for two-thirds of their height with snow, and immense glaciers flow from their wide amphitheatres into the valley of Sel-su and of its tributaries. They form together a glacier which descends very low, its lower extremity, one and a half miles wide, being met with at a distance of fifteen miles from Altyn-mazar. The length of this glacier is not less than twenty to twenty-five miles, and it is fed with several other glaciers of very large size. The oscillations in its length have a great importance, as sometimes it advances so far into the valley as completely to bar up the valley of the affluent of Sel-su, the Baland-kiik; this last thence forms a wide base which afterwards cuts through a passage in the ice and inundates the main valley, destroying the forests; now the glacier is once more in advance, and has nearly barred up the valley of the Baland-kiik. M. Oshanin proposes to give to this glacier—probably the second or third in size in Central Asia—the name of "Fedtchenko-glacier." As to the vegetation of its neighbourhood, it is very poor, the bottom of the valley being covered only with brushes of *Tamaris* and *Atraphaxis*, whilst the lateral valley of the Baland-kiik, although far higher than that of Sel-su, is covered with rich forests and grass. The season was too late for affording opportunities to collect insects, but M. Oshanin observed immense quantities of the *Microplax interrupta*, Fieb., in the neighbourhood of Altyn-mazar. This *Oxycerenina*, which is characteristic of the southern parts of the paleoarctic region in Europe, reaches in Central Asia such heights as in the Alps and Pyrenees are occupied with representatives of the Arctic zone. After having uselessly attempted to penetrate further into the high regions at the sources of the Baland-kiik, M. Oshanin was compelled to return, having thrown but a glance on this region of glaciers.

Nordenskjöld has met with a warm reception at Lisbon. We have already spoken of the honour done him at Naples, and the honours which await him in France. Amsterdam has invited him, Copenhagen will intercept him on his way home, and in Sweden he will doubtless receive a worthy reception. What is our own Geographical Society to do? We hear of no preparations being made for the reception of one of the greatest and most modest of explorers. Wherever he has touched, Nordenskjöld has had honours showered upon him by the governments of the country; but we suppose it would be "bad form" in an English government to show anything like enthusiasm on behalf of science; though there is no saying, the Swedish explorer may, after all, become the fashion for a week.

At the meeting of the Geographical Society on Monday next, Mr. E. Hutchinson, the Lay Secretary of the Church Missionary Society, will read a paper on the ascent of the Binué branch of the Niger, by the missionary steamer *Henry Venn*, in August of last year, supplementing his account of this exploration by remarks on the systems of Rivers Shari and Binué.

We understand that the Free Church of Scotland have received from Mr. James Stewart, C.E., of Livingstonia, an account of his recent exploratory journey from the head of Lake Nya-sa, to the south end of Lake Tanganyika, where he arrived on the afternoon of November 5. Great interest will attach to this report, as we believe that for two-thirds of the way Mr. Stewart's route was considerably to the westward of Mr. Thomson's, and that he met with much less difficult country, and which had, in fact, a very gradual rise and descent. This, no doubt, will account for the erroneous statement first received by telegram from Mozambique, that Mr. Thomson had found the country level between the two lakes.

The principal original paper in the new number (85) of the *Zeitschrift* of the Berlin Geographical Society is the interesting journal of the late Dr. Erwin von Bary, kept during his journey from Tripoli to Ghât and Aïr. There is a fine new map of the Fagüm, by Dr. Schweinfurth, after the survey of Rousseau Bey, in 1871; Dr. Schweinfurth promises a paper discussing several points connected with the geography of the district. In No. 27 of the *Verhandlungen* Dr. Rohlfs furnishes an account of his recent journey to the Oasis of Kufra; a series of barometrical measurement of heights, of Col. Prjevalsky, in Central Asia, is given.

With the current number of *Les Missions Catholiques* is issued an interesting map of a portion of Eastern Equatorial Africa, which has been prepared by Père F. Charmetaut, who went to Africa to organise the first Algerian missionary expedition to the lake region. The features of the country between the coast and Lake Tanganyika are shown in considerable detail, and the routes followed by the Algerian missionaries to Ujiji and Lake Victoria are also laid down. Père Charmetaut bases his map to some extent on special information which he claimed to have obtained in Africa.

We regret to hear that Père Ruellan, who was a member of the second Algerian missionary expedition to East Central Africa, died at Tabora, on November 24, of typhoid fever. Before leaving for Zanzibar last summer, Père Ruellan, with one of his colleagues, was sent to Paris to the Natural History Museum, and the Montsouris Observatory, in order to take lessons in practical geography, astronomy, natural history, &c. Père Ruellan promised to be an energetic geographer, for on the journey to Mpwapwa his first thought on arriving in camp was always to determine the position of the locality, and he looked forward to being able to render useful service to the science of ethnography in Eastern Africa.

Dr. Matteucci, the well-known Italian traveller, who recently left Rome on a journey of exploration in Africa, in company with Prince Borghese, has arrived in Cairo, where he has had the good fortune to meet Mgr. Guillaume Massaja. From Mgr. Massaja's long practical knowledge of Abyssinia and the Galla country, Dr. Matteucci would, no doubt, obtain from him much valuable information respecting those regions, which Italian travellers are beginning to affect as their own particular field of exploration.

From the *Colonies and India* we learn that a scientific survey of the district of the Chaudière River, in Canada, is about to be made in search of the deposits of gold which are said to have been found on both banks of the river. The country is chiefly forest land, and some of the timber-getters there have met with nuggets of gold. The River Chaudière rises some 120 miles south of Quebec, and empties into the St. Lawrence, nearly opposite that city.

The January number of the *Boletin* of the Madrid Geographical Society is largely occupied with three *Memoirs*, accompanied by two excellent charts of the Passage Islands, in the West Indies, two of the *Memoirs* being devoted to the Island of Culebra.

ON THE BAROMETRIC SEE-SAW BETWEEN RUSSIA AND INDIA IN THE SUN-SPOT CYCLE

In his Report on the Meteorology of India in 1877, Mr. Eliot drew attention to the fact that throughout that year the pressure of the atmosphere, as shown by the barometric registers of all parts of India, was more or less in excess of the average; at some places absolutely without intermission (on the means of the several months), at other places with slight and comparatively insignificant interruptions. He also pointed out that this condition was not restricted to India, but appeared to have prevailed also in the distant regions of New South Wales and Victoria, where, however, the oscillations were greater and its continuity more interrupted.

In point of fact this condition of excessive pressure lasted not less than two years in the Indian region, having set in between May and August, 1876, and continued to between May and August, 1878, after which for many months the pressure was as persistently and strikingly below the average as it had exceeded it during the period in question. It included two years of serious failure of the rains, first in the Peninsular and afterwards in the Gangetic provinces. Further examination has shown that the condition of excessive pressure prevailed over not only the Indo-Malayan region and Eastern Australia, but also the greater part if not the whole of Asia, probably the whole of Australia and the South Indian Ocean (at least as far as the Mauritius), but in the extra-tropical regions of both hemispheres it was subject to considerable variations, which were but faintly reproduced in the tropics. As the result of an inquiry into the characteristic features of this widely extended atmospheric condition, pursued back into past years, I have been led to some preliminary conclusions which seem to me of much interest, not only in themselves, but also as opening up a field of research which may be profitably extended to other quarters of the globe. It may be stated at the outset that as regards the Indo-Malayan region, and perhaps also South-Eastern Asia generally, the excessive pressure of 1876-78 was in part the maximum phase of a cyclical oscillation; but that as regards Northern Asia, and probably also Australia, it was anomalous and apparently non-periodic, and even in the Indo-Malayan region, it was probably to a considerable extent of this character also.

With respect to the cyclical oscillation, which appears to conform to the sun-spot period, one or two facts have already been noticed in the pages of NATURE by Mr. F. Chambers (vol. xviii. p. 567), and Mr. Archibald [1] (vol. xx. p. 28); but those which I have now to bring forward will serve to give it greater precision, and a much more extended basis, and they serve also to throw some slight additional light on the nature of the agency by which the oscillation is effected, and which has, I think, been misapprehended by one if not both of the above writers. In the present communication I shall restrict myself to this subject, reserving the more abstruse question of the anomalous element for future discussion.

To begin with the most regular and uniform case of variation, that of an insular station situated almost on the equator. The barometric register of Singapore in lat. 2° (elevation 10 feet above sea-level) gives the following deviations from the several monthly averages since its commencement in 1869.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Mean	29·892	29·894	29·877	29·840	29·836	29·851	29·858	29·863	29·875	29·868	29·865	29·873
1869	—	—	—	—	-·012	-·025	-·020	-·015	-·009	-·015	-·009	-·037
1870	-·093	-·060	-·055	-·043	-·038	-·035	-·035	-·084	-·031	-·022	-·015	-·012
1871	?	?	?	?	?	?	+·004	-·007	-·022	-·024	-·025	+·007
1872	-·003	-·024	-·004	-·021	0	-·035	-·020	-·025	-·021	-·024	-·056	-·043
1873	-·041	-·029	-·025	-·014	-·030	-·024	-·018	-·015	-·008	-·015	+·019	-·003
1874	+·062	+·030	-·010	+·024	+·007	-·003	-·008	+·016	+·004	+·014	+·040	+·043
1875	-·003	-·001	+·025	+·012	+·010	+·015	+·013	+·028	+·028	+·014	+·049	+·023
1876	+·003	+·005	+·011	0	+·033	+·030	+·032	+·023	+·025	+·040	-·014	+·037
1877	+·060	-·043	+·026	+·029	+·020	+·049	+·045	+·054	+·040	+·049	+·036	-·003
1878	+·015	+·033	+·036	+·016	+·002	+·005	-·014	+·014	-·011	-·028	-·037	-·050

I must observe that in 1869 and 1870 the register was taken from the readings of a different barometer from that used subsequently, and no comparison has ever been made between them. There may thus be some small uneliminated error in the figures for these two years, but since both Batavia to the south and Port Blair to the north show a barometric depression in 1870 not less persistent and (in the case of Port Blair) almost as intense, this error can hardly be of importance. The registers of these two latter stations show the following differences. For that of Batavia, I am indebted to the kindness of Dr. Bergsma, who has communicated to me a proof sheet of his forthcoming volume. The values are in millimetres. The Port Blair table is drawn up from the registers in the Calcutta Meteorological Office, reduced to the Calcutta standard and the present elevation of the barometer at 61·16 feet above half-tide level.

BATAVIA (millimetres).

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Means	758·75	758·65	758·68	758·23	758·26	758·78	759·01	759·11	759·20	758·81	758·67	758·42
1866	+0·83	-0·40	+0·38	+0·29	-0·29	+0·34	-0·01	+0·13	-0·12	+0·08	-0·29	+0·59
1867	+1·10	-0·28	+0·79	+0·28	-0·32	-0·15	-0·18	-0·30	-0·52	-0·51	+1·04	+0·75
1868	-0·39	+0·32	+0·44	+0·74	+1·08	+0·76	+0·17	+0·37	+0·37	+0·50	+1·06	+0·52
1869	+1·33	+0·94	+0·15	+0·62	-0·02	-0·09	+0·19	+0·06	+0·32	+0·35	-0·16	-0·28
1870	-1·76	-0·79	-0·65	-0·76	-0·47	-0·45	-0·24	-0·84	-0·17	-0·16	-0·36	-0·19
1871	-0·94	-0·60	-0·17	+0·11	+0·11	-0·13	-0·05	-0·04	-0·25	-0·23	-0·65	+0·08
1872	-0·28	-0·37	-0·28	-0·51	+0·19	-0·78	-0·38	-0·54	-0·55	-0·39	-1·42	-0·94
1873	-0·93	-0·52	-0·54	-0·50	-0·75	-0·17	-0·14	-0·24	-0·14	-0·04	+0·47	+0·18
1874	+0·78	+0·34	-0·89	+0·09	-0·08	-0·43	-0·57	-0·23	-0·48	-0·31	-0·06	+0·13
1875	-0·92	-0·75	-0·31	-0·42	-0·05	-0·28	+0·11	-0·01	+0·11	-0·46	+0·26	-0·73
1876	-0·82	-0·32	-0·55	-0·93	+0·20	+0·02	+0·22	-0·08	+0·07	+0·40	+0·09	+0·83
1877	+1·35	+1·18	+0·71	+0·75	+0·40	+1·28	+1·43	+1·65	+1·38	+1·49	+0·83	+0·21
1878	+0·66	+1·28	+0·98	+0·29	-0·06	+0·15	-0·54	+0·05	-0·37	-0·73	-0·78	-1·18

PORT BLAIR (English inches).

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Means	—	—	—	—	—	—	—	—	—	—	—	—
1868	—	—	—	—	—	+·020	+·037	+·010	+·018	+·028	+·027	+·060
1869	+·079	+·035	+·002	+·012	+·007	-·022	-·009	0	-·007	-·014	+·014	-·022
1870	-·083	-·056	-·049	-·032	-·046	-·014	-·033	-·046	-·032	-·017	-·012	-·081
1871	-·043	-·022	?	?	?	?	+·007	+·014	-·011	-·009	+·007	+·013
1872	+·007	-·001	+·006	-·023	-·020	-·028	-·021	-·034	-·023	-·034	-·037	-·034
1873	-·032	-·031	-·014	-·012	+·007	-·039	-·032	-·011	-·011	-·022	+·023	+·020
1874	+·040	+·001	-·026	+·018	-·015	-·007	-·013	+·005	-·020	+·006	-·017	-·050
1875	-·008	-·039	-·019	-·037	+·020	+·007	-·009	-·001	-·001	-·006	?	+·025
1876	+·007	+·013	+·002	-·025	+·009	+·009	+·004	-·003	+·027	+·030	-·005	+·052
1877	+·082	+·045	+·039	+·055	+·035	+·046	+·048	+·035	+·076	+·081	+·051	+·028
1878	+·039	+·054	+·060	+·046	0	+·002	+·015	+·031	-·015	-·017	-·057	-·043

The registers of Colombo also (N. lat. 6° 56′) as far as they go, viz., since 1872, show a similar graduated variation, but those of the Mauritius, for which I am indebted to the kindness of Mr. Meldrum, differ considerably, and indicate a pressure below the average in 1867 and 1868, and above it in 1871. In 1876 and 1877, however, they agree with those of the other stations in showing an unusually high pressure. The following table shows the annual deviation of the mean pressure at each of the five stations since the commencement of the registers, all being reduced to English inches.

[1] Mr. Archibald mentions that the relation discussed was brought to his notice by Mr. S. A. Hill.

	Mauritius.	Batavia.	Singapore.	Colombo.	Port Blair.
Means	30·071	29·871	29·866	29·847	29·804
1861	–·038	—	—	—	—
1862	–·036	—	—	—	—
1863	–·023	—	—	—	—
1864	+·011	—	—	—	—
1865	+·002	—	—	—	—
1866	+·010	+·005	—	—	—
1867	–·004	+·006	—	—	—
1868	–·012	+·020	—	—	+·029
1869	+·013	+·011	–·018	—	+·006
1870	–·003	–·023	–·044	—	–·042
1871	+·034	–·009	–·011	—	–·006
1872	–·006	–·020	–·023	–·020	–·020
1873	+·008	–·010	–·017	–·005	–·013
1874	+·004	–·006	+·018	+·003	–·007
1875	+·005	–·011	+·018	–·004	–·006
1876	+·015	–·002	+·019	+·002	+·010
1877	+·026	+·042	+·037	+·037	+·052
1878	–·010	–·001	–·002	0	+·010

With the perhaps doubtful exception of the Mauritius, the general conformity of the oscillation shown by these stations to that of the last cycle of sun-spot frequency is sufficiently obvious, without resorting to any expedient for smoothing the minor variations; and it is to be noticed that the maximum pressure coincides approximately with the minimum of sun-spots and *vice versâ*. Other registers, such as those of Akyab and Chittagong on the Arakan coast, of Calcutta and Bombay (as Mr. F. Chambers has shown), and of Darjiling on the Himalaya exhibit a similar oscillation, but more overlaid with irregular variations apparently, the further we recede from the equator. The registers of Calcutta and Bombay reach back to 1853 and 1847 respectively, and thus comprehend three sun-spot minima, and in the latter case three maxima also. The annual deviation of pressure from the general average at each of these two stations is given in the second and third columns of the following table, and in the fourth and fifth columns the smoothed means obtained by substituting for that of each year the mean of three consecutive years. In the last column are given Wolf's sun-spot numbers up to 1875, taken from the revised table published in vol. xiii. of the *Memoirs* of the Royal Astronomical Society.

Year.	From observ.		Smoothed.		Wolf's numbers.
	Calcutta.	Bombay.	Calcutta.	Bombay.	
1847	—	–·012	—	—	97·4
1848	—	–·004	—	–·009	124·9
1849	—	–·011	—	–·005	95·4
1850	—	–·001	—	–·008	69·8
1851	—	–·013	—	–·006	63·2
1852	—	–·004	—	–·004	52·7
1853	–·013	+·005	—	–·001	38·5
1854	–·002	–·005	–·003	+·005	21·0
1855	+·005	+·015	0	+·002	7·7
1856	–·004	–·003	–·004	+·004	5·1
1857	–·013	–·001	–·007	0	22·9
1858	–·003	+·003	–·002	+·002	56·2
1859	+·009	+·003	–·004	0	90·3
1860	–·019	–·005	–·011	–·005	94·8
1861	–·023	–·012	–·020	–·014	77·7
1862	–·017	–·026	–·021	–·018	61·0
1863	–·024	–·017	–·010	–·003	45·4
1864	+·011	+·023	+·002	+·003	45·2
1865	+·018	+·002	+·011	+·013	31·4
1866	+·004	+·013	+·015	+·010	14·7
1867	+·022	+·015	+·016	+·018	8·8
1868	+·022	+·027	+·016	+·016	36·8
1869	+·005	+·005	+·005	+·007	78·6
1870	–·011	–·012	–·005	–·004	131·8
1871	–·008	–·004	–·005	–·010	113·8
1872	+·004	–·014	–·004	–·005	99·7
1873	–·008	+·002	0	–·004	67·7
1874	+·005	+·001	–·004	+·001	43·1
1875	–·008	0	–·004	+·003	18·9
1876	–·009	+·007	+·009	+·015	—
1877	+·044	+·037	+·015	+·011	—
1878	+·014	–·011	—	—	—

Both the Calcutta and Bombay registers exhibit oscillations of pressure coinciding approximately with those of the sun-spots, and more pronounced in the case of Bombay than in that of Calcutta.[1]

Hence it may be concluded that throughout the Indo-Malayan region there is a cyclical oscillation of atmospheric pressure approximately coinciding with that of the sun-spots, the maximum pressure coinciding with or immediately following the epoch of minimum frequency of sun-spots and the minimum pressure that of the sun-spot maximum. This oscillation is most distinctly and regularly developed at insular stations in the immediate neighbourhood of the equator.

The character of this coincidence is somewhat striking when considered in connection with that established by Köppen in the case of air temperature, and which I may observe has been confirmed by further experience. This is, that the air temperature of the tropics is greatest at the epoch of sun-spot minimum and *vice versâ*. In strict accordance herewith the unusual excess of pressure of 1876-78 coincided with an equally striking and persistent excess of temperature, throughout India and its dependencies. Taking the mean of all the deviations of regis-

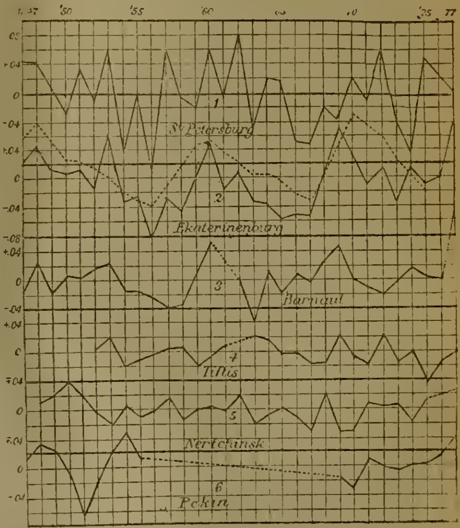


Fig. 1.

tered temperatures from the local averages at all the stations enumerated in the Indian Meteorological Reports for the four years 1875-78 (these averages, be it observed, being deduced from all the existing registers in the case of each station, and not those of the four years only), we have the following results:—

Year	1875	1876	1877	1878
Number of stations	72	72	74	74
Mean variation from from average ...	–0°·29	–0°·08	+0°·17	+0°·62
Differences		–0°·21	+0°·25	+0°·45

This apparent anomaly, the co-existence of excessive pressure with excessive temperature, is, however, in some measure explained, when the barometric registers of the Indian hill stations are compared with those of the plains. Of these former, Darjiling at 6,912 feet above sea-level has furnished the longest register (viz., for twelve years) and affords the best standard for

[1] A fact noticed in the Bengal Meteorological Report for 1868 points to the inference that the registers prior to 1866 are not perhaps quite so trustworthy on this point as those of Bombay. It is stated that in August, 1866, a crust of mercurous oxide was removed from the surface of the cistern, and inasmuch as this oxide is less dense than mercury (and the readings had always been taken from its surface) it is probable that a sensible error affected all such readings.

comparison. On the average of the whole period from May, 1876, to August, 1878, the atmospheric pressure at this level was relatively more excessive than on the plains of Lower Bengal, the mean excess being + 0·0375″ at Darjiling, and + 0·0298″ on the Bengal plains, which stretch away from the foot of the Sikkim Himalaya. Moreover it prevailed more steadily. From August, 1876, to August, 1878, or for twenty-five consecutive months, there was not one in which, at the hill station, the pressure did not exceed the average of the month; whereas on the plains it fell slightly below the average in November, 1876, and also in August and November, 1877. The registers of other hill stations (at least such as are trustworthy) extend over too short a period to furnish a good average; but, as far as their evidence goes, it is consistent with that of Darjiling; and we may therefore draw a second and very important conclusion, viz., *that the excessive pressure of the two years* 1876-1878 *in India was mainly, if not entirely due, to the condition of the higher strata of the atmosphere;* to that portion, at all events, which lies above 7,000 feet. This is very important, and while it explains the apparent anomaly above adverted to, and which in other cases has been emphatically insisted on by the late John Allan Broun, it points a useful caution against the too frequent habit of arguing from conditions of temperature (as observed at the earth's surface) as if the whole thickness of the atmosphere were affected in the like manner.

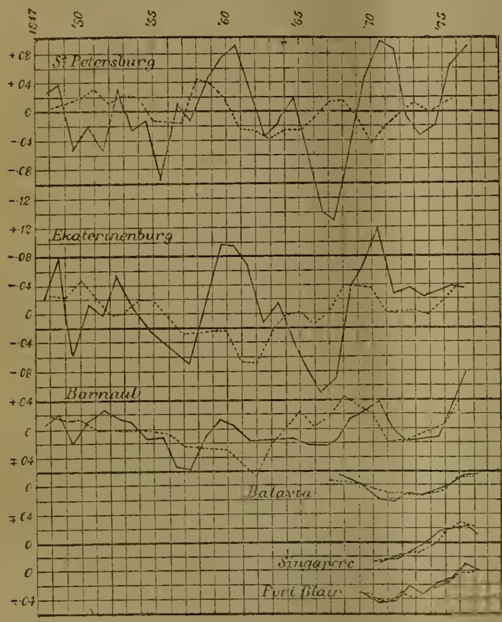


FIG. 2.

Leaving now, for the moment, the Indo-Malayan region, and turning to other parts of the Europe-Asiatic continent, we find in Western Siberia and European Russia, evidence of a cyclical oscillation of pressure, which is of the opposite character to that already noticed. Of all the stations which since 1847 have furnished the registers published in the *Annales de l'Observatoire Central de Russie*, Ekaterinenburg, at the eastern foot of the Ural, is that which exhibits this oscillation in its most salient and regular form. But it is more or less distinctly traceable in the registers of Bogolowsk and Slatoust also in the Ural; of Barnaul at the northern foot of the Altai, and with considerable intensity but much masked by irregular variations in those of St. Petersburg. Tiflis, however, to the south-west, and Nertchinsk and Pekin to the east, show no distinct trace of it. Indeed the somewhat interrupted registers of Pekin give a curve which in some respects rather conforms to the Indo-Malayan type. The accompanying figures 1 to 6 represent the curves of the annual deviation of the mean pressure at the above six stations, up to 1877, and over that of Ekaterinenburg I give a dotted curve showing the variation of the sun-spots. In point of amplitude the oscillation at Ekaterinenburg and St. Petersburg greatly exceeds that of the opposite type in the Indo-Malayan region, as indeed might be expected if these oscillations are reciprocally compensating, and the tropical type prevails over a larger area than the Siberian.

We are thus led to the further conclusion that *between Russia and Western Siberia on the one hand, and the Indo-Malayan region (perhaps including the Chinese region) on the other, there is a reciprocating and cyclical oscillation of atmospheric pressure; of such a character that the pressure is at a maximum in Western Siberia and Russia about the epoch of maximum sun-spots, and in the Indo-Malayan area at that of minimum sun-spots.*

In tabulating the variations of the barometric means of Ekaterinenburg month by month, I was much struck with the greater magnitude of the anomalous deviations of the winter as compared with those of the summer months; in other words with the apparent greater variability of pressure during the winter season. In order to verify this feature and to obtain a measure of the variability, I took the mean of the deviation values of each month for the whole series of (31) years, without regard to algebraical sign, and dividing by 2 obtained the results given in the first figure column of the following table. The registers of St. Petersburg, Barnaul, Greenwich, Adelaide, and Melbourne similarly treated gave the results shown in the five subsequent columns, and those of Calcutta and the Mauritius the figures of the two final columns.

	Ekaterinenburg.	St. Petersburg.	Barnaul.	Greenwich.	Adelaide.	Melbourne.	Calcutta.	Mauritius.
	31 years.	31 years.	31 years.	23 years.	3 years.	8 years.	26 years.	18 years.
January	±·070	±·089	±·045	±·093	±·024	±·028	±·015	±·017
February ...	·078	·086	·045	·058	·026	·016	·013	·027
March	·062	·060	·031	·075	·021	·014	·012	·020
April	·067	·057	·027	·052	·020	·025	·013	·011
May	·029	·031	·022	·034	·054	·036	·016	·013
June	·033	·029	·024	·043	·066	·049	·010	·016
July	·032	·026	·021	·028	·054	·046	·015	·015
August	·038	·037	·024	·032	·036	·034	·013	·011
September ...	·055	·046	·023	·052	·033	·043	·010	·009
October... ...	·048	·049	·029	·055	·033	·034	·014	·009
November ...	·071	·086	·039	·049	·031	·026	·014	·014
December ...	·096	·098	·047	·089	·016	·015	·010	·018

I am not aware whether the climatic features exhibited by this table have before been noticed, but they seem to have considerable significance. At Calcutta the variability of pressure is nearly the same at all seasons of the year, while at the Mauritius it depends apparently on the comparative frequency of cyclones; but at all the extra tropical stations it is from two to three times as great in the winter months as in the summer, and especially so in the two months December and January. Hence (excluding the case of the Mauritius) the less direct the action of the sun, the greater the vicissitudes of the atmospheric pressure.

The question now presents itself, "How far is that cyclical variation of pressure which conforms to the sun-spot period, dependent on the variation of the summer and winter pressures respectively?" It is obvious that the reply to this question must have a very important bearing in indicating the physical cause of the oscillations. If it be essentially a phenomenon of the summer months, we may be justified in regarding it as a possible effect of the more or less direct action of the sun on the continental land surface; but if it be solely or even mainly dependent on the winter variations, no such explanation is admissible. It must, then, rather be regarded as an effect produced under negative conditions to compensate an opposite effect which is due to the direct action of the sun elsewhere.

To ascertain this I have taken separately the means of the four months November to February, and May to August, for the stations St. Petersburg, Ekaterinenburg, and Barnaul, in each successive pair of years or year; and since the figures thus obtained showed irregularities which somewhat masked the periodical variation, I smoothed the original values by substituting the mean of three consecutive summers or winters for the original mean forming the middle term of the triad. I have also done the same for the tropical stations Singapore, Batavia, and Port Blair, and give the results in the following tables. The smoothed means are illustrated by the six pairs of curves in Fig. 2, the summer and winter curves being drawn to the same horizontal lines of reference, the former dotted, the latter continuous.

RUSSIAN STATIONS.

Year.	Summer means.			Smoothed summer means.			Winter means.			Smoothed winter means.			Year.
	St. Pet.	Ekat.	Barn.	St. Pet.	Ekat.	Barn.	St. Pet.	Ekat.	Barn.	St. Pet.	Ekat.	Barn.	
1847	+·036	+·063	+·014	—	—	—	+·228	+·219	+·078	+·025	+·020	+·005	1847-48
1848	-·033	-·032	+·008	+·006	+·025	+·017	-·144	-·088	-·033	+·037	+·076	+·021	1848-49
1849	+·016	+·045	+·030	+·011	+·024	+·011	+·063	+·097	+·020	-·053	-·052	-·023	1849-50
1850	+·049	+·058	-·004	+·017	+·047	+·013	-·130	-·166	-·054	-·019	+·012	+·012	1850-51
1851	-·015	+·039	+·012	+·030	+·024	-·001	-·010	+·106	+·070	-·057	-·003	+·026	1851-52
1852	+·055	-·025	-·012	+·010	-·005	-·001	-·031	+·051	+·062	+·028	+·050	+·013	1852-53
1853	-·009	-·030	-·004	+·022	+·002	-·006	+·125	-·008	-·093	-·026	+·007	+·088	1853-54
1854	+·019	+·061	-·002	+·019	+·020	-·001	-·172	-·021	+·055	-·012	-·020	-·013	1854-55
1855	+·047	+·030	+·004	-·011	+·019	-·004	+·012	-·032	-·014	-·088	-·039	-·012	1855-56
1856	-·098	-·033	-·015	-·014	-·008	-·009	-·104	-·065	-·090	+·013	+·051	-·053	1856-57
1857	+·008	-·020	-·017	-·017	-·030	-·023	+·131	-·057	-·054	-·014	-·068	-·057	1857-58
1858	+·038	-·038	-·037	+·045	-·028	-·028	-·068	-·082	-·028	+·044	+·002	-·010	1858-59
1859	+·088	-·027	-·031	+·036	-·025	-·031	+·070	+·146	+·051	+·072	+·097	+·014	1859-60
1860	-·019	-·010	-·026	+·014	-·025	-·032	+·214	+·226	+·032	+·092	+·093	+·006	1860-61
1861	-·026	-·039	-·040	-·026	-·067	-·052	-·007	-·092	-·058	+·028	+·063	-·014	1861-62
1862	-·033	-·152	-·091	-·029	-·068	-·068	-·123	+·055	-·030	-·037	-·013	-·014	1862-63
1863	-·029	-·013	-·073	-·039	-·032	-·025	+·019	-·002	+·031	-·017	+·015	-·013	1863-64
1864	-·055	+·068	+·088	-·027	-·002	+·003	+·052	-·007	-·054	+·020	-·025	-·012	1864-65
1865	+·002	-·061	-·006	-·027	+·004	+·026	-·011	-·067	-·026	-·060	-·076	-·023	1865-66
1866	-·028	+·004	-·005	-·011	-·018	+·004	-·221	-·154	-·012	-·134	-·110	-·024	1866-67
1867	-·008	+·004	+·022	+·011	+·003	+·014	-·170	-·110	-·059	-·149	-·092	-·016	1867-68
1868	+·069	0	+·025	+·016	+·040	+·043	-·057	-·013	+·005	-·050	+·039	+·015	1868-69
1869	-·014	+·117	+·081	-·003	+·038	+·036	+·076	+·239	+·114	+·043	+·068	+·024	1869-70
1870	-·063	-·002	+·003	-·046	+·035	+·022	+·109	-·022	-·024	+·098	+·122	+·040	1870-71
1871	-·061	-·009	-·017	-·021	0	-·017	+·108	+·148	+·072	+·084	+·029	-·001	1871-72
1872	+·062	+·011	-·038	-·004	+·003	-·017	+·035	-·040	-·045	-·004	+·036	-·013	1872-73
1873	-·013	+·006	+·003	+·010	+·005	-·013	-·156	-·001	-·065	-·029	+·024	-·015	1873-74
1874	-·019	-·002	-·003	-·001	-·004	-·001	+·035	+·113	+·065	-·017	+·029	-·010	1874-75
1875	+·030	-·015	-·004	+·015	+·015	+·004	+·070	-·025	-·030	+·063	+·039	+·030	1875-76
1876	+·033	+·061	+·019	+·022	+·042	+·036	+·085	+·030	+·056	+·093	+·044	+·081	1876-77
1877	+·002	+·080	+·094	—	—	—	—	—	—	—	—	—	—

INDO-MALAYAN STATIONS.

Year.	Summer means.			Smoothed summer means.			Winter means.			Smoothed winter means.			Year.
	Sing.	Bat.	P. Blair.	Sing.	Bat.	P. Blair.	Sing.	Bat.	P. Blair.	Sing.	Bat.	P. Blair.	
1866	—	0	—	—	—	—	—	-·011	—	—	—	—	1866-67
1867	—	-·010	—	—	+·005	—	—	+·017	—	—	+·015	—	1867-68
1868	—	+·024	+·022	—	+·005	—	—	+·038	+·050	—	+·008	—	1868-69
1869	·023	+·001	-·006	—	+·002	-·006	-·044	-·030	-·037	—	-·004	-·009	1869-70
1870	-·048	-·020	-·035	-·024	-·007	-·010	-·018	-·021	-·039	-·027	-·021	-·023	1870-71
1871	-·001	-·001	+·010	-·023	-·012	-·024	-·019	-·012	+·006	-·025	-·024	-·022	1871-72
1872	-·020	-·015	-·026	-·014	-·010	-·012	-·037	-·038	-·033	-·011	-·011	-·002	1872-73
1873	-·022	-·013	-·019	-·013	-·014	-·017	+·024	+·018	+·021	0	-·012	-·013	1873 74
1874	+·003	-·013	-·007	-·002	-·012	-·007	+·012	-·016	-·028	+·018	-·005	+·003	1874 75
1875	+·014	-·009	+·004	+·015	-·009	+·001	+·012	-·016	+·015	+·021	+·001	+·010	1875-76
1876	+·029	-·004	+·005	+·028	+·012	+·017	+·032	+·034	+·043	+·028	+·016	+·034	1876-77
1877	+·042	+·047	+·041	+·024	+·013	+·019	+·033	+·029	+·043	+·007	+·018	+·021	1877-78
1878	+·002	-·004	+·012	—	—	—	—	—	-·023	—	—	—	1878 79

In these tables and figures the true nature of the oscillation is sufficiently obvious. At Singapore, nearly on the equator, both seasons of the year show an oscillation of the same kind and nearly of the same amplitude. At the other intertropical stations, both north and south of the line, the difference, if any, is but small. It would appear, however, that both at Batavia and Port Blair, and also at Bombay (judging from the curves given by Mr. Chambers in his communication previously referred to), that the oscillation when the sun is in southern declination is slightly greater than that pertaining to the summer of the northern hemisphere. At the Russian stations, however, the oscillation of the opposite type is entirely restricted to the winter months, and is therefore far more pronounced in the winter curves in Fig. 2 than in the mean annual curves in Fig. 1. Hence it follows that the direct action of the sun on the tropical region is to produce an oscillation such that the pressure is lowest when the sun is most spotted, and it is as a compensation to this action that in the winter season an oscillation of the opposite character is set up on the plains of European and Asiatic Russia; possibly also in the Arctic regions, but this requires verification. Analogy would lead us to anticipate the existence of a similar oscillation in Antarctic latitudes when the sun is in northern declination, but perhaps less concentrated geographically owing to the absence of any dry continental land surface, corresponding to the Siberian and Russian plains. This point must remain for future inquiry.

While on the whole the Russian curves exhibit the oscillation so distinctly and strongly as to leave no room for doubt as to its reality, they show, nevertheless, that it is liable to great disturbances, which at times are so powerful as entirely to neutralise the effect. This will be very apparent if curves be drawn with the original values in the first three columns of the table above given for the winter months; but the most remarkable instance is that afforded by the winter of the year 1877 (at least of the first two months, for I have not yet received the volume of the Russian *Annales* for 1878). The mean pressure of December, 1877, at stations in Western Siberia, exceeded any on record during the whole period of thirty-one years comprehended in the registers before me; and it is not a little remarkable that in the previous July (the mid-winter of the southern hemisphere) an equally excessive, and (in the eight years for which I have registers) unprecedented pressure characterised South-eastern Australia. These accumulations of pressure were, doubtless, intimately connected with the similar phenomenon which characterised the intervening Indo-Malayan region in 1876–78, but the attendant circumstances are as yet by no means fully worked out.

With respect to the nature of the physical causes which produce that alternating oscillation of pressure between the Indo-Malayan region and the Russian plains, which conforms to the sun-spot cycle, our knowledge is still far too imperfect to allow of my attempting any exhaustive analysis. It may, however, be not wholly uninstructive to recapitulate some of the results of recent inquiry which bear upon this point, even admitting, as we must do, that in certain respects they require further verification. Such as they are, they indicate a possible explanation, which I will set forth as briefly as possible.

Among the best established variations in terrestrial meteorology which conform to the sun-spot cycle, are those of tropical cyclones and the general rainfall of the globe, both of which imply a corresponding variation in evaporation and the condensation of vapour. Now the variation of pressure with which we have to deal evidently has its seat in the higher (probably the cloud-forming) strata of the atmosphere. This is not only illustrated in the present instance by the observed relative excess of pressure at the hill stations as compared with the plains, but also follows as a general law from the fact established by Gautier and Köppen, viz., that the temperature of the lowest stratum varies in a manner antagonistic to the observed variation of pressure. It is then a reasonable inference that the principal agency in producing the observed reduction of pressure at the epoch of sun-spot maximum is the more copious production and ascent of vapour, which may operate in three different ways. First, by displacing air the density of which is $\frac{8}{5}$ths greater; second, by evolving latent heat in its condensation; and thirdly, by causing ascending currents, and thus reducing dynamically the pressure of the atmosphere as a whole. The first and second of these processes do not indeed directly reduce the pressure, but only the density of the air stratum, while they increase its volume. In order, therefore, that the observed effect may follow, a portion of the higher atmosphere must be removed, and this will necessarily flow away to regions where the production of vapour is at a minimum, viz., the polar and cooler portion of the temperate zones, and more especially those where a cold dry land surface radiates rapidly under a winter sky. Such an expanse is the great northern plain of European Russia and Western Siberia north of the Altai.

H. F. BLANFORD

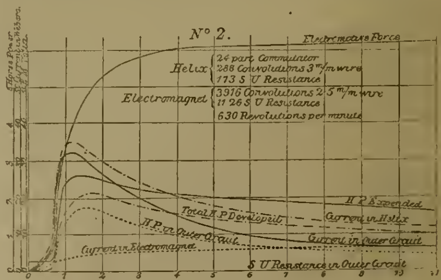
SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 4.—"On the Dynamo-Electric Current and on certain Means to improve its Steadiness." By C. William Siemens, D.C.L., F.R.S.

The author, after alluding to the early conception by Dr. Werner Siemens, of the dynamo-electric or accumulative principle of generating currents, makes reference to the two papers on the subject presented, the one by Sir Charles Wheatstone and the other by himself, to the Royal Society in February, 1867. The machine then designed by him, and shown in operation on that occasion, is again brought forward with a view of indicating the

progress that has since taken place in the construction of dynamo-electrical machines, particularly those by Gramme and Siemens von Alteneck. The paper next points out certain drawbacks to the use of these machines, both of them being subject to the disadvantage that an increase of external resistance causes a falling off of the current; and that, on the other hand, the short circuiting of the outer resistance, through contact between the carbon electrodes of an electric lamp, very much increases the electric excitement of the machine, and the power necessary to maintain its motion, giving rise to rapid heating and destructive sparks in the machine itself.



An observation in Sir Charles Wheatstone's paper is referred to, pointing to the fact that a powerful current is set up in the shunt circuit of a dynamo-electric machine, which circumstance has since been taken advantage of to some extent by Mr. Ladd and Mr. Brush, in constructing current generators.

The principal object of the paper is to establish the conditions under which dynamo-electric machines worked on the shunt principle can be made to give maximum results. A series of tables and diagrams are given, the results of experiments conducted by Mr. Lauckert, electrician, employed at the author's works, which lead up to the conclusion that, in constructing such machines on the shunt principle, the resistance on the rotating helix has to be considerably reduced by increasing the thickness of the wire employed, and that on the magnets has to be increased more than tenfold, not by the employment of thin wire, but by augmenting the length and weight of coil wire employed. We reproduce two of these diagrams, No. 1 referring to the old form of winding and No. 2 to the new.

The results of this mode of distributing the resistances is summarised as follows:—

1. That the electromotive force, instead of diminishing with increased resistance, increases at first rapidly, and then more slowly towards an asymptote.

2. That the current in the outer circuit is actually greater for a unit and a half resistance than for one unit.

3. With an external resistance of one unit, which is about equivalent to an electric arc, when thirty or forty webers are passing through it, 2·44 horse-power is expended, of which 1·29 horse-power is usefully employed, proving an efficiency of 53 per cent., as compared with 45 per cent. in the case of the ordinary dynamo machine.

4. That the maximum energy which can be demanded from the engine is 2·6 horse-power, so that but a small margin of power is needed to suffice for the greatest possible requirement.

5. That the maximum energy which can be injuriously transferred into heat in the machine itself is 1·3 horse-power, so that there is no fear here of destroying the insulation of the helix by excessive heating.

6. That the maximum current is approximately that which would be habitually used, and which the commutator and collecting brushes are quite capable of transmitting.

Hence the author concludes that the new machine will give a steadier light than the old one with greater average economy of power, that it will be less liable to derangement, and may be driven without variation of speed by a smaller engine; also that the new machine is free from all objection when used for the purpose of electro-deposition.

This construction of machine enables the author to effect an important simplification of the regulator to work electric lamps, enabling him to dispense with all wheel and clockwork in the arrangement. The two carbons being pushed onward by gravity or spring power, are checked laterally by a pointed metallic abutment situated at such a distance from the arc itself, that the heat is only just sufficient to cause the gradual wasting away of the carbon in contact with atmospheric air. The carbon holders are connected to the iron core of a solenoid coil, of a resistance equal to about fifty times that of the arc, the ends of which coil are connected to the two electrodes respectively. The weight of the core (which may be varied), determines the force of current that has to pass through the regulating coil in order to keep the weight in suspension, and this in its turn is dependent upon the resistance of the arc. The result is that the length of the arc is regulated automatically, so as to maintain a uniform resistance signifying a uniform development of light.

Linnean Society, March 4.—Prof. Allman, F.R.S., president, in the chair.—Mr. Middleton exhibited two skulls of *Babirussa alfurus*, Less., from Borneo, which though quite adult, were both distinguished by unusual smallness of their tusks.—Dr. A. Günther brought forward two deep-sea fishes obtained during the *Challenger* expedition (*Echiodon* and *Scopelus*) to illustrate two kinds of metameric organs, first described by Dr. Ussow, which he described and designated as the *lenticular* and *glandular* kind. Whilst admitting the great morphological resemblance of the former to an eye, he (Dr. Günther) gave reasons which induce him to dissent from the view that they are organs of vision. He showed that their structure is not opposed to the view that they, like the glandular kind, are producers of light, and that probably this production of light or luminosity is subject to the will of the fish.—Mr. J. Jenner Weir, on behalf of Mr. Edw. A. Nevill, showed the stuffed head of a Prongbuck (*Antilocapra americana*), shot by the latter in the Rocky Mountains, August, 1876. On the median nasal region of this specimen, what appeared to be a short unbranched third horn was developed. On discussion of the abnormality, it was suggested it might rather be an elongated warty growth than a true horn, after the type of the rear ones. A further careful examination into its structural conditions was recommended.—Mr. E. Morell Holmes read a paper on *Codiolum gregarium*, A. Braun, a new British alga discovered at Teignmouth by the Rev. R. Cresswell. The author considers that the hypnospores described by Braun do not belong to *Codiolum*, but to another alga, usually found growing with it. The growth of the plant and its fructification, contrary to Braun's supposition, last through the winter and spring. Mr. Holmes also exhibited specimens of the fructification of *Chætopteris plumosa* found in Britain for the first time by G. W. Traill, of Edinburgh. The unilocular sporangia in this instance were in a more advanced stage than those figured by Areschoug, and the multilocular sporangia differed in character from the illustration given by the last-mentioned Swedish naturalist.—Dr. Francis Day briefly recounted the peculiarities and descanted on the geographical distribution of a specimen of the Hebridal Argentine caught near the island of Skye, October, 1879. This fish has very rarely hitherto been got in the British waters. It is more often met with on the Norway coast, but its range extends southwards as far as the Mediterranean. It is supposed to frequent great depths and not to enter fresh water. A fish has been obtained in New Zealand, *Argentina decagon*, which seemingly quite corresponds with the foregoing, and it will be interesting hereafter, on further examination, to ascertain if they really are identical.—The following gentlemen were elected Fellows of the Society:—Messrs. S. M. Bairstow, J. T. Carrington, R. M. Middleton, S. O. Ridley, T. Charters-White, and Prof. P. Martin Duncan.

Mathematical Society, March 11.—C. W. Merrifield, F.R.S., president, in the chair.—Mr. W. J. Curran Sharp was admitted into the Society, and the following gentlemen elected Members: —Mr. C. S. Peirce, Johns Hopkins University, Baltimore, Mr. Emory McClintock, Milwaukie, Illinois, Prof. Seitz, Kirksville, Missouri, and Mr. E. Temperley, M.A.—The following communications were made to the Society:—Notes on a general method of solving partial differential equations of the first order with several dependent variables, by Mr. Tanner.—Note on the integral solution of $x^2 - 2Py^2 = -z^2$ or $\pm 2z^2$ in certain cases, by Mr. S. Roberts, F.R.S.—Notes (1) on a geometrical form of Landen's theorem with regard to a hyperbolic arc; (2) on a class of closed ovals whose arcs possess the same property as two Fagnanian arcs of an ellipse, by Mr. J. Griffiths.

Anthropological Institute, March 9.—Francis Galton, F.R.S., vice-president, in the chair.—The election of Mr. George Morrison as a new member was announced.—Mr. Francis Galton described the curious psychological fact of Visualised Numerals, on which he wrote a preliminary memoir in NATURE, vol. xxi. p. 252. This paper we hope to publish in our next number.

DUBLIN

Royal Dublin Society, January 19.—Physical and Experimental Science Section.—Howard Grubb, M.E., in the chair.—Note on the conductivity of tourmaline, by G. F. Fitzgerald, F.T.C.D. The author pointed out that though tourmaline did not possess unilateral conductivity for currents of uniform intensity, it might for currents of variable intensity, and that the latter was the true analogue of its unilateral heat conductivity.—Note on the construction of guard-ring electrometers, by G. F. Fitzgerald, F.T.C.D. In this paper the author shows the importance of having both the trap-door and guard-ring constructed of the same metal in order to insure a uniform distribution of electricity. —On the theory of the loud-speaking telephone, by Prof. W. F. Barrett. The author expressed his doubts as to the accuracy of the received theory which attributes the diminution of friction that occurs on the passage of a current to electrolytic action, a film of gas being thereby produced, and hence a reduction of the normal "friction" between the chalk cylinder and the platinum faced arm which vibrates the diaphragm. One objection to this theory is the enormous rapidity of the changes that must occur and the difficulty of conceiving how the film of gas is to be got rid of, even if produced in an infinitesimal portion of time. Moreover, the author showed that even when the chalk was dry, in the ordinary acceptation of the word, the action still took place, excellent speaking being obtained from a cylinder that had been exposed for a month to a highly heated room and not once touched with water since it had been in the author's possession; doubtless if the chalk were strongly heated, its insulation would be too great and the current would not pass. The tendency of a closed electric current is to enlarge itself, and it might be to this cause the phenomenon was due. But the electrodynamic action of the current should occur equally well between a metal cylinder bearing on the metal arm; the author had therefore replaced the chalk cylinder by a polished brass cylinder, and employing a microphone transmitter at the other end of the line, the ticking of a watch was perfectly well heard as soon as the brass cylinder was rotated. Whistling, too, was imperfectly heard, but not conversation. Here no electrolytic action could occur, and, therefore, the self-repulsion of a current on itself or other electro-dynamic action was shown to be a *vera causa*. The repulsive action of a current in passing from one conductor to another, described by Gore, and usually attributed to the production of heat and local expansion at the points of contact was another possible cause. But the author questioned the ordinary explanation of Gore's experiment, and conceived it probable that both it and the variations of friction in the Edison telephone receiver might be due to a common cause in both the currents passed from a bad conductor to a good one, and it was the opinion of the late Principal Forbes, formed after much research and careful inquiry, that a peculiar repulsive force was called into play when both electricity and heat were transmitted from a bad conductor to a good one. From any point of view the subject was one worthy of further investigation, which the author hoped to give to it. In conclusion, the author described an arrangement whereby he had adapted the magneto-telephone to the revolving cylinder in the Edison receiver, so that instead of having to do the entire work of vibrating the diaphragm, as in the Bell receiver, the magnetic action of the current simply varied the friction on the cylinder, and so varied the nature of the oscillations of the diaphragm, which were set up by mechanical means. But as much success was not obtained as was anticipated, nor did the combination in one instrument of the chalk cylinder and the magnetic action give good results, the variations in friction being probably not synchronous, from the direction of impulse not being always in the same way.—Natural Science Section.—G. Johnstone Stoney, F.R.S., in the chair.—On an application of Prof. Rossetti's newly discovered law of cooling to the question of radiation of heat from the earth, and to problems of geological climate and time, by Rev. Dr. Haughton, F.R.S.—Dr. Frazer exhibited a specimen of *Bopyrus squillarum*, parasitic on *Palæmon serratus*, from the west coast of Ireland, also an antler of red deer obtained from the Dodder bar in the River Liffey.

PARIS

Academy of Sciences, March 8.—M. Wurtz in the chair.—The mayor of Chatillon-sur-Long (Loiret), the birthplace of A. C. Becquerel, announced the opening of a public subscription for erection of a statue to Becquerel there, and the Academy willingly entered into co-operation.—On some applications of elliptic functions, by M. Hermite.—On the compensation of temperatures in chronometers, by M. Phillips. This relates chiefly to the perturbation known as the secondary error of compensation.—Chemical stability of matter in sonorous vibration, by M. Berthelot. He operated in two ways—(1) Placing substances in a vessel (of 250 cc. capacity) attached to one branch of a large horizontal tuning-fork vibrated electrically (about 100 simple vibrations per second), the other branch having an equivalent weight; (2) inclosing them in a large horizontal sealed tube, which was longitudinally vibrated by means of friction of a horizontal wheel with moistened felt, and gave 7,200 vibrations per second. The substances tried were ozone, arsenetted hydrogen, sulphuric acid in presence of ethylene, oxygenated water, and persulphuric acid. There was no decomposition, apparently, in any case.—New remarks on the heat of formation of gaseous hydrate of chloral, by M. Berthelot. He points out what he thinks the causes of M. Wurtz's non-success.—On the meeting of the two advance galleries of the great St. Gothard tunnel, by M. Colladon. This gives various interesting details. *Inter alia*, the volume of infiltrations in the south gallery attained 230 litres per second. M. Colladon's compressors at the two ends of the tunnel, sufficed throughout for ventilation, and the costly aspirating vessels required by M. Helwagg were not used. The difference of level at meeting was not over 0·10 m.; the lateral deviation less than 0·20 m. The total length measured in the tunnel was nearly 8 m. less than that calculated geometrically.—On the project of the inter-oceanic maritime canal; letter from M. de Lesseps. He gives a directive memorandum addressed to the members of the Technical Commission (which has been organised in eight brigades, each having its special work). The health of the party is reported excellent.—The President announced with regret the death of M. Zinin, at St. Petersburg, Correspondent in Chemistry.—Investigation of the coefficient of regularity of motion in transmissions by cables, by M. Leauté.—Function of velocities; extension of the theorems of Lagrange to the case of an imperfect fluid, by M. Bresse.—Syrphi and Entomophthoreæ, by M. Giard.—Memoir on the means applicable to destruction of phylloxera, by Dr. Hamm. He advises applying, about the roots, sulphide of carbon with infusorial earth or Peru guano as an absorbent; more of the sulphide can be thus applied without injuring the roots, and the evaporation is very slight. He also points out a line of experimental inquiry to find a pathogenic champignon which would be fatal to phylloxera.—On the toxical influence of the mycelium of vine-roots on phylloxera, by M. Rommier. Where a mycelium with long white filaments was developed on phylloxerised roots kept in a vessel at 15° to 20° temperature, the phylloxera disappeared, whereas it multiplied in the contrary case.—M. Pasteur spoke in favour of seeking a parasite wherewith to destroy phylloxera—as it would have been easy to destroy the silkworm race by means of the corpuscular parasite of pebrine. M. Blanchard, however, dissented; remarking on the limited extent of parasite-ravages on a given species in nature; also on the domesticity of the silkworm as contrasted with the wild independence of phylloxera. M. Pasteur replied, showing the possibilities of experimental multiplication of parasites.—Ephemerides of planet (103) Héra for the opposition of 1880, by M. Callandreau.—Laws concerning the distribution of stars of the solar system, by M. Gaussin. The distances of the planets from the sun and those of the satellites from their planet are in geometrical progression $a = a k^n$.—On the formulæ of quadrature with equal coefficients, by M. Radau.—On systems formed of linear equations with a single independent variable, by M. Darboux.—Demonstration of a theorem of Prof. Sylvester on the divisors of a cyclotomic function, by M. Pepin.—Comparison between curves of tensions of saturated vapours, by M. de Mondesir. The method described furnishes an instrument of singular power for control of the results of experiments.—Action of electrolysis on turpentine, by M. Renard. Among other results the product monohydrate of turpentine is regarded as a pseudo-alcohol, $C_{10}H_{16}H(OH)$.—On the synthesis of aromatic aldehydes; essence of cumin, by M. Etard.—On lesions of the kidney in slow poisoning by cantharidine, by M. Cornil.—On apparent death resulting from asphyxia, by M. Fort. Artificial respiration should be perseveringly practised for a number of hours (not yet determined) after apparent death.—On modifications produced in the system by albuminoid substances injected into the vessels (third series: insoluble ferments), by MM. Béchamp and Baltus. Pancreatine works grave disorder, and causes death where the proportion of it injected reaches about 0·15 gr. per kilogramme of the animal's weight. The substance is only partly eliminated by the urine, and then appears with all its characters.—On two new silicates of alumina and of lithia, by M. Hautefeuille.—On the phosphates and borophosphates of magnesia and lime from the guano deposit of Méjillones (lat. 23° to 24° S.), by M. Domeyko.—On the composition of the waters of Cransac (Aveyron), by M. Willm.—On the pliocene delta of the Rhone at Saint-Gilles (Gard), by M. Collot.

CONTENTS

THURSDAY, MARCH 25, 1880

THE INSTITUTION OF NAVAL ARCHITECTS

THE recent annual meeting of the Institution of Naval Architects was remarkable chiefly for the number of interesting papers affecting the mercantile marine. There were three of special interest, viz., "On Causes of Unseaworthiness in Merchant Steamers," by Mr. Benjamin Martell, Chief Surveyor to *Lloyd's Register;* "On Cellular Construction of Merchant Ships," by Mr. W. John, also of *Lloyd's Register;* and on "Steel in the Shipbuilding Yard," by Mr. W. Denny, of the well-known firm of W. Denny and Bros., Shipbuilders on the Clyde.

The subject of Mr. Martell's paper was, in view of the recent agitation in Parliament and elsewhere, deemed of such importance that the Council, contrary to the usual rule, devoted the whole of one day to its discussion. Certainly no better authority could be found to guide public opinion in forming a correct estimate as to the true causes of the numerous recent losses of grain-laden vessels, than the author of this paper. The public, led in this matter by the not too-well informed zeal of Mr. Plimsoll, has too hastily ascribed these losses to the prevalent custom of lading grain in bulk, without adequate provision having been made for preventing the shifting of the cargo to one side, or the other, of the vessel, in case heavy weather should be encountered. Without ignoring this cause of loss in ill-designed vessels, Mr. Martell takes a far wider view of the matter, and ascribes these numerous disasters to the following ten principal sources:—

"1. Weakness of structure from deficient scantlings, combined with faulty construction in arrangement and workmanship, together with inferiority of material.

"2. Deterioration, causing local defects and unseaworthiness.

"3. Absence of proper control over cocks, valves, and pipes connecting the engines and boilers with the sea. Also a want of proper arrangement of bilge pump suctions, and of suction pipes from sea and bilge, whereby water, from inadvertence or carelessness, can be run from the sea into a vessel.

"4. Faulty and deficient pumping arrangements, preventing the accumulated water being pumped from the wings in turn of bilge, after a vessel, from shifting cargo or other cause, has become inclined.

"5. Breaking down of machinery, and the consequent falling off of the vessel into the trough of the sea.

"6. Bad navigation—leading to collision or vessels running ashore.

"7. Inefficient protection of openings in the deck.

"8. Hasty and improper loading, particularly of grain cargoes in bulk, and deficiency of shifting boards or bulkheads, or other means to prevent cargo from shifting.

"9. Disproportionate dimensions of steamers, combined with undue height of double bottom, thereby causing, with some description of cargoes, deficiency of stability.

"10. Overloading."

Each of the foregoing causes has no doubt at some time or other claimed its victims, but as the first six are thoroughly well understood already, the paper deals chiefly with the fifth and the last four.

The breaking-down of machinery has probably been the cause of more disasters than is generally suspected. It is well known that the first-class Transatlantic steamers, provided with the most powerful engines, have often in very heavy weather as much as they can do to keep their course in safety. It will readily be seen that under-engined cargo steamers must under similar circumstances adapt themselves to a safe and practicable course, and can, when steaming full power ahead, only just manage to keep their positions, and may even in spite of all exertions drift astern. If in these cases the engines thus heavily strained become temporarily disabled, the vessel will refuse to answer her helm, and she will inevitably fall off into the trough of the sea, and be placed in the greatest danger. The same thing will happen, even if the engines work well, provided anything goes wrong with the stearing-gear, which is often of an intricate character.

The seventh source of danger, viz., inefficient protection of openings in the deck, should be, one would think, easy enough to provide against, by properly covering and inclosing all hatches, stokeholds, &c. But the inclosing of these spaces is discouraged by the operation of the Tonnage Laws. The following extract will throw light on this question:—

"The same may be said of the protection round the openings of the engine and boiler space. The best protection possible is an inclosed bridge house around the engine and boiler openings; but as the law at present stands, it encourages the ends of this bridge superstructure being left open instead of being closed by iron bulkheads.

"I was much struck with this a few months ago, when I officially visited a large number of steamers in course of construction in the North for the Atlantic trade, and on pointing out to the owners or builders the desirability of continuing the bridge house to the sides of the vessel, and inclosing it so as to secure effectively the casings round the engine and boiler openings against heavy Atlantic waves, I was invariably met by the observation that it would add too much to the working expenses of the ship, as this space would be measured for tonnage."

This clearly is a case for legislative improvement.

The eighth cause, viz., the improper loading of grain cargoes, is the one which, above all others, engrosses public attention at the present time. There is no doubt but that grain, when loaded too hastily in bulk, will settle very considerably, thus leaving empty spaces between the upper surface of the grain and the decks, rendering the cargo liable to shift in bad weather. In such cases, *if the vessel have but a small margin of stability*, she may only too probably capsize. Mr. Martell describes the method of loading and packing grain in various types of steamer, and the means which are adopted in order to prevent the cargo in the hold from settling and from shifting. The efficacy of these means depends largely upon the way in which they are carried out. It is commonly supposed that by carrying the grain wholly in bags, this source of loss would be obviated completely. Mr. Martell, however, tells us that a cargo composed partly of grain, and partly of bags, can be made just as safe as one containing nothing but bags; and that on the other hand the loading of all grain in bags will not cure the evil, if the vessel be deficient in stability, and if the other causes of danger be overlooked.

This question of deficient stability seems to us of the most vital importance, and we commend the following expression of opinion of Mr. Martell to the attention of Mr. Plimsoll and the Board of Trade:—

"In fact, the figures themselves in the Table of Losses show that there were as many coal-laden steamers as grain-laden steamers lost during the months of the past winter; and although it is possible for coal to shift similarly to grain, it is not a cargo which is prone to shift, or which would be considered dangerous in a fairly-designed vessel. In view of these facts there is nothing to show that the inherent deficiency of stability of the vessels, loaded as they were, might not have been as active an agent, if not a more active agent, in creating the disasters we deplore, as the shifting of the cargo."

It is pretty evident from the author's remarks that many of the steamers at present employed in the grain-carrying trade are ill-proportioned for this purpose; though their stability would be amply sufficient when carrying heavy non-homogeneous cargoes properly stowed. The remedy proposed for new vessels is greater beam and a higher freeboard, combined with a depth of double bottom just sufficient for the purposes of water ballast. For existing steamers of a dangerous type, the only remedy is judicious stowage. This may perhaps best be effected by lessening the weight of cargo between decks, and by bringing the vessel back to the load-line, by introducing a corresponding quantity of water ballast into the tanks in the hold. The only inconvenience of this course would be to sacrifice a small fraction of paying freight; a trifling consideration when compared to the greater security to human life.

The problem of designing these vessels so as to suit the peculiarities of all kinds of cargoes is by no means easy. The requirements of a vessel which has only to carry heavy dead-weights stowed low, and one which carries a homogeneous cargo, like grain or coal, with a high centre of gravity, are very different; and when the same vessel has at different times to carry each description of loading it becomes necessary to effect a compromise between too much stability in the first, and too little in the second case. In such cases it is best to err on the side of too much stability, and to correct this quality when heavy dead-weight cargoes are carried by raising the weights as far as possible.

Mr. John's paper "On Cellular Construction of Merchant Ships" is interesting, as describing a recent return to the system of longitudinal construction, first introduced by Mr. Scott Russell over thirty years ago, and carried out by him in numerous iron vessels, notably the *Great Eastern* and the *Annette*. Mr. Scott Russell first invented this system in order to supply a great want in the iron vessels of that day, viz., deficient longitudinal strength. Since then, however, the longitudinal strength of merchant ships has been amply provided for by the introduction of solid keelsons, skin platings, and of iron decks. The present reaction in favour of a longitudinal system of construction is, as Mr. John is careful to inform us, due not to the necessity for providing additional strength, but to the opportunities which it gives of incorporating water ballast tanks into the structure of the bottom of the vessel. The details of this paper, which is one of great interest and importance to practical shipbuilders, are of too technical a character to be put before our readers.

There are few questions of more practical importance to both shipbuilders and owners at the present time, than the substitution of steel for iron in the construction of ships. The greater strength of the new material renders lightened scantlings possible, and the weight thus saved in a vessel's hull represents so much addition to its cargo-carrying capacity. Mr. Denny's paper "On Steel in the Shipbuilding Yard" is a most valuable record of his firm's experience in the use of steel, and it will be a subject for sincere congratulation to all those who are interested, that Mr. Denny has pronounced the new material to be absolutely trustworthy in every respect, far more so indeed than wrought iron. At present the most vexed question in connection with the use of steel is, what limits of tensional strength shall be allowed. If it be wished materially to reduce the scantlings of vessels it is clear that a material of much greater tensional strength than ordinary wrought iron must be made use of. On the other hand the milder and more trustworthy the steel the lower is its strength in this respect, while very strong steels are proverbially hard and brittle. The Admiralty and the two great classification societies, viz., Lloyd's and the Liverpool Underwriters' Registry, have each at present different limits of tenacity. The Admiralty require that the breaking strength shall be between 26 and 30 tons per square inch; Lloyd's between 27 and 31; while the Liverpool Underwriters fix the limits between 28 and 32 tons. The question as to which of these pairs of limits is the best, was mooted both by Mr. Denny and by Mr. West, the Chief Surveyor to the Liverpool Underwriters, who followed Mr. Denny with a paper on "Steel for Shipbuilding." Both speakers inclined to the higher limits; in fact Mr. West went so far as to propose a minimum limit of 30 tons, and to have no maximum limit. He considers that a maximum limit is unnecessary, because the temper-bending tests in common use amply demonstrate whether or no the steel possesses the requisite ductility.

On the other hand Dr. Siemens, under whose patents most of the steel used in shipbuilding is manufactured, spoke strongly during the discussion in favour of the milder and more ductile material. His grounds for doing so were that the extensibility and strength of each variety of the material were the same up to strains of 15 tons per square inch, and that this strain is a long way beyond anything which the material would have to bear in practice.

There were only two papers of any importance bearing on the subject of the Royal Navy. The first was by Mr. Barnaby, and was a description of the *Nelson* class of protected cruiser. There are two of this class in existence at the present time, viz. the *Nelson* and the *Northampton*. They were originally designed as improvemements on the *Bellerophon* and the *Iron Duke*, and viewed from this point they embody many novel features, constituting no doubt great improvements. The protecting armour in the newer vessels is much more partial than in the older ones, but where it is applied the average thickness is 7·28 inches, as against 5·28, representing nearly double the protecting power. Again, the coal-carrying capacity of the *Nelson* and her sister-ship is 1,200 tons, as against 645 tons for the *Bellerophon* and 460 tons for the *Iron Duke*. This is a most important improvement. In fact the two last-named vessels with their small coal-carrying capacity hardly deserve the name of cruisers at all. The armament of the new ships both in total weight as well as in weight of projectiles fired from the broadside, and right ahead and astern, is much superior to the older two.

Mr. Scott Russell's paper dealt with the true principle of the resistance of armour to shot. Like everything that comes from his pen, it is written clearly and forcibly. It advances for the first time a rational explanation of the great resistance of steel-faced armour-plates as compared with the old-fashioned armour.

In addition to the above many other papers were read, some of them being of great interest and originality. For instance, Mr. MacFarlane Grey's paper "On the Simplification of the Thermodynamics of Steam," which however much we may object to the word *simplification* in the title, is nevertheless a singularly bold and original attempt to account for many of the phenomena of steam and other effects of heat when applied to matter. Want of space however prevents our reviewing this paper in the way it deserves. The same remark applies to Mr. Merrifield's description of Prof. Amsler Laffon's new instrument for calculating simultaneously the area, the statical moment, and the moment of inertia of any closed figure.

Upon the whole the Institution of Naval Architects must be congratulated upon the very valuable and interesting nature of its transactions. It is only to be regretted, that on account of the large number of papers and the limited time for the meetings, so little time is often left over for discussion.

THE LOCAL ENDOWMENT OF RESEARCH

BIRMINGHAM enterprise and Birmingham manufactures are known all the world over. One of the present remarkable features of this hard-working provincial town is a gradual infusion of the apparatus of scientific culture not before its time. Thus we have now a potential, college, to say nothing of an increase in the number of its educational institutions and scientific societies. One of the most recently founded of these institutions is the Birmingham Philosophical Society—a title which one is apt to associate with respectable dulness—a circulating library, and a well-stocked reading-room. But the Birmingham institution, founded only in 1876, is something very different, and bids fair to rival her well-known Manchester sister. Already has the Society published a third thick part of its *Proceedings*, containing a number of original papers that would do credit to a London society.

But Birmingham is nothing if not innovating; her politicians founded a new school of politics, and now her men of science have initiated a new departure in the conduct of scientific societies. This will be plain from the following circular, a copy of which has been sent us:—

"The Council, having taken into consideration the advisability of establishing an Endowment of Research Fund, will submit the following scheme for the consideration of the Society:—

"*Scheme for Establishing and Administering a Fund for the Endowment of Research in Birmingham*

"The Council are of opinion that this Society would be omitting a principal means of the advancement of science—the end for which all such associations exist—if it neglected the question of the endowment of research. To maintain a successful investigator in his labours, even though no results of immediate or obvious utility can be shown to spring out of them, is of interest to the community at large. Indeed it is just because the practical usefulness of such work is not immediate or obvious that it becomes necessary to give special support; for, otherwise, it would have its own market value, and endowment would be superfluous. But the proper and effectual administration of an endowment fund is perceived to be so beset with difficulty as often to deter even those who recognise the principle, from advocating it in practice. Most of the dangers usually foreseen would, however, as a rule, be avoided, simply by the distribution of such funds from local centres, under such a scheme as is now proposed.

"The Council are therefore anxious to establish a fund, in connection at once with the Society and the town, for the direct endowment of scientific research. And they are further of opinion that the eminent merits of Dr. George Gore, F.R.S., as an investigator of exceptional originality and success in the domain of chemistry and physics, clearly point him out as fittest to be the first recipient of endowment from the fund. In accordance with these views the Council propose the following regulations for the fund:—

"1. That the fund be entitled, 'The Birmingham Endowment of Research Fund.' 2. That contributions be invited, payable either at once, or in instalments distributed over a term of years, as individual subscribers may desire. 3. That the money collected be deposited with the Birmingham Banking Company, in the name of the Council of the Birmingham Philosophical Society; and that all cheques on this fund be signed by the president, the treasurer, and one of the secretaries for the time being. 4. That the management of the fund shall be in the hands of the Council of the Birmingham Philosophical Society, who shall have the power of allotting such sums and under such conditions as they may deem fit to any one or more persons engaged in scientific research, for the purpose of assisting them in carrying on their investigations. 5. The Council shall present a report of their proceedings in connection with the fund at the annual meetings of the Society.

"Subject to the approval by the Society of these General Regulations, the Council have resolved—1. That Dr. George Gore, F.R.S., be elected as the first recipient of an endowment from the fund. 2. That in order that Dr. Gore may have greater facilities for continuing in Birmingham his original researches, if the sum collected permit, the amount of 150*l*. per annum for three years be allotted to him. 3. That the first cheque on the sum subscribed be payable on the 1st of July of the current year."

These resolutions were carried unanimously at a full meeting of the Society on the 11th inst. It is not necessary for us to say a word in praise of the important initiative which has thus been taken by one of the youngest of our provincial societies. The lessons to be derived from this action seem plain. Nothing, we think, could conduce more to the encouragement of scientific research in this country than the establishment in the great centres of wealth or industry of funds similar to that with which the Birmingham Philosophical Society have resolved to endow Dr. Gore. To so enormously wealthy a town as Birmingham what is 150*l*. or even 1,500*l*. a year? And need we remind practical Birmingham manufacturers that in their own special lines the most lucrative results have been obtained from investigations that originally had no practical ends in view? Need we also remind them of what during the past few years their balance-sheets have given evidence over and over again, that this country is fast losing its old industrial supremacy through sheer lack of the scientific knowledge which other countries are turning to such practical account? But it is not on these grounds we would urge the leading scientific societies in our great provincial towns to follow the admirable example set by Birmingham. Scientific research, for its own sake, is a worthy and ennobling pursuit, blessing those that give as well as those that receive the funds for carrying it on, when these are given in a generous spirit and with a discriminating hand. We feel quite sure the Birmingham Philosophical Society would have not only little difficulty in raising the modest sum with which they have ventured to start, but that the wealthy Birmingham manufacturers, and probably even the Birmingham Corporation, will see it to be to their best interests to make the fund a permanent one, and so increase it as to produce wide and substantial results. The example, it is to be hoped, will be followed by other provincial towns, as Manchester, Liverpool, Newcastle, and Glasgow, all of which have reputable philosophic or other similar societies, plenty of money to spare, and everything to gain and nothing to lose by such a wise and noble use of it.

May we not also hope that the example set by this provincial Society will strengthen the weakness of knee which, in the opinion of many, the Royal Society has displayed in its administration of the fund which Government has committed to its care for the endowment of research? At Birmingham the endowment becomes an honour, and not an alms to be sued for on the "proper form," and it is not frittered away so as to miss the real object of the creation of the fund. That some such fund is necessary seems to us clearly proved, if further proof were needed, by the action of the Birmingham Society; and the Royal Society will show itself scarcely worthy of its position as the leading Society of the kingdom and the only Society which demands original research as a condition of admission, if through feebleness or any false sense of dignity it should allow the modest sum it now administers to lapse from its hands. It need not fear that in administering this fund, and in taking all the trouble that must be taken to do so wisely and honestly, it sustains any loss of prestige. There are certain things with which to meddle would certainly be undignified on its part; but in doing work of this kind it seems to us it is performing a proper function.

Perhaps nothing would sooner convince our ignorant and one-sided politicians of the reality of science, and of the necessity for its national recognition than efforts similar to that begun at Birmingham, carried out in all our great industrial centres. In the somewhat humiliating agitation now being carried on all over the country we hear much from both sides of the country's highest welfare; and yet not a single statesman of them all ever gives a hint that he knows what science really means, far less what important national issues depend upon the results of its cultivation. Let our great municipalities take the matter up as Birmingham has done, and we are confident that while much will thus be done for the promotion of scientific research throughout the country, their action will not be without its effect upon the Government. For while such action in the provinces is in the highest degree desirable and laudable, it is no more a substitute for the national recognition of science than municipal government is a substitute for a central administration.

Meantime the Birmingham Philosophical Society, whatever may be the final result of its enterprise, will be entitled to hold an honourable place in the annals of English science.

ECLIPSE OBSERVATIONS

Observations made during Total Solar Eclipses. Collated by A. C. Ranyard, M.A., Sec. R.A.S. *Memoirs* of the Royal Astronomical Society, vol. xli., 1879.

THE idea of collecting different accounts of the same eclipse, and breaking them up, so that all descriptions of one and the same phenomenon should be found side by side, first originated with the Astronomer-Royal, who began to collect all accounts he could procure of the eclipse of 1860. As pressure of work prevented him from carrying out his idea, Mr. Cowper Ranyard took it up at his suggestion and gradually extended the plan, so as to include all the more important physical observations which have ever been recorded during total solar eclipses. This enormous work has now been published in a volume of nearly 800 pages, and there cannot be two opinions as to its usefulness and value. It must, however, be borne in mind that this is a mere work of compilation, and the reader who expects to find a general and correct account of the conclusions to be drawn from the observed phenomena and the results which have actually been arrived at, will be bewildered rather than instructed by the perusal of the book. The volume is simply intended to classify the observations which have been made, and not to discuss them. A good discussion is very much wanted, but it could hardly have been made by a single man, and certainly not without consulting the chief authorities on the subject. It is of course impossible to avoid altogether reference to theories which have been proposed, and their comparison with observations for which they are supposed to account, but Mr. Ranyard has acted in this respect with commendable self-restraint, and whenever he departs from his general rule, he only makes us feel how grateful we ought to be to him, that he has not more often indulged in such vague, confused, and unsatisfactory discussions as here and there disfigure the book. As it is, it will not be difficult to draw a pen through all statements involving debateable matters, and we shall then have a volume which will do credit to its author and to the Society which has published it.

In order to gain an idea of the great variety of observations which are dealt with in the volume, we have only to look over the table of contents.

The first chapters contain accounts of phenomena of minor importance, yet of considerable interest. Most of these can also be observed in partial eclipses, such as the occultation of sun-spots by the moon, the darkness of the moon compared to sun-spots, the fringe round the moon's limb, &c.

Chapter IX. contains an account of the remarkable moving shadow-bands which have been observed just before and after totality. There can be no doubt that these shadows originate in our own atmosphere; but whether the currents which give rise to them are produced by the chilling effect of the eclipse, or whether they are always present, but only cast a visible shadow when the solar light is confined to a narrow crescent, we do not know. These bands were noticed a short time ago, without an eclipse, in Lord Lindsay's observatory, and were then produced by the sun disappearing behind the mountains. The eleventh chapter treats of the brushes of light apparently emanating from the cusps of the sun during the partial phase. Prof. Stokes has offered an explanation of this phenomenon, and the explanation seems to agree very well with the drawings given by some of the observers. It cannot, however, be reconciled, we believe, with the description given by Mr. Brett, who observed them through his telescope and called them "exquisitely defined."

The subjects of greatest interest and importance of the volume are contained in the three last chapters, which form about two-thirds of the whole volume. They treat of "Polariscopic Observations," "Spectroscopic Observations," and "Photographs and Drawings of the Corona." A good part of the chapter on polarisation may serve as an example of what the book might have been, had Mr. Ranyard more frequently indulged in theoretical speculations. We cannot of course go into any detailed criticism, but shall give two examples in order to justify our remarks. In the first place, we think that Mr. Ranyard has treated the observations which relate to the polarisation of our atmosphere in the parts of the sky occupied by the corona, in a rather careless manner. It appears that one observer makes the polarisation vertical, one horizontal, and seven leave it doubtful whether the polarisation was vertical or horizontal. But on p. 255 all the observations which leave the matter doubtful are given as proving vertical polarisation, and about the one contradictory observation we are told that "it must be borne in mind that a half rotation of his instrument would be sufficient to reverse the position of the colours."

We are then informed that vertical polarisation is exactly what "we should expect." But in a footnote on page 330 we are treated to some vague considerations, from which it "evidently" appears that the polarisation ought to be horizontal or exactly opposite to what we were first led to "expect." And now we are informed that out of eight observations which have been adduced to prove the first statement, seven prove nothing, and the observation which we first had to set aside on account of the "half rotation" is now treated as the only good one. Of the one observation which contradicts this new result we are told that "it seems, perhaps, more natural to assume that he commenced his observations with the polarimeter in a vertical rather than in a horizontal position."

Mr. Ranyard adds that this note must be taken as overriding the opinion expressed on page 255.

What we should "expect" is not at all so "evident" as Mr. Ranyard makes it out to be. If we confine ourselves to clouds, as Mr. Ranyard does, or to the reflection of sunlight from the surface of the illuminated parts of the earth, the polarisation would altogether depend on the distribution of the clouds, it would in all cases be very small, and a small change in the distribution might change the polarisation from one plane to the other. The polarisation due to reflection from unobserved parts of the earth or clouds uniformly covering it, ought to be vertical as we might "expect," in Mr. Ranyard's first statement, and not horizontal, as is "evident" in his second. If the clouds are higher up a different result is possible. There is, however, a second and much more powerful cause of polarisation which is due not to clouds, but to particles which scatter the light without polarising it, but are not sufficiently dense to make the medium opaque or to form a cloud. It is well known that in the neighbourhood of the sun the light is always polarised in a horizontal plane, and the cause we have mentioned seems to be the only one which can account for the facts. Exact observations during total eclipses would be of great use, and might throw some more light on the subject, which has by no means been fully cleared up. A great deal more may be said on this question, but we have only made the foregoing remarks in order to show that the subject cannot be treated in the short offhand way adopted by Mr. Ranyard.

Our second remark refers to a somewhat clumsy mathematical investigation. Mr. Ranyard investigates the polarisation of the light scattered from an atmosphere of particles uniformly distributed within a spherical shell surrounding the luminous point. We may mention that no conclusions whatever can be drawn from this problem with regard to the corona. One of the supposed results, however, of the investigation is that the light coming to us in the direction of the luminous point itself is polarised, and on this result Mr. Ranyard remarks—"At first sight it might appear that at the central part of the corona the light should be entirely unpolarised, but it must be remembered that the illumination of the particles adjacent to C will be very great, and the polarisation of the light dispersed by them will, it appears, overpower the non-polarisation of the light dispersed by the higher parts of the corona." In this passage the atmosphere of particles referred to above is called the "corona," and C is the luminous point. Had Mr. Ranyard ever asked himself the question in what plane the polarisation in the central part of the corona ought to be, the above passage could never have been written, for, reasons of symmetry would have been sufficient to show that no such polarisation is possible. Nor is the reason why the formula breaks down in this particular case far to seek.

We turn with pleasure to the chapter on spectroscopic observations, not that we consider this chapter faultless, but because in it we have brought before us a greater array of facts and not so much theory. For any one who in future eclipses intends to follow up the results achieved with the spectroscope by previous observers, this chapter will be invaluable. In no case is the comparison of different observations of such importance as in spectroscopy, and we are glad to have before us all the evidence, positive and negative, on a great many partly still undecided questions. The last and longest chapter is in some respects the most interesting. In it we have a careful comparison of the more important drawings and photographs of the corona, made during a long series of eclipses. The symmetry of the corona about an axis, nearly coincident with the solar axis, cannot be doubtful any longer, but whether the axis of symmetry is really the sun's axis or only approximately coincident, is one of the important points which will have to be decided during future eclipses.

At the November meeting of the Cambridge Philosophical Society in 1878, I drew attention to some remarkable changes which the outline of the solar corona had undergone during recent years; the change seemed to be periodical, and the period seemed to be that of the sun-spots. In the *Observatory* for December I also made some remarks to the same effect. Pp. 496–501 of the volume before us contain short descriptions of the general shape of the corona during all the eclipses, of which we have drawings, and in all cases information on the number of sun-spots is given.

The result seems to be altogether in favour of such a relation between the two phenomena as I have pointed out. In the papers above referred to, as well as at the November meeting of the Astronomical Society in 1878, I also pointed out a still more remarkable, though perhaps more doubtful, coincidence. It is generally found that the symmetry of the corona is not complete, but that one side is nearly always more fully developed, while the other is more contracted; and this departure from symmetry seems to be related to a direction fixed in space. Thus the eclipses of 1868, 1874, 1875, 1878, which all happened near the minimum of solar activity, resemble each other in general character; but in the eclipses of 1874 and 1875 the east[1] side of the corona was much wider than the west, while in 1868 and 1878 the west side was the broadest. Now the eclipses of 1874 and 1875 happened in April, while the eclipses of 1868 and 1878 happened in August and July. The eclipse of August, 1869, resembles also the two last mentioned in this departure from symmetry, and the eclipse of December, 1871, does not show any decided difference either way. If this remarkable connection of the general outline of the corona with the heliocentric position of the earth at the time of the eclipse should be confirmed, it would tend to show that the outer corona at any rate is of cosmic origin, and this view would be supported if it should be found, as is probable, that the axis of general symmetry of the corona is not exactly coincident with the solar axis. The connection between the sun-spots and corona would, according to this view, be reversed; that is to say, the more disturbed state of the corona at the maximum would not be produced by the increase of sun-spots, but the sun-spots would ultimately be produced by a cosmic cause which has the same period. The next eclipse in 1882 will not unfortunately throw much light on this question, as it will most likely resemble the eclipse of 1870 or 1871.

The great value of the book before us lies in the many suggestions for future observation which offer themselves on its perusal. It teaches some lessons which all of us who have ever observed eclipses or are likely to observe them in future would do well to remember. Thus on reading over the different and often conflicting accounts of one and the same phenomenon, we are struck with the insufficient descriptions of the apparatus and instruments with which the observations have been made. We are told by an observer what he has seen and what he has not seen, but on trying to compare his account with that of others, we generally miss some important information. Observers with the spectroscope, for instance, generally do not tell us anything, or at any rate they do not tell us enough, about the width of slit which they have used and about the luminosity of their spectroscope. Observers with the polariscope speak of bands, vertical or horizontal, and their description generally fails where it is most wanted, and we cannot decide whether a certain polarisation has been observed, or one at right angles to it. We ought, however, to exempt the Washington observers from this general condemnation. The reports emanating from the United States Naval Observatory are generally a model in the accuracy of their accounts.

[1] Owing to a slip it was said in the Report on the Eclipse of 1875 that the west side was the widest in 1874 and 1875.

The preparation of the eclipse volume has necessarily taken a good many years, and it would have been useful if some information had been given as to when different parts of it have been written. The Report of the Eclipse of 1875, for instance, appeared while the work was progressing, and it is natural, therefore, that only those observations could be mentioned which referred to subjects treated in the last few chapters. Yet some information might have been given that the treatment of that eclipse is only incomplete. The remark on p. 373 can only have been written before Mr. Ranyard could have known anything of the results which had been achieved.

As a book of reference to those interested in eclipse observations, the present volume is, as we have already mentioned, of very great value. Our thanks are due to Mr. Ranyard for the great trouble he has taken in its preparation. The blunders contained in it are so obvious, as a rule, that they will hardly mislead any one who is likely to make use of the book. ARTHUR SCHUSTER

NICHOLSON'S TABULATE CORALS

On the Structure and Affinities of the Tabulate Corals of the Palæozoic Period, with Critical Descriptions of Illustrative Species. By H. Alleyne Nicholson, M.D., D.Sc., &c., Professor of Natural History in the University of St. Andrew's. (London and Edinburgh: W. Blackwood and Sons, 1879.)

THIS handsome post octavo volume contains a disquisition on a rather heterogeneous assemblage of organisms partly Cœlenterate and partly Bryozoan in nature, partly of uncertain affinities. Of the palæozoic Cœlenterate corals described, the major portion are probably Alcyonarian. None of them, except perhaps Labechia, appear to belong to the Hydroids, the family of the Hydrocorallinæ being, as far as has yet been discovered, of comparatively recent origin, and not of older date than cretaceous deposits at the most, unless, as believed by Mr. Carter, Stromatopora and its allies of the Silurian formations are in reality closely related to Millepora.

Prof. Nicholson, in the recent edition of his "Palæontology," places Stromatopora amongst the sponges, and does not accept Mr. Carter's conclusions. He seems in doubt about the true relationship of Labechia from the Upper Silurian, the similarity in the structure of which to the Milleporidæ was first pointed out by Dr. Lindström. The author himself, in conjunction with Dr. Murie, was one of the first to investigate the finer structure of Labechia, and described his results in a memoir on the Stromatoporoids, in the *Journal* of the Linnean Society.

The present work commences with a short review of all those corals which possess tabulæ or transverse calcareous partitions within their pores or calicles, and which were formerly grouped together by MM. Milne Edwards and Haime on that account as a special division of the corals, the *Zoantharia tabulata*.

By the researches of the late Prof. Agassiz, Prof. Verrill, Mr. Moseley, and others, these peculiar structures, the tabulæ, on which MM. Milne Edwards and Haime relied as the foundation of a natural group, have been proved to be of very secondary importance, and to exist in corals of most widely different structure in other and more essential particulars.

Prof. Nicholson, in his preliminary review of the various different forms thus formerly brought together, describes the most important structural details of each, and assigns them to their several places in the animal series. Some, as Heteropora, are, according to the late researches of Mr. Busk, of Bryozoan affinity, and Mr. Busk's results have been so very recently obtained that this fact can only be explained in the book in a note appended to the preface. The Milleporidæ and their allies are Hydroids, the Helioporidæ and Heliolites Alcyonarians, the Pocilloporidæ Madreporarians. The Favositidæ and Syringoporidæ, notwithstanding the close relationship of the latter, in general appearance to the Tubiporine Alcyonarians, the author refers, contrary to the opinion of Dana, Haeckel, and Zittel, to the Madreporaria, expecting "that they will find a place, though a special one, in the series of the *Zoantharia perforata*."

Twelve groups of tabulate corals in all are reviewed, namely, the Milleporidæ, Pocilloporidæ, Favositidæ, Colummariadæ, Syringoporidæ, Auloporidæ, Halysitidæ, Tetradiidæ, Thecidæ, Helioporidæ, Chaetetidæ, and Labechidæ. It is to be hoped that so heterogeneous an assemblage will not be placed again side by side in scientific works, now that the wide differences by which its components are naturally separated are fully known. Succeeding the general introduction there follow in the book a series of chapters devoted to the description of the peculiarities of the families and genera of those of the above cited families of corals which are of Palæozoic age, with detailed descriptions of certain selected types and discussions on the affinities of each family, the affinities being in many cases as yet obscure.

The text is illustrated by excellent woodcuts, and there are fifteen plates containing details of the structures of various forms as exhibited in microscopic sections. The whole cannot but prove of value to specialists who occupy themselves with the investigation of these difficult fossil organisms; but the matter of the book is necessarily too technical in character to allow of detailed review with advantage to the readers of NATURE. Some of the descriptions of types and figures have appeared already in the *Annals and Magazine of Natural History*.

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.*]

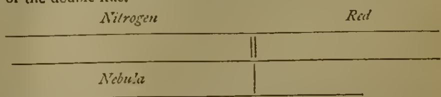
Dissociation of the Metalloid Elements

IN the account given in NATURE, vol. xxi. p. 445, of M. Raoul Pictet's proposal to dissociate the metalloid elements the following reason is given as the ground of his belief that these elements are compounds:—

"The spectrum of the sun when scrutinised with the most elaborate skill and knowledge reveals another very striking circumstance. A large number of the substances regarded by the chemist as elements have now been recognised by the characteristic absorption lines of their spectra as existing in the heated matters surrounding the sun. The researches of Mr. Lockyer show that nearly forty of the metals are thus to be detected. But not a single metalloid is thus discoverable. Indeed so marked is their absence that the presence of hydrogen in such great abundance is held by no less an authority than Mr. Dumas to be a convincing proof that hydrogen is a metal and not a metalloid."

M. Pictet is doubtless unaware that for many years I have advocated the same conclusion. The grounds I have given for this belief are twofold, firstly, that the peculiar chemical reactions of these elements on which the law of even numbers rests leads to this result; and, secondly, that no spectrum of any one of these elements has as yet been found in the light of the sun or fixed stars. Oxygen, I may say, is not included in my list. My first published observations on this subject date from the years 1866–1867 ("Calculus of Chemical Operations," part 1, *Trans.* R. S., 1866, p. 859, and *Chemical News*, June 14, 1867, p. 302). Last year I had occasion to recur to this question, and in an article by myself in the *Philosophical Magazine*, June, 1879, p. 430, the following passage occurs:—

"It is a significant fact that a very large proportion of the class of elements which I have termed composite elements have not been found in the sun. In reply to inquiries on my part Mr. W. Huggins writes to me thus:—So far as I know, nitrogen, phosphorus, arsenic, antimony, boron chlorine, iodine, bromine, have not been found in the sun. In one paper Lockyer suspects iodine. Dr. Miller and I found coincidence of the three lines of antimony with three lines in Aldebaran. Though this observation would show considerable probability of antimony in star, I do not think the spectroscope (two dense prisms of flint glass) was sufficiently powerful to make its existence there certain. In the case of nitrogen, no coincidence was observed in any of the stars. In my paper in the *Transactions* of the Royal Society on Spectra of Nebulæ, I show coincidence of principal line with the strong line in spectrum of nitrogen. Now this line of nitrogen is a double one; and I was not at first able to be certain if the line in the nebula was similarly double. Subsequently with the powerful spectroscope I used for the motions of stars, I was able to make a certain determination of this point (*Proceedings*, R. S., 1872, p. 385). I found the line in the nebula single and coincident with the middle of the less refrangible of the components of the double line.



I say 'middle' because the line in the nebula is narrower and more defined than either of the two lines forming the double line. I made experiments to see if under any conditions of pressure and temperature the more refrangible of the two lines fades out, so as to leave only the one with which the line in the nebula is coincident. I did not succeed. So the matter stands. Is nitrogen compound? Are there any conditions under which the one line only appears? Has the line in the nebula no real connection with nitrogen further than being sensibly of the same refrangibility?

"Now we must either consider that the matter of these elements so abundant on the earth does not exist in the sun or stars (which is hardly probable), or that they have passed into forms of combination in which they cannot be recognised by the spectroscope (which is also hardly admissible at that elevated temperature), or that they have been decomposed."

The important work of Victor Meyer on the behaviour of chlorine and iodine at elevated temperatures which must now be regarded as finally established by the experiments of which an account is given in the recent number of the *Berichte der deutschen chemischen Gesellschaft* (March, 1880), and on which I ventured to offer some theoretical considerations in a paper which appeared in the *J. Chem. Soc.* last autumn, point in the same direction. It is difficult not to admit the force of such a body of coincident evidence as that of which I have here given a brief outline.

March 14 B. C. BRODIE

The Aurora at Last

YESTERDAY, Wednesday, March 17, was a magnificently bright sunshiny day from early morning to latest evening; and at 9 p.m. the aurora appeared, just as it used to do years ago in the last sun-spot cycle, and when that strange influence was in its then vigorous existence. Your readers were warned last October that the sun-spots of the new cycle had then begun "in earnest," and now we have to chronicle the first of their *auroral* fruits.

It was a long low arc of mild quiescent light, about 2° in transverse breadth, 20° long, rising about 7° high in the middle, and sensibly dark between its lower edge and the horizon; the centre was over the north-north-west point of the horizon, but swayed slowly several degrees of azimuth on either side. Towards 11 p.m. the arc began to break up into brighter pellets of light, and these shot fainter rays upwards, making a brilliant and variegated appearance for a few minutes, but apparently soon exhausting itself, for after that there remained only a faint ghostly image of the arc up to 1 a.m.; all this being clearly visible to the naked eye, although a moon seven days old and in 24° N. Decl. was shining brightly in the west.

In the spectroscope, with a narrow slit, nothing but the one inscrutable citron-coloured line appeared, its place in wave-numbers, per British inch, and as ascertained in both hydrogen and carbonic oxide vacuum tubes, being between 45592 and 45690. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, March 18

A Museum Conference

ALLOW me to deprecate most strongly any attempt to form an association having for its object to talk about museums. Museum officials either know their business or they do not. In the former case they have something better to do than to talk; in the second case the less they say the better. The multiplication of conferences threatens to become a nuisance, and special conferences for every grade, class, and description of humanity will soon be proposed by fussy idlers. We shall be told that it is time to have a conference of housekeepers, of lamplighters, of railway guards, boot-makers, beadles, perhaps ballet-girls.

The fact is that endless time and trouble and money are wasted in England in maintaining rubbishing local museums in the care of ignorant and pretentious curators. Conferences are not required, but *proper salaries* for the curators, who should be educated and capable men; were such men secured by adequate salaries they would soon make the museums in their charge very different from what they now are.

A curator with proper salary ought to be made to attend daily at his museum during office hours, and not allowed to leave it to take care of itself whilst he is lecturing here or there, or eking out his pay by literature. ACADEMICUS

I AM glad to see that Mr. Paton has, in NATURE, vol. xxi. p. 442, again revived the subject of a museum conference, and offers to give his aid towards such attaining a practical form. The desirability of a Museum Association was first suggested in an article in NATURE, vol. xv. p. 276, and this was followed by a more definite proposal for a conference by "J. P.," and with the addition of a letter in favour of the same object by Dr. Meyer nothing further was published about it. This looked as if the subject was not considered of any great importance, but I believe many curators were decidedly in favour of it, and only awaited it assuming a practical form to give it their hearty support. The success which has attended the Library Association gives every reason to believe that the formation of a similar association of museum officials would lead to equally good results. Apart from the benefits to be derived from an interchange of ideas and results of experience, which, considering the varied nature of museums and the many practical questions involved in their successful management, could not fail to be considerable, there are many things affecting provincial museums generally that would be greatly advanced by united action. One of these, the distribution of the British Museum duplicates, I should like to refer to. In the British Museum Removals Bill a clause was inserted at the instigation of Mr. Mundella, M.P., and Mr. Chamberlain, M.P., which states that "the Trustees of the British Museum may also give away any duplicate works, objects, or specimens not required for the purposes of the Museum." Instead of giving away, however, I learn that the Trustees are about to *sell by auction* some of the duplicate prints, drawings, &c., in the Museum; and fearing that other duplicates might be disposed of in a similar manner I had the matter brought before Mr. Mundella, who obtained an interview with the Right Hon. Spencer Walpole, Chairman of the Trustees, and was informed that instructions had been given for duplicates in the Natural History Departments to be laid aside and catalogued for distribution among the principal museums. This is somewhat reassuring, but why not treat all their duplicates in this way?—for it should be remembered that provincial towns contribute their share of imperial taxes.

I must not, however, occupy your valuable space with matters that ought properly to be discussed by such a conference as Mr. Paton suggests; and I hope that all who are interested in museums will heartily co-operate with Mr. Paton, whose great success in developing the museum at Glasgow and his extensive acquaintance with museums both in Britain and on the Continent, eminently qualify him to speak with authority on the subject.

Sheffield Public Museum, March 23 E. HOWARTH

A Method of Calculating the Expansion of a Substance on Vaporisation

HAVING occasion last summer to determine the volume of gas which would result from the vaporisation of a given quantity of a certain solid, I made use of a simple way of obtaining approximate results which may not prove uninteresting to some of your readers, unless, as is very likely, they have already made use of it or a better way themselves. For purposes of illustration we may take it that 1 gram of hydrogen gas occupies a volume of 11,200 c.c. at normal pressure and temperature; moreover, the weight of 1 c.c. of water is 1 gm. at 0° C.

Knowing the atomic weight and specific gravity of any liquid or solid, we can now find the volume which 1 c.c. of it will assume on passing into the gaseous state by a simple "rule of three" sum.

For the weight of 1 c.c. of the substance is given by the number which indicates its specific gravity; and the weight of 11,200 c.c. of its gas is given by its atomic weight.

Hence

$$\frac{\text{sp. gr.}}{\text{at. wt.}} \times 11{,}200 = \text{vol.},$$

to which 1 c.c. of the substance expands on becoming gaseous.

It is interesting to note that the fraction $\frac{\text{sp. gr.}}{\text{at. wt.}}$ is the reciprocal of $\frac{\text{at. wt.}}{\text{sp. gr.}}$, which is the expression for the so-called atomic volume (v) of a substance, and thus the expansion of 1 c.c. of a solid or liquid as it becomes gaseous may also be determined by dividing the number 11,200 by the atomic volume of the substance.

In this way we find that 1 c.c. of sodium will occupy 474 c.c. in the state of gas, and 1 c.c. of potassium 249 c.c., or, what is the same thing, 1 c.c. of each of these substances in the gaseous state will occupy $\frac{1}{474}$ c.c. and $\frac{1}{249}$ c.c. in the solid state respectively. But equal volumes of gas under the same conditions of temperature and pressure contain an equal number of molecules, and hence $\frac{1}{249}$ c.c. and $\frac{1}{474}$ c.c., the products of the condensation of equal volumes of potassium and sodium gas must contain an equal number of molecules. From this we readily deduce a real physical meaning for the fraction $\frac{\text{at. wt.}}{\text{sp. gr.}}$, or, in other words, for the expression "atomic volume," the significance of which, at first, was merely conjectured.

Lists of homologous series of elements and compounds, with their "condensation numbers" attached, give very interesting results; I have only one such at hand, which I here give:—

Butyl series.	At. wt. 2	Sp. gr.	Condensation.
C_4H_{10}	29	0·600	231·7
C_5H_{12}	36	0·628	192·3
C_6H_{14}	43	0·669	174·2
C_7H_{16}	50	0·699	156·6
C_8H_{18}	57	0·726	142·6
C_9H_{20}	64	0·741	132·9
$C_{10}H_{22}$	71	0·757	119·4
$C_{11}H_{24}$	78	0·766	110·0
$C_{12}H_{26}$	85	0·778	102·5
$C_{13}H_{28}$	92	0·796	97·0
$C_{14}H_{30}$	99	0·809	91·5
$C_{15}H_{32}$	106	0·825	87·1

From this it will be seen that the amount of condensation of the gas, as it passes into the liquid state, becomes less and less as the molecular composition becomes more complex, and moreover, that the difference in amount of condensation of any two adjacent members of the series becomes diminished at the same time; thus the difference in condensation on passing from butyl hydride to amyl hydride is 39·4; from myristyl to benyl only 4·4 c.c. If the fact that the sp. gr. of these substances has been taken at a common temperature, instead of at their boiling points be considered, it will be seen that the difference is really less marked than it otherwise would be.

From the fact that an increase in the number of atoms in the molecules is accompanied by a decrease in condensation, it would appear that a substance might be found which should possess the same, or nearly the same, specific gravity in the state of gas and solid, *i.e.*, in which these states should become identical. A large number of atoms would have to enter into the formation of a molecule to bring about this result, though if there be any truth in the formula for albumin quoted by Herbert Spencer on the authority of Mulder, it must be approached by this substance. This formula—$10(C_{40}H_{31}N_5O_{12}) + S_2P$—gives us an atomic weight of 3912·5, and if we assume the specific gravity of albumin to be 2, this will give us—

$$\frac{2}{3912} \times 11,200 = 5·8 \text{ about.}$$

So that 1 c.c. of albumin, on this assumption, would be only about five times as heavy in the colloid as in the gaseous state. This fact may help to throw some light on the peculiar properties of colloids, and taken in conjunction with Herbert Spencer's reflections, on that most curious of all colloids:—protoplasm.

W. J. SOLLAS

A Claim for Precedence

IN reference to the notice of Favre in NATURE, vol. xxi. p. 417, I shall be obliged if you will kindly allow me space for a few remarks.

Credit for much valuable work is given justly to Favre, but I must be allowed to protest against having the few grains of corn belonging to others added to his well-filled granary. One of the discoveries ascribed to Favre in your notice is "the relative diminution in the heat evolved by the combination of a compound body compared with that due to the combustion of its varied constituents," or rather, the cause of it. Now he was not the discoverer of this, but I was. In October, 1851, I published in the *Philosophical Magazine* a paper proving that decomposition absorbs heat, and exactly to the same extent that the previous combination of the constituents had evolved it. I proved it by passing a galvanic current through water and finding the increase of temperature. This gave the heat produced by the resistance lessened by the decomposition of the water. Then, to find the heat of resistance undiminished by decomposition, I passed a similar current, as shown by a galvanometer, through a platinum wire offering the same resistance as the water, and surrounded by an equal quantity as in the first experiment. The difference of temperature in the two experiments was, of course, the heat absorbed by the decomposition.

In some twelve months or so after this publication, Favre and Silberman published in vol. xxxvii. of the *Annales de Chimie et de Physique*, p. 507, the very same experiment to prove the same principle, giving it as their own.

In 1852 a paper from me was read at the Belfast meeting of the British Association, and published the same year, in November, in the *Philosophical Magazine*, giving the first experiments made in thermo-chemistry in which decomposition is taken into account, and showing the principle by which the heat of combination of bodies can be known from that absorbed in their decomposition, and which has since been used in all thermo-chemical researches.

This principle and my experiments were published six months afterwards by Favre and Silberman (*Annales de Chimie et de Physique*, vol. xxxvii. p. 484) without allusion to me.

These publications and dates are easily to be referred to. It is no matter of opinion whether I should be looked on as the originator of thermo-chemistry as it at present stands, but it is a matter of fact that I am, as can be proved by the references I have given; and I think I should not be acting wisely to allow the credit of much labour and thought which is due to myself to be given to another, at least without protest. I do not, of course, want to compare myself with Favre, but I certainly claim, and prior publication establishes for me, the discovery of the principle that originated all the thermo-chemistry of the day which is generally given to him; nor do I expect that I will ever be given as an authority as long as scientific men can quote the names of Favre and Silberman; but I ask that, in fairness, my claim should be put on record, for although it makes very little difference to the world in general who first works out a discovery, yet to the individual whose only gain is the consciousness of having done it, the matter is quite a different thing.

Parsonstown, Ireland, March 9 THOMAS WOODS

The Origin of Man

SEEING that the doctrine of evolution has gained ground now almost universally among naturalists, it is surprising that the problem of the origin of man does not raise up an army of investigators, resolved to establish it by "demonstrative evidence" on an unassailable foundation.

It is true that this question has been engaging the attention of naturalists, and that individual explorers have devoted themselves to its solution, but little, if any, *united* effort has been organised hitherto. Were the matter taken up with as much earnestness as has been brought to bear on explorations in Assyria or Palestine, or in the Rocky Mountains of America, it is hard to believe that this question would long remain unsolved.

If the organisation of a society for the purpose of prosecuting research of the kind above indicated were widely agitated, there would not be wanting, I am convinced, either members or funds to further its success. By a strong united effort—international, if necessary—there is no doubt success would be achieved.

We are not utterly without a clue as to the time and place of man's origin. At least such hints as we possess it is our duty to follow up instead of standing by in idle perplexity as to where research should begin.

We now know that it is useless to look for the remains of Simian man in deposits later than pliocene, since the remains of man—not Simian man, but man truly so-called—have been found in pre-glacial and pliocene deposits in the New World as well as in the Old.

The simple fact of the distribution of man over both eastern and western hemispheres having been accomplished as far back as pliocene times, compels us to suppose that man had probably originated not later than the latter part of the miocene age. The discovery of anthropomorpha (*Pliopithecus* and *Dryopithecus*) in miocene deposits, while as yet eocene strata have only yielded lower members of the primates seems to point to miocene times as somewhat near the date of man's origination. So much for our present clue as to *Time*.

Next as to the Place. Inasmuch as the tertiary formations in the New World have produced hitherto no higher members of the primates than inferior types of monkeys and lemurs, except the recently discovered remains of man himself in pliocene deposits, the inquiry may be confined to the Old World.

In the Old World the most northerly position at which the remains of Anthropomorpha have as yet been found is about the forty-fifth parallel of latitude, namely, in Switzerland and in the south of France.

Now as the higher existing apes are only found in Western Tropical Africa and the Malay Archipelago, while the lower apes (the gibbons) extend into Southern China and Northern India. The migration, since miocene times, of the Anthropomorpha, has probably passed along a grand *Main Line* extending from China through Northern India, Baloochistan, Persia, Asia Minor into the south and south-west of Europe; and from this main line by *Two Branches*: one from Southern China into Malaysia, the other from the region of the Caucasus through Syria, and perhaps Arabia into Africa.

The nearer the form and habits of man in his most primitive stage resembled those of the apes, the more in all probability would his habitat or range have been identical with theirs. Therefore an examination of miocene or early pliocene deposits along this line and its diverging branches would scarcely be unattended with success in producing many fossil remains of very primitive or Simian man.

I trust I have said enough to indicate the direction which inquiry ought to take as far as present evidence goes, and I hope that a gigantic combined effort may ere long be made by all naturalists and all lovers of truth to attempt in a downright earnest manner the solution of this great question of the origin of man.

W. S. DUNCAN

The Stone in the Nest of the Swallow

WOULD any of your readers be kind enough to give me some information about the origin of the fable to which Longfellow refers in the following passage of his "Evangeline," Part I., at the end :—

"Oft in the barns they climbed to the populous nests on the rafters,
Seeking with eager eyes that wondrous stone, which the swallow
Brings from the shore of the sea to restore the sight of its fledglings;
Lucky was he who found that stone in the nest of the swallow!"

Leiden, March 19 P. P. C. HOEK

Carnivorous Wasps

SIR DAVID WEDDERBURN'S inquiry (NATURE, vol. xxi. p. 417) reminds me of my experience on this subject. Many years ago I was examining an apple-tree, when a wasp alighted on a leaf which formed a caterpillar's nest neatly rolled up. The wasp examined both ends, and finding them closed, it soon clipped a hole in the leaf at one end of the nest about one-eighth of an inch in diameter. It then went to the other end and made a noise which frightened the caterpillar, which came rushing out at the hole. It was immediately seized by the wasp, who, finding it too large to carry off at once, cut it in two and went off with his game. I waited a little, and saw the wasp come back for the other half, with which it also flew away.

After witnessing such evidence of intelligence I have had a great respect for wasps, and gave orders to my gardeners never to destroy one.

I gained some further evidence of their carnivorous taste when I once took my children to Switzerland for a holiday, and on a butterfly hunting expedition. We had spread out the day's find in the evening, and next morning I placed the boards in the sun to dry. On looking at them some hours later I found nearly all the bodies gone, only the thorax and wings left; and while examining them a wasp alighted on the board, and I soon proved that he was the culprit.

I have no doubt that wasps are most serviceable to gardeners by destroying caterpillars. R. S. NEWALL

March 21

Intellect in Brutes

SOME time since I observed the following conduct of two spiders, which will show how they sometimes overcome difficulties in the way of capturing their prey. A rather large house-spider had its web in the corner of a room, and during the summer it feasted upon the insects that were unlucky enough to be caught. One evening I noticed a large dipterous insect strike the web; the spider darted out and succeeded in fastening one foot of the fly. The spider then kept running back and forth, attaching a thread to a wing, then to a leg, which was soon broken by the violent efforts of the fly to release itself. The spider worked without ceasing for over half an hour to secure its victim; it then quitted operations, and retired to a distant corner of its web. After seeming to reflect for a while what was best to do, it left the web, went up the wall eight or ten inches distant, and entered a crack in the ceiling. I supposed at the time that the spider had been injured in the scuffle, but what was my surprise after a few moments to see the spider coming back, and close behind another followed; the two went on the web near the centre, and stopped side by side, apparently consulting as to the best mode of attack. Then at the same instant both spiders darted upon the insect, one towards the head, the other towards the tail. So rapid were their movements I could hardly follow them. In a short time the insect was securely fastened. Both spiders then returned to the centre of the web. Soon after the friendly spider went to the crack in the ceiling, while the other enjoyed the feast alone. A. M.

North Manchester, Indiana, U.S., February 25

Diatoms in the London Clay

YOUR correspondent, Mr. W. H. Shrubsole, inquires where sections may be seen in the lower part of the London clay. He will find a good exposure in a brick-yard, half a mile south-west of Roydon Station on the Great Eastern Railway; in another at Hadham Ford, on the Buntingford branch line, and several in the brick-fields near Bishop Stortford. In all these sections the lowest part of the London clay may be seen, resting upon sands, or loams, of the Reading series. Upon direct application, or otherwise, I shall be happy to supply Mr. Shrubsole with further information. W. H. PENNING

Granville House, Finsbury Park, N.

VISUALISED NUMERALS

SINCE I addressed a preliminary memoir to you on this subject,[1] so much curious matter has reached me that I trust you will permit me to state my views afresh, and to deduce some inferences. Many of my readers do not and cannot visualise, and few have the habit in a pronounced degree. I must, however, beg them not to consider their own minds as identical with those of every other sane and healthy person. Psychologists ought to inquire into the mental habits of other men with as little prejudice as if they were inquiring into those of animals of different species to their own, and should be prepared to find much in many cases that is quite unlike their own personal experience.

Persons who have the tendency to use mental pictures as the symbols with which they carry on their processes of thought, do so especially in the case of numerals. Thus, when they think of "six," the figure "6" arises before the mind's eye more readily and vividly than the sound "six" echoes in their mind's ear, or than any other perception of that numeral manifests itself. Now the peculiarity that I accidentally found out is this, that about one out of every thirty males, or fifteen females, not only visualise their numerals in this way, but also invariably assign to each of them a definite place in their mental field of view, where it seems to have a home. Thus 6 may always lie low down to the left, 7 may be found a little higher and more to the front, and so on. It follows that whenever these persons think of a series of numbers, as 1, 2, 3, 4, 5, &c., they always appear to the mind's eye as ranged in a definite pattern or "form." This form is stated in all cases to have been in existence at the farthest period to which recollection goes back, though in many cases it has insensibly grown until it included the higher numbers and even negative values. It is usually of a rambling irregular shape, and though constant for the same person, it differs very greatly in different persons. It may consist of a row or rows of faintly marked figures, suspended in the air or lying on a hazy ground, and when the mental eye travels along the row, each as it is looked at in succession becomes for the moment vivid. Or it may consist of a faint line with nothing on it, along which the eye is wont to travel until it reaches the place where the figure it wants is known to reside, and then the figure starts into sight. Or it may be a haze penetrated by faint lines. Or there may be no figures at all in the line, but only dots denoting position. The planes on which the forms lie slope in some cases up to the heavens, in others down to an immeasurable abyss. They often start a little below the level of the eye and rise gently upwards, reminding one of what the appearance of objects on a table would be to a child whose head hardly overtopped it. All these forms can be drawn in a way more or less satisfactory to those who see them, and I have now received nearly eighty drawings, in about

[1] NATURE, vol. xxi. p. 252.

equal proportions from either sex. I exhibited copies of fifty-four of them (made by a camera lucida) at the Anthropological Institute on Tuesday, March 9, when I read a paper on the subject. The meeting was attended by several of my correspondents, who are well known in the scientific world, and who explained to the meeting their respective forms. They were Mr. George Bidder, Q.C., the Rev. G. Henslow, Mr. Roget, Mr. Schuster, F.R.S., Mr. B. Woodd Smith, and Col. Yule, C.B. Two of these, namely, Mr. Henslow and Mr. Schuster, see the forms objectively; they can point to the direction in which at any moment any particular figure appears to them to lie, and when they move their eyes the form moves too. In the other four cases the close co-ordination between brain and eye does not exist, and their images appear in a sort of dreamland having no strict relation with external space. The form of each observer is quite unserviceable to the rest, having no meaning except to himself.

The language employed by persons in respect to some of the features of these forms is apt to be very similar. Phrases are frequently met with, such as "Ever since childhood I have always seen . . ." "I cannot account for their origin in any way;" "It is perfectly independent of the will." I have verbally questioned a great many acquaintances whether they see numerals in any particular way. They usually say No; they ask what I mean, then profess inability to understand my object, and evidently think it some nonsensical fancy. But I get my reward in the proportion of cases I have mentioned. I have already become familiar with the quick look of intelligence on these occasions, and with the reply in words denoting that the right chord had been struck. Then the details are poured forth. I am frequently told how the habit used to be mentioned to relatives, but was ridiculed, and had ceased to be spoken about; or again, how some particular brother or sister had the same habit, but that one only, and so forth. The more I follow up the inquiries, the more the accuracy of the first replies becomes evident; thus, I ask for fresh sketches, and they correspond to the first. The general result is, that these statements bear all the marks one could expect of being the reports of what is clearly seen and what the writer is anxious to describe exactly. Among my foreign correspondents whose names are well known to the scientific world, and whom I am permitted to quote, are M. Antoine d'Abbadie, the traveller, and Member of the Institute, and Baron von Osten Sacken, the Russian entomologist.

Now for the results. These forms (as distinguished from the figures now seen upon them) are survivals of a very early mental stage, and must have originated before the child learnt his letters. There is no nursery book or diagram that could suggest their fantastic shapes. Their very variety shows them to be derived from no common origin. They frequently turn with a left-handed twist, which written and printed things do not. They are more archaic than the alphabetical and historical forms used by the same persons, for these bear evident marks of their origin. The clock face has little or nothing to do with them, for its influence can only be traced in three cases. I believe the forms to have been mnemonic diagrams, invented by the children when they were learning to count *verbally*, the *sounds* of the successive numerals being associated with the successive points of the form. Also, that when the children began to read, the visual symbols of the numerals quickly supplanted the verbal ones, and established themselves permanently in their place. On this supposition we possess in these numerical forms a representation of the route along which the attention naturally travels in the mental field of view of the child. It is entirely the child's own way of working, and therefore true to his nature; and being natural, it persists through life and offers itself in the adult for our examination.

The characteristic run of the lines in each form has some general similarity to that of the correspondent's hand-writing, but it must testify more directly to his mental peculiarities than the latter. The form shows the ways that the mind most likes to travel by, but the hand-writing is a compromise between what the writer desires to produce under the joint guidance of a natural fancy, of education and of fashion, with what the muscles of the hand can most easily effect. These forms or natural lines of thought are, I presume, analogous to those that instinctively prompt each species of animal to make his lair, burrow, nest, or other piece of domestic architecture, on an identical plan, with trifling individual variations, and that prompts gregarious animals to group themselves always in the same sort of array. In these numerical forms we find real "psychograms."

One of the most obvious facts common to them is the curious proof they afford of the perplexity caused by our barbarous nomenclature of the numerals. We *say* "ten," "eleven," "fifteen," &c., when we *see* "one-nought," "one-one," "one-five," &c., and other civilised nations are as bad or worse than ourselves, as the French with their "soixante quinze." The way in which the perplexity is shown is by the wriggles and twists in the forms at 10 and 12 and by the exceptional length of the 'teens. It is not easy to describe in a few words what is so variously pourtrayed, but the general effect on looking at my collection is most striking. It is really painful to think of the vast amount of petty difficulty to the existence of which this indisputable testimony is given. The difficulty does not cease with childhood, else the twists would have been smoothed away, and I am sure from trials on myself that I for my part still feel it much. I can dictate more easily by saying on-one, on-two, &c., and I can write and sum from dictation much more quickly when some such plan is used. It should be adopted by those who want to remove as much friction as possible from their brain-work. I have little doubt that the conflict between our language and our notation is a serious though unsuspected hindrance to the ready establishment of decimal weights and measures.

I find from inquiries made for me at schools that young people see forms more commonly than adults, but that their forms are less developed and sure. I conclude that where they are vivid and serviceable they are much used, and insensibly grow in vividness, in definition, and in automatic character. Otherwise they decay from disuse and become forgotten. Hence arises the rather sharp division between the seers and non-seers in adult life.

I am still desirous of more information on this subject, especially concerning children, and on colour associations with figures, letters, and words.

42, Rutland Gate, London FRANCIS GALTON

THE TELEPHONIC EXCHANGE IN THE UNITED STATES

THE telephone has already become firmly established in America as a medium of daily communication. Eighty-five towns are thus connected, and to the various telephonic companies there are 70,000 subscribers, and the number is rapidly increasing. For some details as to the working of this method of intercommunication we are indebted to our French contemporary *La Nature*. If we enter the great hall of the central office of the Merchants' Telephone Exchange at 198, Broadway, New York (Fig. 1), we see a series of "Switchmen" engaged in establishing communications among the subscribers. There is a switchman corresponding with one of the subscribers who has called (Fig. 2); further on is another *employé* engaged in raising the notice signal. In the city, in the subscriber's house or office, is the office telephone, which is set up in a great number of houses; this model is very convenient for business, for it permits of speaking into the mouth-piece placed on the left, of listening with the telephone, which is unhooked to apply to the ear, and at the same time of taking notes on the desk with the free hand.

The Broadway system of telephones belongs to the class of Pile Telephones, which allows these piles to be used to call the attention of the subscribers by means of ordinary bells, like the one in the desk, Fig. 4.

The transmitter is Edison's carbon telephone, based on the variations in electric resistance produced by variations of pressure which the plate exercises when we speak in front of the mouthpiece. The circuit is formed by the pile, two Leclanché elements, the transmitter, and a small Ruhmkorff coil. It constitutes the primary circuit of the coil. The line and the receiver of the other post are connected by the secondary wire of the bobbin, a wire whose other extremity is connected with the receiver of the post and with the earth. It follows that the line-currents are currents induced by the variations of activity of the current which traverses the primary wire of the coil. This arrangement has the effect of transforming into currents of tension the undulatory currents of the transmitter, of rendering them less sensible to the variations of resistance of the line, of facilitating the adjustment and suppressing a part of the commutators, the management of which might cause mistakes.

The receiver is a Phelps telephone, analogous to the Bell telephone, but the magnet of which is turned round in the form of a ring, which renders its management very easy (Fig. 4). In the position of repose or waiting, the telephone hangs on its hook, and by this fact alone, it comes into contact with a part forming a commutator, which suppresses all the telephonic part of the circuit, in order that the bell alone may intervene. Everything is thus ready for a call.

FIG. 1.—Interior view of the administration of the Merchants' Telephone Exchange, New York.

The telephones of the central post, speaker and receiver, are analogous to those of the subscribers; but to facilitate the management of these apparatus the speaker and receiver are mounted on the same steel stem, somewhat bent to serve as a handle, as in Fig. 2, and forms at the same time the magnet of the receiver. We may now follow all the series of operations. Suppose subscriber No. 731, whom we will call Edward, wishes to correspond with 511, whom we will call John. Edward begins by pressing on a small knob on the right side of the desk, Fig. 4. As the telephone is suspended it follows that in that position the current of Edward's pile traverses the line and a small electro-magnet in the central office; the electro-magnet, becoming active, detaches a small door (Fig. 2), which falls with a noise sufficient to call the attention of the *employé*, and exposes the number 731. The *employé* then places himself in communication with Edward, by placing the wire which corresponds to his telephone on a longitudinal copper bar also connected with Edward's line. The conversation then begins with the useful shout of hallo! hallo! Edward asks the *employé* to place him in communication with No. 511. If No. 511 is free at the moment the *employé* presses a knob after having connected the wire of No. 511 with the knob. The bell of John is set agoing, and when he himself is ready to correspond he presses the knob of his bell, which causes the door of his number to fall. By then placing a wire of communication directly between the two horizontal bars which correspond to the wires of Edward and John, direct communication between these two correspondents is established. If at this moment the *employé* is obliged to withdraw his telephone the communication between Edward and John is secret. If while these two are in conversation No. 42, James, wishes to correspond with John, for example, the *employé* may join in the conversation of the two interlocutors just like a servant announcing a visitor. If required, conversation may be established between the three subscribers. When the conversation between Edward and John is ended, they each hang up their telephones and press upon the

Fig. 2.—Switchman corresponding with a subscriber.

knobs, when the number of each is again exposed at the central post. The *employé* then knows that the conversation between the two subscribers is ended; he raises

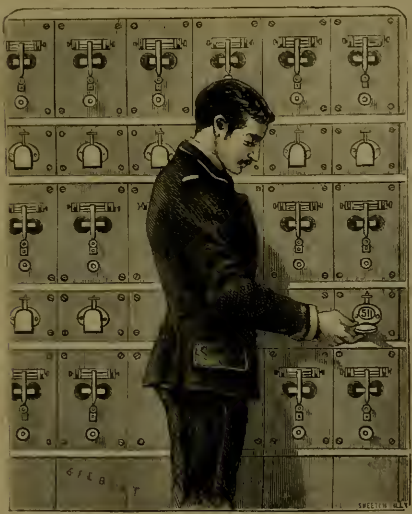


Fig. 3.—Another *employé* raising the warning si ,nal.

the door, suppresses communication between Edward and John, and all is ready for a new call.

In posts where there are 500 or 600 subscribers the numbers are arranged in order on tables containing each 500 to 100 doors; special arrangements are then employed to bring the series into communication with each other. At New York the central office makes not less than 6,000 communications daily, and everything is conducted to the complete satisfaction of the subscribers. The telephone has become for them as indispensable as the omnibus or hansom for London. Every month a list of subscribers is distributed from the central office. The Chicago list already forms a small volume. The Ameri-

Fig. 4.—Telephone fitted up in a subscriber's office at New York.

can District Telegraph Company has greatly extended its services, and informs its subscribers that in three minutes after they call a liveried servant will be at their doors to distribute notes, circulars, &c., carry parcels, accompany a lady or a child to any place desired, or go for them, carry umbrellas to the children at school on a wet day, fetch the doctor, a cab, &c., &c., at any hour. We believe a beginning has been made in London of this invaluable means of communication; we trust that some arrangement will be come to with the Post Office authorities that will permit of its becoming universal. Its advantages are patent.

AN AMERICAN SEA-SIDE LABORATORY

THERE are some persons who, in their enthusiasm for doing a good thing, are led to mistake the name for the deed and to make as much fuss and general congratulation over an utterly inadequate representation of the good thing aimed at as would only be justified by the accomplishment of the good thing itself. One would have no special remark to offer on such curious self-deception, were it not that very frequently harm is done in connection with it in consequence of the enthusiastic individuals deceiving not only themselves but the public. Thus a worthy object is liable to be shelved or put aside from public attention on the ground that it has been accomplished, when really there has been only the most ridiculous pretence (consisting in the use of empty words), of attaining a long-desired and important end. Not only this, but such shams having once passed currently for the real things, the name of which has been delusively assigned to them, and subsequently having proved to be failures and wind-bags, the real worthy object in the name of which they have been paraded, suffers. It is only too readily accepted by the unbelieving Philistine that such-and-such a scheme has been tried and has proved to be a failure, when in reality only a puffed-up substitute, and not the scheme in question, has ever had a chance.

The term "zoological station" is suggestive of these remarks. The term was introduced by Dr. Anton Dohrn when about to establish at Naples a large aquarium connected with a series of laboratories, worked by a permanent staff of scientific observers and of fishermen and other attendants. Dr. Dohrn had a very clear notion of what he meant by a "zoological station," and has shown what that notion was by carrying it fully into effect, devoting thereto indomitable will and untiring energy. Dr. Dohrn's notion of a zoological station was an institution which should play somewhat the same part in zoology as the State astronomical observatories do in astronomy. A favourable locality was to be chosen, a building erected with all appliances for observation, and a staff of workers employed in making observations. A special feature in these "stations" was, however, anticipated, and has proved in the working of that at Naples to be a practical feature, viz., that capable investigators would from time to time leave their home-avocations and come to make observations for a few months at a time in the well-equipped well-located "station." The total cost of erecting and fitting the Naples zoological station cannot have been less than from 12,000*l.* to 15,000*l.*, whilst its income derived from various endowments and fees, and expended upon its maintenance and in the salaries of its officials is not less than 3,000*l.* a year.

That any enthusiastic young person who may unfold his umbrella on the sea-shore and contemplate under its shadow the starfish washed to his feet—should say that he has "opened a zoological station" may be strictly true so far as the etymology of the words "zoological" and "station" respectively is concerned; but it is at the same time a misleading announcement, and likely to do more harm than good to the cause of zoological stations.

There is no need to call a little sea-side laboratory by the pompous title which gains its connotation from Dr. Dohrn's magnificent institution on the Mediterranean shore, and it is a very satisfactory thing that such laboratories, open under certain conditions to naturalists who wish to make use of them, are coming into existence. At Concarneau, on the Brittany coast, the French Government had started a laboratory (under M. Coste) even before Dr. Dohrn's enterprise at Naples; M. de Lacaze Duthiers has since established a small laboratory at Roscoff, and the Austrian Government has constructed a laboratory and aquariums at Trieste which may one day rival those of Naples in extent and completeness.

Soon after Dr. Dohrn's institution had been set going, a liberal American offered to the late Prof. Agassiz the island of Pennikese as a site for a "zoological station." The attempt was forthwith made to make bricks without straw; a class of students were landed on Pennikese, and after a sort of holiday pic-nic of some weeks, returned home. No money was forthcoming to build the necessary laboratories and to maintain the necessary staff of scientific and other employés; so the Pennikese "station" was quietly and very wisely dropped. Mr. Alexander Agassiz has since constructed for himself (and described in NATURE) a private laboratory on the coast where he carries on his own admirable researches, and can receive three or four other naturalists, and give them working-room. This is no doubt the reasonable thing to do, supposing a limited sum of money is at command. It is of no use to proclaim in the absence of abundant straw that you are about to start a fine brick-field; you must either abandon the business altogether or be content to make a quiet little heap with the aid of what straw you have at command.

These things cannot be done without money, and at present the public in England and America will not subscribe so handsomely towards the erection of the first zoological station as they do to that of the fifty thousandth church. They were taught long ago to subscribe to church-building by the example of states and princes. It requires some such initiation to render the subscription lists of zoological stations popular.

In the absence of paternal governments and intelligent princes, where can zoologists look for the supply of the funds necessary to start zoological stations, necessary even for more modest institutions which may be called "sea-side laboratories"? Assuredly it is the business of *Universities* possessing some disposable funds and as yet free from the imbecility which Government commissions leave as their mark upon commission-ridden academies, to start such laboratories. Oxford or Cambridge, or both together, might support a very nice little laboratory at Guernsey, or Falmouth, or Arran, which would be managed by a resident director, and continually frequented in vacation time by the advanced students of the Universities, as well as by other naturalists from all parts of the country. It seems, however, improbable that such a laboratory will be *immediately* started by either Oxford or Cambridge. It is probable that the newest of universities, and one of the most active and efficient, if we may judge by the work produced by its students, fellows, and professors, viz., the Johns Hopkins University of Baltimore, U.S.A., will be the first to possess a sea-side laboratory of its own.

Already in the year 1878, Mr. W. K. Brooks, now assistant Professor of Comparative Anatomy in the University, was charged with the superintendence of a summer class in a temporary laboratory at Chesapeake. The scientific results of this session have been published by Mr. Brooks, and include some good observations by students of the University, besides his own—the more interesting notices relating to the development of Lingula and of Gastropod molluscs.

Last year Mr. Brooks was engaged on the study of the development of the oyster, and subsequently undertook again the direction of a temporary laboratory on the coast where work was done as yet unpublished. There is now a probability that the Chesapeake laboratory may be placed on a permanent footing, and it is, perhaps, pardonable for Transatlantic colleagues to express the opinion that such a step would be one of great and serious importance for the welfare of zoological study. It is quite evident that at Chesapeake there is access to a varied and abundant fauna, including some of the most interesting of marine forms, some not to be met with in European waters. It is also clear that there are capable students ready to avail themselves of the facilities of a laboratory, and energy and talent of the right kind to keep the institution at work. The spasmodic descent upon the sea-coast in a summer vacation, which is all that many a naturalist can, under present conditions, afford, is a very delightful thing, and may sometimes lead to the collection of a few new species of one group or another: but it is not in this way that the zoology of to-day can be forwarded. Protracted and minute study of the steps of development of all organisms is what is now necessary, and, similarly, careful observation at all times of the year of the habits and changes of adult forms. For this purpose a naturalist should be permanently (at any rate during a portion of his career) resident upon the coast. There is, further, a more obvious advantage and a very real one in the conditions of a permanent sea-side laboratory. The locality becomes *thoroughly well known* to the naturalists who frequent it; the accumulated knowledge is handed on from year to year, until at last what were regarded as the rarest or most out-of-the-way animals can be fished up at five minutes' notice, and the time of appearance of this or that form, of the eggs of another, of the larvæ of another, is so precisely ascertained that the zoologist can go—not in his present hap-hazard fashion, to study anything which may turn up—but definitely primed and prepared to settle an important question in relation to a form which he is sure to obtain.

These advantages, and the honour of being the first University to possess a sea-side laboratory of its own, cannot be secured by the Johns Hopkins University without a certain definite outlay of money. What may be the cost of buildings and of permanently employing a fisherman, two attendants, and a scientific director in the United States, it is difficult to guess, but nothing less than an expenditure of 5,000*l.* on the building and an annual outlay of 700*l.* would give such an experiment a fair chance of success in this country.

E. RAY LANKESTER

THE SOLUBILITY OF GASES IN SOLIDS

MESSRS. HANNAY and Hogarth recently communicated to the Royal Society an important paper on the Solubility of Solids in Gases. The subject, an outline of which was given to our readers in an abstract of a preliminary paper by the same authors a few weeks ago, has attracted the more notice since it led Mr. Hannay to the research upon the artificial production of crystallised carbon, which is associated with his name.

The original purpose of Messrs. Hannay and Hogarth in undertaking this research was to investigate the condition of gases at their "critical point" with respect to their solvent power. For if at the critical point there really occurs a transition from liquid to gaseous state, and if the property of solids is one possessed by liquids alone, there ought to be precipitation of the dissolved solid matter as the substance passes through the critical point. If no such precipitation occurred, this would furnish an independent proof of the perfect continuity of the liquid and gaseous states, in addition to the proofs derived from the observed relations of temperature and pressure, and from the inability of optical tests to discriminate between gas and liquid in the condition of matter raised above its critical temperature.

A simple qualitative experiment was therefore undertaken as a preliminary test of the matter. "A solution of potassic iodide in alcohol was prepared, and a strong tube filled to about one-half with the solution. After sealing the tube was placed in an air-bath, and heat applied. No precipitation of solid could be seen even at a temperature of 350° C., more than 100° C. above the critical point of alcohol." A solution of resin in paraffin spirit showed no trace of decomposition at 360° C. under similar conditions.

To permit of experimenting under more exact conditions, a modification of Andrews's apparatus was devised, which, from its simplicity and efficiency deserves mention. A T-tube of wrought-iron of ½-inch internal and 1-inch external diameter was furnished with wrought-iron screw caps. Through one of these the pressure-screw works; through the opposite end the experimental tube is fixed. The side-branch, about 3 inches long, admitted an air-manometer. The apparatus, which was less than 12 inches in length, was filled with mercury. The device for packing consisted in the employment of stout india-rubber plugs. Where the pressure-screw passed through the rubber the latter was protected by a greased leather lining. When high pressures were employed the tube was cemented in with oxychloride of zinc. This extremely simple method of packing was so perfect as to give freedom of motion without leakage even at the enormous pressure of 880 atmospheres.

With this apparatus it was demonstrated that a clean crystal of potassic iodide dissolved gradually away in pure alcohol gas (the term *gas* referring, as Andrews suggested, to the fluid, at any temperature *above* its critical point). Bromide of potassium, and chloride of calcium were also found to be soluble in alcohol gas. Cobaltous chloride remained in solution at 320° C., and continued to exhibit its characteristic blue colour. It even showed a spectrum identical with that shown at 15° C. The spectrum of the acid decomposition product of chlorophyll similarly dissolved in alcohol, gives identical spectra at 350° C., and 15° C., though in air it decomposes below 200° C.

Other experiments with sulphur, selenium, and arsenic in bisulphide of carbon gave interesting but less conclusive results. The question whether the critical point of a gas is altered by having a solid dissolved in it appears to be affirmatively decided; for the authors found that while the critical point of pure alcohol is 234°·6 C. at a pressure of that of 65 atmospheres, alcohol containing potassic iodide was 237° at a pressure of 71·1 atmospheres.

Further attempts were made to obtain solutions of sodium in ammonia, gas, and hydrogen, in the latter case with partial success.

As a final conclusion the authors claim that "these experiments, made at temperatures much further removed from the critical point than those from which Andrews reasoned, afford further proof of the perfect continuity of the liquid and gaseous states, and also complete proof of the solubility of solids in gases.

THE LATE MR. THOMAS BELL, F.R.S.

TO few men does English biological science owe more than to the veteran zoologist whose death we briefly recorded in NATURE, vol. xxi. p. 473. Born at Poole, in Dorsetshire, on October 11, 1792, Thomas Bell was educated as a surgeon-dentist, and on his establishment in practice in London he soon gained a high professional reputation. From an early period of life he devoted his leisure hours to zoological studies, and the fruits of his careful and conscientious labours are preserved in his numerous contributions to the *Transactions* and *Proceedings* of the Linnean, Geological, and Zoological Societies, and in his well-known manuals on "British Quadrupeds," "Reptiles," and "Stalk-eyed Crustacea." These latter formed part of the series of works published by Mr. Van Voorst, which have done so much to spread a knowledge of the natural history of our islands; and Mr. Bell was specially adapted to such a task, having a happy faculty of conveying scientific information in such a form as to be attractive to the general reader. A still more important undertaking was his illustrated folio, "Monograph of the Testudinata," begun in 1836, but unfortunately the publisher failed when only eight parts had appeared; the plates, along with some which had remained unpublished, were re-issued to the public in 1872 by Mr. Sothern, with letterpress by the late Dr. J. E. Gray.

But the services which Mr. Bell rendered to science were far from being confined to his published writings. From 1848 to 1853 he was one of the secretaries of the Royal Society, of which he had been elected a Fellow in 1828, and his business habits, energy, and personal popularity enabled him greatly to advance its interests. On his resigning this secretaryship in 1853 he was elected President of the Linnean Society, of which body he had been a member since 1815. Neither the scientific standing nor the financial position of the Society were then in a state at all worthy of its name and traditions, and the new President set vigorously to work at its reform. By personal example and influence in procuring suitable papers and in assuring good attendances, by an active enlistment of new members, and a rigorous supervision of expenditure, and by generous private donations to the funds, Mr. Bell was completely successful in his object. Up to nearly the close of his long life he was in the habit of coming to town to attend the anniversary meetings of a society of which he may almost be called the second founder.

In 1866 Mr. Bell purchased The Wakes, Selborne, from the grand-nieces of Gilbert White, and the last twenty years were spent by him there in peaceful retirement, but not in idleness. Giving up systematic scientific work, as well as professional practice, he devoted the long evening of his life to observation in the field, especially of birds and plants, and to the reverent study of the life and labours of the famous historian of his adopted home. Only three years ago, at the age of eighty-five, he published an edition of the "Natural History of Selborne," which may safely be said to be by far the best of the numerous issues of that classic work.

In his Hampshire retreat, as in the heat and bustle of metropolitan life, Mr. Bell retained all the charm of manner and fine qualities both of heart and mind, which endeared him to all who had the privilege of knowing him; and up till very recently his robust health enabled him to bear the weight of years lightly as an honour rather than a burden. Under Gilbert White's roof-tree he died peacefully on Saturday, the 13th instant. By his death the scientific world seems to have lost one of its last links with a generation of good and faithful workers whose labours are too apt to be overlooked in the stir and struggle of controversies of the day.

NOTES

We continue this week, by the courtesy of General Myer, our monthly series of Meteorological Charts for the Northern Hemisphere, compiled by the U.S. Signal Office. The present map shows the mean pressure, temperature, force, and direction of wind for June, 1878. To meteorologists the lessons of the chart will be plain; the next one which we issue we hope to accompany by an article explanatory of the purposes and utility of the whole series.

After Easter the Royal Society is to meet at half-past four in the afternoon instead of half-past eight in the evening.

The keepership of the mineralogical department of the British Museum has become vacant by the resignation of Prof. Story-Maskelyne, F.R.S., who is a candidate for the representation of Cricklade in the new Parliament.

The work of casting the lenses of the great refracting telescope of the Paris Observatory has already begun at Feil's establishment. The founding of the flint disc has taken five days, and the annealing a full month. A like operation will soon take place for the Bishofsheim Observatory instrument.

The *Melbourne Argus* says:—"The Count de Castelnau, for many years French Consul at Melbourne, died yesterday (February 4) at his residence, Apsley-place, East Melbourne. The deceased gentleman was an ardent student of natural history, and had pursued his studies in the various parts of the world whither his official duties led him. He was director of the Scientific Expedition sent by Louis Philippe, the King of the French, to South America, and was afterwards French Consul in divers parts of the southern hemisphere. While at the Cape of Good Hope he wrote a "Mémoire sur les Poissons de l'Afrique Australe." When he returned to Europe and began to put his voluminous notes in order, he made the disheartening discovery that while he had been temporarily disabled his servant had been for more than a month in the habit of using the sheets of paper on which he had bestowed so much time and labour to light the fires. He disposed of the remainder of his notes and drawings to Prof. Lacordaire, and about 1862 arrived in Melbourne, where he has since resided. Count Castelnau was an active member of the Zoological and Acclimatisation Society of Victoria. He contributed several valuable papers on the fishes of Australia, which have been published by the Society, and are recognised by naturalists as works of authority on the subject."

The American Philosophical Society of Philadelphia, the oldest scientific society in America, celebrated the one hundredth anniversary of its incorporation by a public dinner at the St. George Hotel, on March 15. The Society was founded May 25, 1743, and incorporated March 15, 1780.

An American correspondent writes that on March 30 and 31 the ninth annual meeting of the American Fish Cultural Association takes place. This association is by no means local in its character, but has extended fish culture all over the United States. It was through its exertions that the Government was induced to form the U.S. Fish Commission, with the secretary of the Smithsonian at its head. Among the members of the Association are found most of the leading icthyologists in the United States, with all of the Canadian officers who have Her Majesty's Provincial Fisheries under their charge.

A telephonic line has been formed between the meteorological station on the Pic du Midi and Bagnères-de-Bigorre (30 kilometres distance). General de Nansouty writes in high terms of the Edison telephone, which he is using.

The Observatory at Mannheim has been removed to Karlsruhe.

The Vesuvius railway from the observatory to the crater will be opened in April.

A correspondent of *La Nature* sends that paper a photograph of a curious phenomenon met with in the cold of December last. It shows a bottle which contained a solution of nitrate of silver (1 per cent.). The cork is forced out and imprisoned at the extremity of a long cylinder of ice, due to increase of the volume of the mass in freezing. The bottle was also cracked, and several pieces detached.

The cold room established by Tellier at the Conservatoire des Arts et Métiers for the fabrication of standard metres and kilogrammes on behalf of the several foreign governments in the international union, is not to be discontinued when the International Observatory at St. Cloud is finished. The apparatus will be sold to the French Government and used by it for the fabrication and comparison of standard kilograms and metres to be used in the several public conservatoires of France and the Colonies.

The annual meeting of the West London Scientific Association was held on Tuesday, followed by a *soirée* and a varied and interesting exhibition.

There was a shock of earthquake on Monday at Poitiers and Chatellerault.

A number of pneumatic clocks have been installed by a Viennese speculator on the Paris Boulevards for the distribution of the time, in competition with the electric system advocated by Leverrier and now in course of experimentation. Three systems, Breguet's, Garnier's, and Redier's, which have been successful in a first competition, are to be tested successively.

It may be noted in confirmation of the theories advocated by Mr. Blandford in our last issue, that the period of north winds, clear skies, and high pressure set in in France in October 1878, and has continued without any long interruption up to the present moment. The date of the beginning of that remarkable period is almost the same as the end of the high-pressure period noted in India and the great Archipelago of Asia.

M. TIRARD, the French Minister of Agriculture, has directed the Prefects to report what kinds of fruit trees, pines, vines, and cereals suffered most and least from the December frost, in order that hints may be obtained for agriculturists, &c. The damage sustained by the Paris parks may be judged from the fact that in the Bois de Boulogne 54,000 evergreens, 20,000 firs, and 30,000 deciduous trees are required to fill up gaps, while in the Champs Elysées 3,200 trees were killed and 6,000 require cutting down to the roots. The total loss to the Municipality in the parks, avenues, and nurseries is calculated at a million francs.

As we stated last week, the council of magistrates of the city of Berlin had under consideration a few days ago a proposal, submitted by the firm of Siemens and Halske, for the construction of an electric railway across a portion of the capital. The line would start from the Belle Alliance-place, and run through Friedrich and Chaussée streets on to the Wedding-place. There will be two lines of rails, one for the up and the other for the down journey. The viaduct will be carried on iron pillars 14 feet 9 inches high, and nearly 33 feet apart. These pillars will be placed along the edge of the footpath, so as to cause the least possible interference with the ordinary traffic. The carriages will be narrow and short, containing ten sitting places and four standing places. The electro-dynamic machine which will propel the carriages will be placed under the floor of the carriage between the wheels, and a steam-engine of 60-horse power, which will be employed in the production of the electricity, will be placed at the terminus. The stoppages will be very few, and the rate of speed will be, it is expected, about twenty miles an hour. The chief object of the undertaking is to convey persons quickly across the city, and especially to facilitate access to the city line of railway.

AT a recent meeting of the Boston Society of Natural History, Mr. F. W. Putnam gave an account of his explorations of the ancient mounds and burial-places in the Cumberland Valley, Tennessee. The excavations had been carried on by himself, assisted by Mr. Edwin Curtiss for over two years, for the benefit of the Peabody Museum at Cambridge. During this time many mounds of various kinds had been thoroughly explored, and several thousand of the singular stone graves of the mound-builders of Tennessee had been carefully opened. The material obtained from the explorations is now arranged and on exhibition in the Peabody Museum. Mr. Putnam's remarks were illustrated by drawings of several hundred objects obtained from the graves and mounds, particularly to show the great variety of articles of pottery and several large and many unique forms of implements of chipped flint. He also exhibited and explained in detail a map of a walled town of this old nation. This town was situated on the Lindsley estate, in a bend of Spring Creek. The earth embankment, with its accompanying ditch, encircled an area of about twelve acres. Within this inclosure there was one large mound with a flat top, 15 feet high, 130 feet long, and 90 feet wide, which was found not to be a burial-mound. Another mound near the large one, about 50 feet in diameter and only a few feet high, contained sixty human skeletons, each in a carefully-made stone grave, the graves being arranged in two rows, forming the four sides of a square, and in three layers. From these graves many interesting articles were obtained. The most important discovery he made within the inclosure was that of finding the remains of the houses of the people who lived in this old town. Of them about seventy were traced out, and located on the map by Prof. Buchanan of Lebanon, who made the survey for Mr. Putnam. Under the floors of hard clay which was in places much burnt, Mr. Putnam found the graves of children. As only the bodies of adults had been placed in the one mound devoted to burial, and as nearly every site of a house he explored had from one to four graves of children under the clay floor, he was convinced that it was a regular custom to bury the children in that way. He also found that the children had been undoubtedly treated with affection, as in their small graves were found many of the best pieces of pottery he obtained, and also quantities of shell-beads, several large pearls, and many other objects which were probably the playthings of the little ones while living.

AT a subsequent meeting of the same Society, Mr. Putnam made a communication on the principles involved in the ornamentation of the pottery of some of the ancient nations of America, with particular reference to that from the Cumberland Valley in Tennessee, and from Nicaragua; illustrating his subject by a fine series of vessels of various shapes, selected from the Peabody Museum of American Archæology and Ethnology. After a general review of the methods of ornamentation employed by American nations of the past, he showed that, by a study of such large collections as those in the Peabody Museum, the artistic development of the ancient peoples of America was far greater than generally stated by writers; and that the art of ornamentation had, in many instances, risen above the simple patterns made by incised lines, rude stamps, and other early and crude forms. Both in colour and plastic work a realistic art had been produced which had often resulted in conventionalisms of great interest. He also stated that a study of this ancient pottery, with these principles of conventionalism borne in mind, would not only place some of these ancient American nations in a much higher artistic period than formerly supposed, but would also lead to the understanding of many of the singular ornaments on the ancient vessels, many of which, without this knowledge of the existence of realistic and conventional art, would be looked upon as crude and meaningless attempts at ornament, whereas, as he showed by several series of specimens, the simple knobs arranged symmetrically about a pot or water bottle, were instances of pure conventionalism from realistic forms, and prove that a comparatively high attainment in the decorative art had been reached. A proper and careful study of the principles involved by this interpretation of the artistic development of the ceramic art in America, he thought, would in time furnish means of making comparisons in regard to the probably connection of one ancient American nation with another, and also an understanding of many of the singular resemblances between widely separated peoples. Still, he said, the whole subject was yet in its infancy, and the connection of one ancient people with another in America can at present only be suggested from very unsatisfactory data.

THE following are among the papers to be read at the meetings of the Society of Arts after Easter, so far as the arrangements are yet complete:—April 2, "The Best Route for a Line of Railway to India," by B. Haughton, C.E. April 6, "Art in Japan," by C. Pfoundes. April 7, "Buildings for Secondary Educational Purposes," by E. C. Robins, F.S.A., F.R.I.B.A. April 8, "Recent Improvements in Benzine Colours," by F. J. Friswell, F.C.S. April 14, "The History of the Art of Bookbinding," by Henry B. Wheatley, F.S.A. April 16, "Russia's Influence over the Inhabitants of Central Asia during the last Ten Years," by Prof. Vambéry. April 21, "The Present System of Obtaining Materials in use by Artist Painters, as compared with that of the Old Masters," by W. Holman Hunt. April 22, "On Some Recent Advances in the Science of Photography," by Capt. Abney, R.E., F.R.S. April 27, "Iceland and Its Resources," by C. G. W. Lock. April 28, "Recent Improvements in Gas Furnaces for Domestic and Laboratory Purposes," by Thomas Fletcher. May 5, "The last Forty Years of Agricultural Experience," by John C. Morton. May 7, "The Present Condition and Prospects of Agriculture in South India," by W. Robertson, M.R.C.A.

May 13, "The Optical Properties of Crystals, and some of their Practical Applications," by Prof. W. G. Adams, F.R.S. The course of Cantor Lectures, which will be delivered during the same period, will be the third for the present session. It will consist of six lectures by Mr. R. W. Edis, F.S.A., on "Art Decoration and Furniture," to be given on the following dates:—April 5, 12, 19, 26; May 3, 10.

In a report which he has addressed to the Department of Finance and Commerce at Calcutta, Mr. E. Colborne Baber, lately H.M.'s Consular representative at Chungking, furnishes some very interesting information respecting the western frontier of China, to one part of which, however, we can only allude. During his travels in the mountainous region west of Kiating-fu, in Szechuen, Mr. Baber discovered two kinds of tea of a very unexpected nature. In the monasteries on Mount Omi (or Ngomi) he was given an infusion of tea which is naturally sweet, tasting like coarse congou with a plentiful addition of brown sugar. It is only grown by the monks on the slopes of the mountain, and two days' further west its existence was unknown. The other variety, odd as it may appear, has a natural flavour of milk, or perhaps more exactly of butter. What is most interesting is the fact that it is wild tea, growing in its native elevated *habitat* without cultivation, and an unimpeachable instance of a wild tea-plant has, Mr. Baber affirms, never yet been adduced in China. This wild tea is found in the uninhabited wilderness west of Kiating and south of Yachow, at heights of 6,000 feet and upwards, and was described to Mr. Baber as a leafy shrub 15 feet high, with a stem some 4 inches thick. Every part of the plant, except the root, is used for making the infusion; the wood is chopped up and put into a kettle of water with the dried leaves and twigs, and being boiled yields a strongly coloured but weak tea, possessing a buttery flavour, which gives it some resemblance to the Thibetan preparation. Mr. Baber only found it in the Hwang-mu-chang plateau, a terrace perched among the stupendous gorges of the Tung river.

The letter on the "Tay Bridge Storm," which appeared in Nature, vol. xxi. p. 443, was written by the Hon. Ralph Abercromby, and not by Sir Ralph Abercromby, Bart., as erroneously stated.

The additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseo-viridis*) from North-East Africa, presented by Mr. W. C. Gordon; a Sykes's Monkey (*Cercopithecus albogularis*) from East Africa, presented by Mr. E. S. Savage; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, presented by Mrs. Ladell; two Spanish Ichneumons (*Herpestes widdringtoni*) from Andalusia, presented by Mr. J. C. Forster; a Caffer Wild Cat (*Felis caffra*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; three Impeyan Pheasants (*Lophophorus impeyanus*) from the Himalayas, a Square-spotted Snake (*Oxyrrhopus doliatus*) from South America, deposited; four Concave-casqued Hornbills (*Buceros bicornis*) from India, a Brazilian Cariama (*Cariama cristata*) from Brazil, two White-backed Trumpeters (*Psophia leucoptera*) from the Amazons, a Redshank (*Totanus caladris*), British, purchased; two Common Badgers (*Meles taxus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

Suspected Variable Stars.—Mr. Tebbutt, of Windsor, N.S.W., has drawn attention to the variability of the star B.A.C. 2472, which he appears to infer from its occurrence as a sixth magnitude in the occultation list of the *Nautical Almanac*, and his ineffectual attempt to observe its occultation on April 22, 1874, added to the circumstance of its present brightness not exceeding the eighth magnitude. But it seems probable that the supposed variability arises from an oversight of Taylor's in his observations either in 1834 or 1835. In vol. iii. of the Madras Observations it is certainly rated 6m., and Baily has followed Taylor in the British Association Catalogue, whence the *Nautical Almanac* estimate of magnitude was no doubt taken. Lalande, who observed the star twice, rated it 8 and 8½, D'Agelet, Piazzi, Bessel, and Argelander in the *Durchmusterung*, 8·0; so that observers, with the exception of Taylor, agree, and as he did not observe the star closely preceding on the parallel 65 Geminorum in 1834 or 1835, we may suspect that the magnitude of this star was inadvertently attributed to B.A.C. 2472, though his position undoubtedly refers to the latter star. Mr. Tebbutt also mentions that he has reason to think the neighbouring star, Lalande 14571, is variable; in this case there are not published data to guide us: it is 8½ in the "Histoire Céleste," 8 and 8·9 in Bessel, and 8·1 in the *Durchmusterung*.

The Southern Comet.—Mr. Gill, in a letter dated—Royal Observatory, Cape of Good Hope, February 24, incloses an approximate orbit of the great southern comet, calculated by Mr. Finlay, the first assistant. The elements are as follows:—

Perihelion passage, January 27·55 G.M.T.

Longitude of perihelion	280° 16′
,, ascending node	123 24·5
Inclination	75 12
Logarithm of perihelion distance	7·90315

Motion—direct.

It will be remarked that this orbit is entirely different to that we published last week, which was deduced from the only positions available for the purpose—the very rough ones forwarded by Mr. Gill on February 17. From the same approximate data an orbit was also calculated at Lord Lindsay's observatory, with results almost identical with those in Nature, but which were received too late for insertion last week. It is to be presumed that Mr. Finlay will have availed himself of the accurate places which were obtained at the Cape on February 11, 13, and 15, but so far as we know have not yet been transmitted to Europe; hence it may be anticipated that his elements will prove to be the true ones, and we shall have, in the case of this comet, a similar one to that of the comet of 1533, for which two orbits by Douwes and Olbers, bearing no resemblance, appear in our catalogues, having been deduced from rough observations extending over a limited period. We have already had occasion to point out in this column that the comet of 1686 presents a similar difficulty if only the European observations are employed, but the correct orbit is assigned when we introduce in the computations the positions observed at Amboyna and in Siam.

Calculating from Mr. Finlay's elements, we have the following places of the comet for 8h. Greenwich M.T.

	R.A. h. m.	N.P.D. ° ′	Log. distance from Earth.	Sun.
March 27	5 7·9	96 20	0·2347	0·2237
28	5 10·1	96 3		
29	5 12·2	95 47	0·2492	0·2334
30	5 14·3	95 31		
31	5 16·4	95 16	0·2633	0·2427
April 1	5 18·4	95 1		
2	5 20·4	94 47	0·2769	0·2516

It is right to state, that from the greatly diminished intensity of light which the comet is likely to present at this time, Mr. Finlay doubted if it would be possible to observe it in Europe, and Mr. Gill adds that in strong moonlight on February 23 he failed to discover the least trace of it, and was not sanguine with his optical means that he would see it again. Nevertheless as instruments of much greater capability can be brought to bear upon a search for the comet in these latitudes, the above places may be found of service.

We are indebted to correspondents in Australia, Tasmania, and South America for various notices of this fine comet, chiefly extracted from the public journals. The *Launceston Examiner* of February 3 states that attention had been called the previous evening to what appeared to be the tail of a very large comet, which "extended from thirty to forty degrees above the horizon, and was setting almost in a line with the sun, which prevented the nucleus and brighter part of the tail being seen earlier;" it is added, "if it were now winter instead of summer it would present a glorious spectacle about dark." At Melbourne the tail was seen on February 2 soon after sunset, but the nucleus had not been visible at the Observatory up to February 5; no doubt Mr. Ellery will give a good account of it later, and should nothing prevent the great reflector from being brought to bear upon the comet, observations of much value may be received from Melbourne.

Mr. E. A. Fry, writing from Birmingham, incloses an extract from the *Anglo-Brazilian Times* of February 24, wherein M. Liais publishes the rough approximation to the elements, which the Emperor of Brazil telegraphed to the Academy of Sciences at Paris. M. Liais states that he had combined the two directions observed at Rio on the 4th and 8th inst. with the information in relation to the appearances observed at other places to arrive at some indication of the nature of the orbit, and with such meagre data it is not surprising that his figures should differ so greatly from Mr. Finlay's. He suggests that the object which several American astronomers mention having remarked during the totality of the solar eclipse of January 11 in California, which was "distinct from the fixed stars and planets," and conjectured to be an intra-Mercurial body, "may have been this comet:" not a very happy suggestion if we are to rely upon Mr. Finlay's elements, since at the time in question the comet would have been situated 22° west and 23° south of the sun.

Other notices received describe the brilliant appearance of the tail in the first week of February, but supply no particulars with reference to the position of the nucleus.

METEOROLOGICAL NOTES

THE storm of December 28, 1879, will long stand out among British storms, not only as having occasioned the fall of the Tay Bridge, but also as having presented peculiarities which, taken together, are, so far as observation goes, unprecedented in these islands. Some of the more important of these peculiarities were brought before the meeting of the Scottish Meteorological Society on March 10 by Mr. Buchan. Of these the most remarkable were the barometrical fluctuations, which were quite extraordinary along the central path of the storm from Barra Head to Wick. The barometric readings at Dhu Heartach Lighthouse, twelve miles south-west of Iona, reduced to 32° and sea-level, were, in inches, 29·615 at 10 A.M., 29·405 at noon, 29·205 at 1·30 P.M., 28·905 at 4 P.M., 28·705 at 5·5 P.M., 28·645 at 6 P.M., 29·105 at 7 P.M., and 29·342 at 9 P.M. Thus in one hour, from 6 to 7 P.M., the barometer rose 0·460 inch, or nearly half an inch. That this extraordinary fluctuation was no isolated phenomenon is shown by what was noted at the other lighthouses in the vicinity. Thus the barometer rose, from 4 to 9 P.M., 0·790 inch at Barra Head, from 5 to 9 P.M., 0·681 inch at Monach, 0·760 inch at Ushenish, and 0·660 at Skerryvore; from 5.30 to 9 P.M., 0·700 inch at the Point of Ardnamurchan; and from 6.15 to 9 P.M., 0·590 inch at Kyleakin. To north and south of the central path of the storm the fluctuations, though unusually large, fell far short of these amounts. From the observations made at the numerous stations of the Society, including the sixty Scottish lighthouses, the position of the centre of the storm could be determined with a close approximation to exactness hour by hour. From the results it is shown that the cyclone travelled onwards in each of the five hours respectively from 4 to 9 P.M., 30, 45, 53, 70, and 70 statute miles, the rate of progress from 7 to 9 P.M. being thus about 3½ times the average rate in this part of Europe. The behaviour of the temperature of the air was equally striking, rising everywhere to from 52° to 57° as the centre of the cyclone advanced, and falling after it had passed. In other words, the temperature rose on this occasion to the average of the first week of June. From data supplied by Mr. Scott, of the Meteorological Office, the maximum velocity of the wind during the heaviest gusts was at the rate of 96 miles an hour at Aberdeen, 120 miles at Glasgow, and probably 150 miles at Seaham. Had pressure anemometers been pretty generally in action over Scotland on that evening, much higher wind-forces than these would doubtless have been recorded. The force of the wind was comparatively little felt to the north of the central path of the cyclone, owing to the low gradients in that direction, no notice of a storm being recorded, for example, at Cape Wrath, Stourhead, or the Butt of Lewis; but in the path of the centre and for some distance to southward, the storm swept onwards with destructive and uncontrolled fury, raising the spray in what seemed solid masses of water against the lantern of the Dhu Heartach Lighthouse, 145 feet high, which struck the glass with a sound like that of road metal, and completely overturning whole forests of Scotch firs 200 years old, so that not a single tree was left standing, and where the trees were fast rooted in the rock prostrating them along the ground after forming a joint near the roots by splintering this part of their trunks to a bundle of matches. The steepest gradient afforded by the barometric observations which were made is about 1 inch to 110 miles. Steeper gradients were noted during the great Edinburgh hurricane of January 24, 1868, when a gradient of 1 inch to 72 miles occurred, and in accordance therewith an amount of damage was done to structures of solid masonry of which the storm of December last affords no parallel

MR. CHARLES CARPMAEL, who has recently been appointed Superintendent of the Meteorological Service of the Dominion of Canada, has issued the first number of a *Monthly Weather Review*, presenting with fairly satisfactory fulness the weather and other meteorological phenomena of the Dominion for January, 1880. The storms which in any way affected Canada during the month are detailed, and their tracks indicated. Weather-probabilities are issued by the office in Toronto at 10 A.M. daily, and posted up at 350 places in Canada within an hour from the date of issue. From an analysis of the successes and non-successes of the weather-probabilities of the month given in the *Review*, it would appear that 80½ per cent. were fully verified, 93½ per cent. either fully or partly verified, leaving only 6½ per cent. of failures. The outstanding features of the meteorology of the month were the low mean pressure in the west, the high pressure in the east, and the very high temperature which prevailed at all the stations. The mean temperature for January, 1880, was the highest yet recorded in any year at Toronto, thus offering a striking contrast to the weather which prevailed generally over Europe during the month. This meteorological service is under the deepest obligations to Prof. Kingston, through whose exertions chiefly it was called into existence. These arduous exertions have told seriously on his health, and he has been obliged to retire from the position of superintendent. He carries with him the best wishes of meteorologists coupled with a hope that in his retirement he will be able to continue his services in the furtherance of American meteorology.

IN a twelfth contribution to meteorology, Prof. Loomis presents us with isobars for the United States, showing for January and July the mean pressure of the atmosphere from the observations made by the Signal Service of the War Department for the six years ending June, 1877. In July pressure is highest in Florida, being 30·100 inches, from which it diminishes on advancing into the interior to 29·850 inches in Utah, rising again on proceeding west to about 30·100 inches on the Pacific coast, in latitude 45°. This state of things is, roughly speaking, reversed in January, with, however, several noteworthy differences. The highest pressure, 30·250 inches, is now in Utah, and the lowest generally round the coasts, falling to the minimum, 30·000 inches, at the entrance to Fundy Bay. The high pressure of the interior may be regarded as spreading over the States occupying the region from Minnesota to California. The slight break in it on the chart, as occurring about Cheyenne, will require confirmation from future observations. A second area of high pressure spreads over the larger portion of the south-eastern and Southern States. These two distinct areas of high pressure are separated from each other by a region of lower pressure stretching in a south-west direction from Chicago, towards the Rocky Mountains. The discovery of this peculiarity in the winter-distribution of pressure in the States which, correctly we think, is ascribed to the path usually taken by the barometric minima of American storms in the earlier part of their course, constitutes, perhaps, the most valuable contribution to meteorology yet made by Prof. Loomis.

PROF. LOOMIS institutes an interesting comparison of the varying rates of progress of storm-centres, and shows that over the United States the rate of progress is twenty-six miles an hour, whereas, over the Atlantic, it is only fourteen miles, and on the continent of Europe, as shown by Dr. Neumayer, it does not exceed sixteen miles an hour. In this connection it is pointed out that the winds on the Atlantic are stronger than they are over either of the continents, and the winds of central Europe are stronger than the winds of the United States, relations that suggest whether friction may not be concerned in determining the rate of the onward progress of storms. As bearing, however, more immediately on this question, Prof. Loomis draws attention to this important distinction between American and European storms, viz., from the Rocky Mountains to the Atlantic Ocean storms advance from a drier to a more humid atmosphere, whereas in Europe, while storms pursue their easterly course, they proceed from a humid to a drier atmosphere. An examination of the rate of progress of storms in north-western Europe, as compared with the rate in the interior of the continent, would contribute important data to the inquiry here raised.

PHYSICAL NOTES

ACCORDING to a theory of crystallogenesis recently brought before the Bologna Academy by Signor Marangoni, the formation of crystals is due to composition of molecular vibrations. As vibrating plates give the symmetrical nodal lines of Chladni, so solid bodies, in their vibrations in three directions, produce nodal surfaces, which correspond to the cleavage surfaces of crystals. The author (confining himself to simple substances) considers a chemical molecule as one produced in general by union of two atoms rotating round one another; a physical, as arising from two chemical rotating round one another. If these motions do not occur in the same plane, we have motions of a pendular nature in the three directions of space. Where the times of vibration are in simple ratios to each other, crystals are formed; where, again, the relations are complicated or incommensurable, we have liquids; and in the gaseous state, the physical molecules break up into the chemical. If the ratios of the three motions are 1 : 1 : 2 we have 4 osculating planes, enclosing a tetrahedron. The common orientation of these planes in all molecules produces planes of cleavage. If the ratios are 1 : 1 : 3, there are 6 osculating planes and a rhombohedron. By means of a tuning-fork throwing a soap-bubble into vibration, the author illustrates his hypothesis. He deduces a number of crystallographic properties, further assuming that parallel-directed vibrations attract each other, while opposite repel.

A SERIES of experiments in spectrum-analytical comparison of gas, sun, day, and the electric light has been lately made by Herr Meyer (Carl's *Zeitsch. für angew. Electr.-Lehre*, 1, p. 320, 1879). He used both Vierordt's method and a method first suggested by Bohn; in the latter a Nicol prism is fixed before one-half of a slit and receives the light from one source; behind it is the Nicol, rotatable in a graduated circle of Wild's polaristrobometer. The light beam passing through both prisms strikes a rectangular glass prism, which reflects it into the spectrum apparatus. The second slit-half is illuminated either directly or through a second rectangular prism from the second light source. The numbers show that the brightness of the colours in the gas-spectrum, compared with that in sun or daylight and the electric light, steadily decreases from the red to the violet end of the spectrum. As sunlight is considerably brighter in the middle parts of the spectrum than the electric light, the latter should appear yellow with the former; and in a Ritchie photometer the surface illuminated by the electric light did indeed appear yellow like an orange, in comparison with that illuminated by the sun. Another interesting fact elicited is that in daylight there is comparatively more red and yellow, and less blue and violet light than in sunlight.

LAST year M. Van Rysselberghe devised a regulator rigorously isochronous in theory, that is, the movable masses of which were displaced exactly along a parabola. It was considered, however (in the Belgian Academy), that practically the number of articulations was too great to allow of the isochronism being realised. M. Van Rysselberghe has now hit upon a different and very simple combination, in which the articulations are reduced to a minimum, and which gives a very close approximation to the parabola, though not that figure rigorously. He has a model, the velocity of which is maintained constant to nearly $\frac{1}{1000}$, while the force transmitted to the vanes and absorbed by them, varies in the ratio of 1 to 200. He does not despair of pushing the precision to $\frac{1}{100000}$ (or less than a second a day). One special feature in the apparatus is a system of vanes designed to increase the resistance in a proportion slightly greater than that furnished by the increasing aperture of the moderator-lozenge. These vanes, on a straight horizontal axis, strike the air at different inclinations according to the resistance to be developed, being moved by suitable gearing, and automatically into various positions from the horizontal to the vertical. There is also a system of compensation for variations of temperature. This regulator is expected to be of great service in application to registering at a distance, to chromographs, to equatorial telescopes, to siderostats, to telegraphs, and to industrial motors. (It is described in the *Bulletin* of the Belgian Academy, No. 1, 1880.)

SOME experiments by Herr Reusch, with a view to determining the modulus of elasticity of ice, have been recently published (*Ann. der Phys.*, No. 2). Rectangular prismatic lamellæ of ice were obtained by pressing the edges of two heated plates of zinc, fixed parallel in a frame, into plates of ice, the ends being then cut with two other zinc plates in the frame. After careful measurement and weighing, the number of transverse vibrations of the tone given by the lamella supported near the outer fifth was determined by means of a Marloye sonometer (a monochord 1 m. long, with tuning-fork giving 256 vibrations per second). This was done, of course, in a room with the temperature below zero. Calculating according to the formula given by Seebeck, Herr Reusch found the arithmetic mean (from five experiments) of the modulus of elasticity E, in kilogrammes per square millimetre = 236·324. The only previous determination known to him is that of Frankenheim (in Mousson's "Physics"), where E = 541, a number which he therefore thinks more than twice too great.

IN a recent paper in the *Annalen der Physik* (No. 2), Herr Fröhlich endeavours to prove that of the three electrodynamic fundamental laws enunciated by Clausius, Riemann, and Weber severally, as satisfying the principle of conservation of energy, that of Clausius—and, supposing unequal velocity of the two electricities in the galvanic current, the two others also—leads to theoretically unreliable and practically useless results.

GEOGRAPHICAL NOTES

LETTERS have been received from Prof. J. B. Balfour, announcing that he had been safely landed by H.M.S. *Seagull* in Golbourn Bay, at the west end of Socotra, on February 11, weather not permitting the vessel to go round to the principal port, Samarida. Prof. Balfour had formed pretty high expectations of the island from what he had heard, but these were greatly exceeded by the reality. The flora was found to be rich and varied, and 150 species of plants, some of great interest, had been obtained in a few days. Birds were numerous, as also reptiles and insects. There was plenty of water, and some splendid *Dytisci*. The geology was very perplexing, granite, limestone, and dioritic rocks being mixed up in an extraordinary manner.

WE are glad to see that the Geographical Society is doing its best to show honour to Prof. Nordenskjöld and to give him a hearty welcome to this country. A distinguished deputation awaited his arrival at Portsmouth on Monday, but unfortunately the *Vega* did not appear, though by this time she has, most probably, arrived. The highest British mark of honour awaits the explorer—a dinner at Willis's Rooms, at which, we are glad to learn, the Prince of Wales will be present. We have said so much concerning the work of Prof. Nordenskjöld that scarcely anything new is left to say either concerning himself or concerning his services to science in the voyage he has so successfully accomplished. Commerce is sure to follow up the pioneer work of the *Vega*, and we hope that very soon the region explored will be garrisoned, as the *Times* puts it, by meteorologists who will "watch the winds where they are born."

AT the meeting of the Geographical Society on Monday evening it was announced that Prof. Nordenskjöld, who is already a Gold Medallist, had been elected an Honorary Corresponding Member. Mr. E. Hutchinson afterwards read a paper on the ascent of the Binué branch of the Niger in 1879 by Ashcroft, an agent of the Church Missionary Society, in the little steamer *Henry Venn*. The party left Lokoja, at the confluence with the main river, on July 8, and on August 28 arrived opposite Yola in N. lat. 9° 16′ and E. long. 12° 31′, some 364 miles to the eastward in a straight line. From Yola they proceeded past the junction of the Faro tributary, where Dr. Barth crossed in 1851, and for about forty miles higher up, anchoring on September 4 off the town of Garawa, which lies some distance from the river bank. This place is situated in N. lat. 9° 28′ 45″ and E. long. 13° 26′. As the river was falling fast, Mr. Ashcroft only ventured to go a few miles further up in a steam launch. The distance traversed by the *Henry Venn* Expedition, which had never been previously explored, is probably not far short of 150 miles, and of this an exceedingly good chart has been made by Mr. Flegel, a German who, in his anxiety to join in the exploration, accompanied the party as ship's clerk. It is satisfactory to learn that the natives, except at one spot, showed themselves particularly well-disposed.

Mr. Hutchinson also made some interesting remarks, partly of a speculative nature, on the river systems of the Binué and the Shari, and their possible connection near Lake Chad.

MR. J. W. MOIR, of the Central Africa Trading Company, has just sent home from Livingstonia some notes of an expedition from the Mombera country, near the northern end of Lake Nyassa, to the north-west portion of the great basin of the Loangwa, which falls into the Zambesi at Zumbo, above the Kebrabasa rapids. Crossing the Kasitu river he marched a little north of west through an uninhabited, undulating forest-land, scantily supplied with water. No game was seen, but the *tsetse* fly was very abundant in several swampy valleys. Mr. Moir then crossed the Rukuru river, and after a march of twenty miles further west and north-west, passed over a low sandy watershed into the Loangwa basin. The country was that of the Basenga, whose chief village is in the bend of a very small stream which flows at the bottom of a deep broad course, probably well filled in the rainy season by the neighbouring Palaosenga hills. In this part water was very seldom to be had, except by digging in the watercourses, but the soil appeared fertile. Mr. Moir was able to get very little information about the surrounding country, as the people professed that they had never dared to leave their villages owing to their dread of the Mangoni. On the return journey the party passed through an uninhabited tract, chiefly covered with rather scrubby forest, to the Mombero country. In the Basenga country the first chief met with was Tembwe, who, it is interesting to note, saw Livingstone, probably in 1863, in the Tumbuka country further to the south; he has a large village, and there are generally some Arabs there. The principal chief of the Basenga, Kambombo, lives at the first-mentioned village, which is strongly stockaded. Here an Arab caravan had settled down for a time, having come from Zanzibar *viâ* Ujiji.

WE regret to learn that fears are entertained in St. Petersburg of the safety of Col. Prejevalsky, who at the last news was attempting to make his way into Thibet from China. It is stated that the German embassy at Pekin has received a letter from Count Szecheny, who was following the Russian expedition, saying he intended to return, not wishing to share the same fate as befel Col. Prejevalsky, whatever that may be. Disquieting rumours also come from Russian Turkestan as to the traveller's safety. One guide returning from Chardini reports that while he was searching for a road that had been lost, Prejevalsky and his comrades disappeared, and he was obliged to turn back. We earnestly hope these rumours may turn out to be unfounded; Col. Prejevalsky's loss would be a severe one to scientific exploration.

TWO Austrian travellers, the *Times* Calcutta correspondent telegraphs, March 21, have arrived at Rangoon from China by the overland route through Yunnan and Bhamo. They attempted to enter Thibet, but were prevented by Chinese officials. No doubt this is the party of Count Szecheny referred to above.

IN its last summary of colonial intelligence the *Colonies and India* furnishes a curious piece of news from New South Wales, which recalls to memory a sad incident in Australian exploration. A few years ago, we are told, a man named Hume, who had penetrated very far into the interior, stated that there was a white man living with the blacks in the far west, who, he was confident, was a survivor of Leichhardt's expedition. This assertion was at the time mostly disbelieved, but information has now been received which leads to the impression that Hume's statement was true, and that the white man in question died about November, 1876, when making an attempt to leave the black tribe with which he had been living, and to reach the camp of some white explorers.

FROM the Hongkong papers we learn that Commander Salmond, in H.M.'s Gunboat *Midge*, has recently paid a visit to Sandakan Bay, in Northern Borneo, where he found Mr. Pryor, the agent of the English Association, holding, as we have before recorded, a large concession from the Sultan, diligently prosecuting his work of inquiring into the resources of the country. The natives are reported to be quite content with his system of administration.

THE current number of *Les Missions Catholiques* contains the first instalment of Père Janvier Martini's account of his journey from Khartûm to Gardaref, as well as much information respecting the late Abbé Debaize, who died at Ujiji on December 12. Under the title of "Captivité et Deliverance," Père Deguette also commences the narrative of his misfortunes in Corea.

THE *Presse* of Vienna announces that Capt. Weyprecht is making, in conjunction with Count Wilczek, the final arrangements for a new Polar expedition. Many Dalmatian sailors have already offered to take part in the expedition. Count Wilczek and Capt. Weyprecht will shortly visit Hamburg to confer with representatives of various European Societies.

ACCORDING to the *Times* Candahar correspondent Mr. Giesbach, geologist, has, at the Sirdar's special request, been appointed by the Indian Government to report on the mineral capabilities of the Candahar district. Major Leach, R.E., has also been specially deputed for survey purposes in that district under Col. St. John's orders.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The number of failures to pass the Local Examinations continues very large; possibly this may be traced to defective teaching of science subjects, and the relation of the elements of the theoretical to the concrete aspects of geometry and physics. Four senior girls and twenty three senior boys obtained a first class. None of the former are distinguished in the physical science subjects. Thirty-six junior girls and 215 junior boys obtain a first class. More than one-third of these junior girls have distinguished themselves in one or more subjects of physical science.

PROFESSORS PAGET, Stokes, Liveing, C. C. Babington, and Dewar will lecture in the coming term; also Mr. W. J. Sell (Chemistry), Mr. Sedgwick (Demonstrations in Mammalia).

SOME new cases for the Bird Room, and apparatus for the Chemical Laboratories has been voted.

THE late Dr. Andrew Vans Dunlop of Edinburgh has left the University of that City the residue of his estate, amounting to about 50,000*l*. Of this sum, 30,000*l*. will, it is understood, be paid to the University authorities; while the remaining 20,000*l*. will ultimately accrue to the University. 3,000*l*. is to be added to the general fund of the University; and the remainder of the 50,000*l*. is to be employed in founding sixteen "Vans Dunlop Scholarships," of the annual value of 100*l*. each, tenable for three years. It is also provided by the will that the first six scholarships created shall be for students of medicine, while the others are to be equally divided amongst students of the classes of chemistry, English literature, classics, political economy, logic and moral philosophy, natural philosophy, mathematics, natural history and engineering.

SCIENTIFIC SERIALS

THE *Proceedings of the Linnæan Society of New South Wales*, vol. iv., parts 1 and 2 (Sydney, 1879).—Part 1. Rev. J. E. T. Woods, on some tertiary fossils; describes a large number of fossil shells from the tertiary (probably miocene) beds of Muddy Creek, Western Victoria; figures of all the species are given. On some new marine shells from Port Jackson (three new species described and figured). On some freshwater shells from New Guinea (three new species of Melania, with figures).—On some new marine shells from Moreton Bay (three new species). On *Arauja albens* (notice of its appearance at Moreton Bay).—F. M. Bailey, on some of the introduced plants of Queensland. On a new species of Asplenium from Trinity Bay Range.—W. A. Haswell, M.A., on the Australian species of Penæus (six species described as new). A contribution to a monograph of the Australian Leucosiidæ; adds twelve new species to the list of Australian forms, *i.e.*, four new species of Leucosia, two of Myra, one of Myrodes, three of Phlyxia, one of Lithadia, one of Arcania, nearly all of which are figured.—Wm. Macleay, on some fishes from the Solomon Islands; gives a list of fifteen species, not one of which is mentioned in the fishes of this group as given in the "Voyage of the *Curaçoa*," and describes a new species of Mesoprion.—E. P. Ramsay, on the zoology of the Solomon Islands (enumerates forty-five species of birds). Contributions to the zoology of New Guinea; parts iv. and v. On Mr. Goldie's collections, with a list showing the distribution of the species of birds.—N. de Miklucho-Maclay, the proposed zoological station at Sydney.—E. Meyrick, on a micro-lepidopteron destructive to the potato (*Lita solanella*).—Dr. Cox, on two new species of Helix from the Louisiade group.—Part 2.

Rev. J. E. T. Woods, on the relations of the Brisbane flora; and, with the assistance of F. M. Bailey, a census of the flora of Brisbane, including the plants of Moreton Island and the country within twenty-five miles of the city of Brisbane; the total number of species enumerated is 1,228.—E. Meyrick, descriptions of Australian micro-lepidoptera. Part 2. Crambites. —James Hobson, notes on *Cypræa guttata*; gives as the habitat of this extremely rare shell, New Britain, but few particulars are given.

Journal de Physique, February.—On the determination of the elements of a vibratory movement, by E. Mercadier.—On the law of the thermal capacities of gases, by N. Slonginoff.—Atmospheric polarisation and influence of the terrestrial magnetism on the atmosphere, by H. Becquerel.—On the differential equation $\frac{d^2u}{dt^2} = a^2\frac{d^2x}{dt^2}$, which leads to the theoretic expression of the velocity of sound, by M. Amagat.

SOCIETIES AND ACADEMIES

London

Royal Society, March 18.—"On the Structure of he Immature Ovarian Ovum in the Common Fowl and in the Rabbit. To which is appended some Observations upon the Mode of Formation of the *Discus proligerus* in the Rabbit, and of the Ovarial Glands or 'Egg-tubes' in the Dog." By E. A. Schäfer, F.R.S.

"On the Modifications of the Spectrum of Potassium which are Effected by the Presence of Phosphoric Acid, and on the Inorganic Bases and Salts which are found in combination with Educts of the Brain." By J. L. W. Thudichum, M.D., F.R.C.P.L. Communicated by John Simon, C.B., F.R.S.

"Researches into the Colouring Matters of Human Urine, with an Account of the Separation of Urobilin." By C. A. MacMunn, B.A., M.D. Communicated by A. Gamgee, M.D., F.R.S., Brackenbury Professor of Practical Physiology and Histology in Owens College, Manchester.

"On the Coalescence of Amœboid Cells into Plasmodia, and on the so-called Coagulation of Invertebrate Fluids." By P. Geddes. Communicated by Prof. Burdon Sanderson, LL.D., F.R.S.

Zoological Society, March 16, Dr. A. Günther, F.R.S., vice-president, in the chair.—Mr. W. K. Parker, F.R.S., exhibited and made remarks on the eggs and embryos of some crocodiles (*Crocodilus palustris*), obtained in Ceylon by Dr. W. R. Kynsey, Principal Medical Officer of Colombo.—Mr. W. A. Forbes read a paper on some points in the anatomy of the Sumatran rhinoceros.—Mr. Edward R. Alston exhibited and made remarks on a coloured drawing of an adolescent specimen of *Tapirus dowi*, now in the Paris Museum.—Mr. Alston also exhibited a specimen of a remarkable and little known Australian marsupial, *Antechinomys lanigera* (Gould).—A communication was read from Mr. L. Taczanowski, giving the descriptions of a collection of birds made in Northern Peru by Mr. Stolzmann during the last months of 1878 and the first half of 1879. Amongst them were examples of three species believed to be new to science, and proposed to be called *Turdus maranonicus*, *Arremon nigriceps*, and *Colaptes stolzmanni*.—Mr. Alfred E. Craven read descriptions of three new species of land and freshwater shells, from Nossi-Bé Island, N.W. coast of Madagascar. —Mr. Craven also read a paper on a collection of land and fresh-water shells, made during a short expedition to the Usambara country, in Eastern Africa, with descriptions of seven new species.—Mr. F. Jeffrey Bell read some remarks in reference to certain statements made by Mr. A. Agassiz in a paper on the synonymy of the echini, communicated to the Society at a previous meeting.—Mr. W. K. Parker, F.R.S., read a paper on the structure of the skull in the chameleons.

Geological Society, March 10.—Robert Etheridge, F.R.S., president, in the chair.—John Ward was elected a Fellow, and Prof. F. von Hochstetter, of Vienna, and Prof. A. Renard, of Brussels, Foreign Correspondents of the Society.—The following communication was read:—On the geological relations of the rocks of the south of Ireland to those of North Devon and other British and Continental districts, by Prof. Edward Hull, F.R.S., Director of the Geological Survey of Ireland. In this paper the author, after referring to his previous paper on the geological age of the Glengariff beds (*Quart. Journ. Geol. Soc.*, vol. xxxv. p. 699), in which he showed that between them and the succeeding Old Red Sandstone in the south of Ireland there existed a very great hiatus, proceeded to compare the sections of the rocks of the south of Ireland with those of North Devon, and to show that the hiatus in question is represented in the latter locality by the whole of the Middle and Lower Devonian rocks. He then discussed the relations of the Devonshire rocks to those occurring north of the Severn, in Scotland, and in Belgium; and from this review of the whole question he arrived at the following conclusions:—1. That there is only one Old Red Sandstone properly so-called—represented in Devonshire by the Pickwell-Down Sandstone; in Ireland by the so-called Upper Old Red Sandstone, including the Kiltorcan beds; in Scotland by the so-called Upper Old Red Sandstone; and in Belgium by the "Psammites du Condroz." 2. That the so-called Old Red Sandstone of Herefordshire is the estuarine representative of the Middle and Lower Devonians of Devonshire; and that the so-called Lower Old Red Sandstone of Scotland, with its fish-remains, is the lacustrine representative of the Upper Silurian rocks. In conclusion the author discussed the physical conditions under which these various formations were deposited.

Physical Society, February 28.—Prof. W. G. Adams in the chair.—A paper was read by Mr. Ridout on some effects of vibratory motion in fluids. It was found by Savart and Tyndal that jets of water were sensitive to notes or air vibrations like flame, and the author conceived the idea of vibrating the jet of water internally. To do this he caused an electro-magnetic arrangement to pinch the tube, conveying the water 400 to 500 times per second, so as to communicate a vibratory motion to the stream of fluid. The issuing jet spread out in two streams, beautifully broken into drops, and representing the fundamental note. When the pinching lever vibrated irregularly harmonics were observed. When the water was thrown into vibration in two different planes, the resulting jet rotated in the tube. Froude's deduction that a liquid moving in a tortuous tube has a tendency to straighten the tube was illustrated by oscillating a pipette with its nozzle in a vessel of water, and filling a coloured liquid into it, which is seen to flow from the nozzle through the water in a tortuous line. By giving the pipette also a motion round its axis, the line becomes a spiral. A sounding body produces no disturbance in the stream. The author also showed that the cardboard experiment of M. Clement Desormes can be extended to water. In this experiment a cord is attracted to another cord by blowing a jet of air through the latter upon the surface of the former. Mr. Ridout allows a jet of water to flow out of a glass tube with a cup-shaped mouth upon the surface of a glass ball, and when the ball is within a certain distance of the mouth, it is attracted towards the latter and sticks in the mouth. In explanation of this fact it was shown that the ball and cup remained in such a position that the outflow of water was greater than if the globe had been entirely absent. Prof. Perry explained this action by the hydrodynamical fact that the pressure is less at the centre of the mouth of the cup than at the edges. Prof. Guthrie said that he had tried a similar experiment with a funnel-shaped mouth and a glass cone, but failed. He surmised that perhaps the cohesion of the water for itself, as it formed a shell round the ball, might help to cause the success of the ball method. Prof. Adams pointed out that with the cup and ball there was less difference of head of water between the centre of the mouth and the edge where the water escaped, than with the funnel. Dr. Stone stated that he had been able recently to imitate many physiological sounds, such as the murmur of the heart, by means of constrictions, in tubes through which water and air were flowing. His demonstrations were made before the Royal College of Physicians.—Dr. C. W. Wright then read an important paper on a determination of chemical affinity in terms of electromotive force. After giving a history of the subject, he described his original experiments. These consisted in performing electrolysis of sulphuric acid and measuring the heat evolved in the process, and by recombustion of the materials. A voltameter with spade-shaped platinum electrodes soldered to stout copper wires, and sealed by a large plug of gutta-percha, was employed for the electrolysis. An ordinary water calorimeter was used to measure the heat given off, as Bunsen's was found to contain sources of loss of heat. The strength of the current employed was varied from 6 webers to $\frac{6}{10}$ weber. The volume of gas produced was measured by Joules's plan. Radiation loss was corrected for by three methods. From an average of eighteen experiments the value of e, the electromotive force was found to be 1·5038 C.G.S.

or volts. Taking the formula $J = \frac{e}{(H + n)\chi}$, where J is Joules's equivalent, H is the heat actively evolved, n the heat evolved by recomposition, and χ a constant to which Kohlrausch gives the value of ·000105, Dr. Wright finds that Joules's equivalent should be $4{\cdot}196 \times 10^7$, instead of $4{\cdot}20 \times 10^7$, as given, to answer the formula. The author thinks that Joules's water-friction experiments gave the truest value of J, and that his electric heating experiments gave a result about ½ per cent. too low, owing to the B.A. unit of resistance being about 2 per cent. too high and other causes.

Chemical Society, March 18.—Mr. Warren De la Rue, president, in the chair.—Prof. Tidy read a paper of over 100 pages on River-water. He discussed the subject under three heads:—1. Analytical details of river-waters. 2. The various sources of impurity to which river-water is subject, and the means whereby purity is maintained by nature or may be effected by art. 3. The extent to which statistics warrant us in condemning or in approving the supply of river-water for drinking-purposes. Under the first head the author gives detailed analyses of water from the Thames from 1876–1879; analyses are also given of water from the rivers Nile, Severn, and Shannon. Under the second head is discussed the effect (1) of flood-water, which at first deteriorates and then improves the quality of river-water; (2) of peat, the quantity of which in a water is kept in check by "a," the inherent power that water possesses of self-purification, owing to the oxidation of the peat by the oxygen held in solution in the water, and "b," mechanical precipitation by admixture with coarse mineral matter suspended in the water; (3) of sewage matter. This, in the opinion of the author, is a most vital question. From inspection of the effect produced by sewage on rivers, from analyses of the river-waters, and from experiment, the author concludes that the oxidation of the organic matter of sewage takes place, when mixed with unpolluted water and allowed a certain flow, with extreme rapidity. The various methods of artificial purification are discussed; of these filtration through sand is preferred. Under the third category the arguments for and against the use of river-water for drinking-purposes are examined: it is shown that the death-rates of towns supplied by wells and of those supplied by rivers are practically alike, and that in London there is very little to choose, as regards mortality, between districts supplied with well-water and those supplied by river-water; and while admitting that, as a matter of sentiment, he would prefer well-water, the author contends that there is no reason for supposing that the *materies morbi*, whether it exists as a germ or not, can resist oxidation, which is efficient in destroying other organic matter, as proved by chemical analysis. The author finally submits the two following conclusions:—1. That when sewage is discharged into running water, provided the dilution with pure water be sufficient, the whole of it, after the run of a few miles, will be efficiently got rid of. 2. That facts indicate that whatever may be the actual cause of certain diseases, the *materies morbi* which finds its way into the river is destroyed along with the organic impurity.

Meteorological Society, March 17.—Mr. G. J. Symons F.R.S., president, in the chair.—Sir A. P. Bruce Chichester, Bart., W. H. Cochrane, Rev. H. Garrett, M.A., H. Jonas, J. Lingwood, Lieut.-Col. L. W. Longstaff, Rev. C. E. Sherard, J. H. Stewart, and Dr. W. J. Treutler were elected Fellows of the Society.—The following papers were read:—Thermometric observations on board the Cunard R.M.S.S. *Algeria*, by Capt. William Watson, F.M.S.—On the Greenwich sunshine records, 1876-80, by William Ellis, F.R.A.S.—At 8 p.m. the discussion was suspended in order to afford the Fellows an opportunity of inspecting a large number of new and interesting meteorological instruments which had been brought together for exhibition.

Entomological Society, March 3.—H. T. Stainton, F.R.S., &c., vice-president, in the chair.—Dr. Hy. Chas. Lang, of 41, Berners Street, and Mr. Frank Crosbie, of Barnet, were elected Ordinary Members of the Society.—Mr. Pascoe exhibited several species of scorpions in reference to a statement recently made elsewhere that scorpions had been known to sting themselves to death when surrounded by fire. This Mr. Pascoe doubted, and showed that the two common European species, *Scorpio europæus* and *Buthus occitans* were almost physically incapable of effecting such a purpose.—Mr. Stevens exhibited a dwarfed female specimen of *Plebius icarus* (*Lycæna alexis*).—The Rev. A. E. Eaton exhibited several plates of drawings of *Ephemeridæ*, part of a forthcoming work, and contributed remarks thereon.—The Secretary exhibited, on behalf of Mr. Geo. Francis, of Adelaide, the microscopical specimens referred to at the last meeting of the Society.—Mr. Howard Vaughan exhibited a series of *Cidaria russata* from Yorkshire and the Isle of Arran, in illustration of local variation of the species.—The Rev. H. S. Gorham read a further communication on the *Lampyridæ*, and also a paper giving the result of his observations on these insects with respect to their phosphorescence, which he believed to be due to sexual causes. With regard to the typical species of the family, he observed that in the most highly organised genera, such as *Lamprocera* and *Cladodes*, the light-emitting faculty did not appear to be developed in proportion with the rest of the organs, and that the eyes were also reduced "in a direct ratio with the light," being small and uniform in both sexes, "whilst the antennæ were developed in an inverse ratio as the phosphorescence was diminished."—Mr. C. M. Wakefield communicated a paper by Mr. Fereday containing descriptions of new species of the family Lucanidæ and the genus Chlenius.—The following papers were also communicated:—On synonyms of heterocerous lepidoptera, by Mr. Butler; and descriptions of Cetoniidæ and Cerambycidæ, from Madagascar, by Mr. Waterhouse.

Photographic Society, March 9.—James Glaisher, F.R.S., president, in the chair.—A paper was read by the Rev. H. Lansdell, F.R.G.S., on a tour round the world, *viâ* Siberia and California, from which it appeared that photography in Russia and Siberia, in relation to its art-element, is in a very advanced condition. Some very interesting pictures of the eastern tribes of Russia and Siberia, bordering on China were shown, and also of the entire route, covering 25,510 miles.—A paper was also read by Capt. Abney, R.E., F.R.S., on the lateral spread of the image during alkaline development, showing that there was a travelling outwards of the deposit by alkaline development from the nucleus which forms the undeveloped image; this takes place in all directions, but when spreading laterally, it caused a blurring of the outline, seen in gelatine emulsion plates.

Institution of Civil Engineers, March 9.—Mr. W. H. Barlow, F.R.S., president, in the chair.—The paper read was on the purification of gas, by Mr. Harry Edward Jones, M.Inst.C.E.

Statistical Society, March 16.—Sir Rawson W. Rawson, C.B., K.C.M.G., in the chair.—Two papers were read, the first by Dr. T. Graham Balfour, F.R.S., on vital statistics of cavalry horses.—The second paper, read by Prof. Leone Levi, LL.D., was entitled a survey of indictable and summary jurisdiction offences in England and Wales, from 1857 to 1878, showing that the last twenty-two years have been on the whole favourable to the economic condition of the people, and the leading operating causes of crime have been less intense than in former years.

DUBLIN

Royal Dublin Society, February 16.—Physical and Experimental Science Section.—Wentworth Erck, LL.D., in the chair.—Physical observations of Mars, 1879-80, by Charles E. Burton, F.R.A.S. 22 sketches of the planet were obtained under favourable circumstances. To these Mr. Dreyer, of the Dunsink Observatory, added two, taken by himself with the "South" equatorial. The whole series, besides supporting the hypothesis that the principal markings are permanent as regards form and position, generally confirms the existence of the "canals" of Schiaparelli, adding perhaps a few which appear to have been detected for the first time in 1879, though it is not asserted that they are newly formed. The author's impression, from observation and comparison with earlier results, is that no rapid surface changes are now proceeding on Mars, and the great changes of appearance are due to formation and disappearance of cloud or mist in the planet's atmosphere. A number of areograpic positions of spots, determined by Kaiser's method, with the help of Marth's ephemeris, are included in the paper. The analogy between Mars and the earth is seemingly weakened by recent observations. —Notes from the Physical Laboratory of the Royal College of Science, by Prof. W. F. Barrett:—1. On the cause of the vibration in the Trevelyan rocker. The author attributes the motion to the force exerted by a thin layer of gas between the hot rocker and the cold support. As long as there is sufficient difference of temperature between the two surfaces, the supporting edges of the rocker are alternately repelled from the cool leaden block in the same manner as the vanes of a radiometer are repelled from the relatively cool sides of the surrounding glass envelope.—2. On the effect of temperature on the illuminating power of coal-gas.—On a new harmonic relation between the lines of hydrogen, by G. Johnstone Stoney, D.Sc., F.R.S. The author pointed out that the stellar line H_1, which Mr. Huggins's investigations show to be probably a hydrogen line, stands in a simple harmonic relation with the known hydrogen line near G; H_1 being the 35th, and the line near G the 32nd, harmonics of a vibration the periodic time of which is $\tau \div 72{\cdot}003$, where τ is the time that light takes to advance a millimetre in air. The other known hydrogen lines, viz., C, F, and *h*, are already known to be the 20th, 27th, and 32nd harmonics of another vibration the periodic time of which is $\tau \div 76{\cdot}2$.—Natural Science Section, with which the Royal Geological Society of Ireland is associated.—G. H. Kinahan, M.R.I.A., in the chair.—The Chairman, as president of the Royal Geological Society of Ireland, delivered the anniversary address.—V. Ball, M.A., F.G.S., read a paper on the evidence in favour of the existence of floating ice in India during the deposition of the Talchir (Permian) rocks. In this communication the author gave a *résumé* of the facts which are held by Indian geologists to prove that during a part of the Talchir period the climate of Peninsular India was sufficiently cold, during the winters at least, to cause the formation of land-ice on the margins of the great lakes which then existed. The facts are similar to those employed to establish the glacial period of Europe. There is a boulder-bed which contains huge masses of rock enveloped in fine silt. In some cases it is demonstrable that these boulders have been carried from long distances in a direction contrary to the present slope of the surface. In others, but less commonly, polished and striated boulders have been found resting on scored and striated surfaces. The fossils of the Talchir rocks, consisting of a few ferns and equisitaceæ—all previous periods having been azoic—are not inconsistent with a mild, temperate climate. Reference was made by the author to the Karroo beds of South Africa and the Permian breccias of England, which are likewise believed to have had a glacial origin.

PARIS

Academy of Sciences, March 15.—M. Ed. Becquerel in the chair.—The following papers were read:—On a particular development of the perturbative function, by M. Tisserand.—On the compensation of temperatures in chronometers, by M. Phillips.—On the hypothesis of Laplace, by M. Faye. He shows the adverse bearing of various modern discoveries on it.—Reply to M. Berthelot's observations on hydrate of chloral, by M. Wurtz.—Action of oxygenated water on oxide of silver and on metallic silver, by M. Berthelot. Oxygenated water forms with silver oxide, in equal equivalents, a first unstable compound, $Ag_2O_33HO_2$, with separation of metallic silver. This is almost immediately decomposed into hydrated sesquioxide, water, and oxygen—with liberation of heat. If the silver oxide is in excess the action ends there; but if there is an excess of oxygenated water the sesquioxide acts in its turn on this, reproducing $Ag_2O_33HO_2$, which is again decomposed, and so on, till total destruction of the oxygenated water. The same theory accounts for the decomposition of oxygenated water in contact with metallic silver.—Memoir on the temperature of the air at the surface of the ground and to 36 m. depth, also on the temperature of two pieces of ground, one bare, the other covered with sod, during 1879, by MM. Becquerel. The results seem mainly to confirm those of previous observations.—Present state of the question as to the interoceanic canal; letter from M. De Lesseps to M. Larrey. He gives, among other news, a local account of the recent earthquake at San Salvador.—On a microphonic apparatus receiving speech at a distance, by MM. Bert and D'Arsonval. They use a plate of hardened rubber, through which passes the fixed carbon. The other carbon is carried by an iron rod which can turn about an axis, and whose mobility is regulated by a movable magnet. When the magnet is distant, the rod can turn on its pivot indifferently, but in the opposite case it is strongly directed, giving vibrations of very small amplitude and great rapidity. Speaking loudly at 4 or 5 m. from this instrument (or with low voice near), the speech is distinctly transmitted.—Practical rules for the establishment of telodynamic transmissions, by M. Léauté.—On the economic product of electric motors, and on measurement of the quantity of energy which traverses an electric circuit, by M. Deprez.—Laws concerning the distribution of the stars of the solar system, by M. Gaussin. Three more are given.—On the systems formed of linear equations with a single independent variable, by M. Darboux.—On the reduction of linear substitutions, by M. Jordan.—On the equation with partial derivatives of potential, by M. Picard.—On a new telemeter, by M. Landolt. This is based on the principle of refraction through a prism of variable angle, composed of two elementary prisms of the same power turning one on the other with the same velocity in opposite directions. The two have a central aperture concentric with the axis of rotation, and equal to half the surface of section of the bundle of luminous rays which enters the eye. The observer thus looks at once through the apertures and through the prisms. In one position of the prisms the object is seen simple, but on turning it is doubled, and from the amount of rotation necessary to bring the two images to a given position, the distance may be deduced. The instrument serves also for measurement of the size of inaccessible objects.—Application of the telephone to measuring the torsion of the motor-shaft of engines in motion, by M. Resio. Two similar copper wheels with equidistant palettes are fixed on the shaft, and turn before the core-ends of two similar bobbins wound oppositely, the wire forming part of a telephone circuit. While there is no torsion and the palettes therefore pass the cores simultaneously, the telephone is silent; but torsion makes it sound. By displacing the second bobbin on a graduated circle, silence is again had, and the amount of torsion can be estimated.—On a process for the measurement of high temperatures, by MM. Crafts and Meier. This is an adaptation of the gas-thermometer.—Electrolysis of malonic acid, by M. Bourgoin.—Synthesis of ulmic matters, by M. Millot.—On the products of decomposition of proteic matters, by M. Bleunard.—On the anatomical characters of the blood in phlegmasia, by M. Hayem.—On the digestive action of the juice of papaya and of papaïne on the sound or pathological tissues of the living being, by M. Bouchut. All organised tissues, even when living, may be peptonised by this substance (papaïne), which is the *vegetable peptone*.—On anchylostomiasis, by MM. Concato and Perroncito.—On the artificial production of felspars with base of baryta, strontia, and lead, corresponding to oligoclase, labradorite, and anorthite, by MM. Fouqué and Lévy. They operated by producing crystallisation at a high temperature, below the point of fusion, but near it.—Eruption and fall of volcanic dust at Dominica on January 4, by M. L. Bert. *Inter alia*, the cloud-carrying dust is shown to have travelled very slowly, though the wind was high.—Examination of the volcanic dust (just referred to) and the water which accompanied them, by M. Daubrée. The presence of innumerable crystals of pyrites in the powder is specially notable; also the presence of galena.—Separation of minerals whose density is greater than that of quartz with the aid of fused mixtures of chloride of lead and chloride of zinc, by M. Bréon.—*Aperçu* on the genesis of the mineral waters of Savoy, by M. Lévy.—Composition of the mineral waters of Bussang (Vosges), by M. Willm.

CONTENTS

THURSDAY, APRIL 1, 1880

FOSSIL ECHINODERMS

Handbuch der Palæontologie. Unter Mitwirkung von W. Ph. Schimper, Professor an der Universität zu Strassburg, herausgegeben von Karl A. Zittel, Professor an der Universität zu München. I. Band, iii. Lieferung. Mit 195 Original-Holzschnitten. (München: R. Oldenbourg, 1879.)

MORE than three years ago a notice appeared in these columns (vol. xiv. p. 445) of the first Part of a new treatise on Palæontology by Professors Zittel and Schimper. Of the first volume, that which is devoted to Palæozoology, and is from the pen of Prof. Zittel, three Parts have now been published. The last one, which deals with the fossil echinoderms, fully justifies the great expectations to which the first gave rise, both text and illustrations being of a very high order of excellence.

It commences somewhat abruptly in the middle of a sentence belonging to the introductory chapter on the sub-kingdom generally, the earlier pages of which appeared at the end of Part 2. At the end of the volume, in like manner, there are four pages which contain the first portion of the chapter on the Vermes.

Like most Continental writers, Prof. Zittel divides the Echinoderms into four classes only, viz., Crinoids, Starfishes, Urchins, and Holothurians. The first class is a large one, including the Cystids and Blastoids, as well as the true Crinoids, or *Eucrinoidea*, as Zittel calls them; and very nearly half the book is devoted to it, while the Urchins take up the greater part of the remainder.

Each class is treated separately as regards its general anatomy, terminology, classification, and distribution, both in space and in time. Besides the numerous references scattered through the text, a valuable bibliographical list is appended at the commencement of every section but that on the Holothurians, to which, for obvious reasons, only one page is devoted. In the sections on the Urchins and the Crinoids the results of the *Challenger* Expedition (so far as published) are fully considered, and attention is drawn to the analogy between the recent *Comatulæ* and the palæozoic Crinoids in the very limited geographical distribution of individual specific forms, and in some cases even of genera.

The chapter on the general anatomy of the Crinoids is fairly complete, except as regards the blood-vascular system, and exceedingly accurate on the whole, though we must take exception to the passage on p. 329, in which it is stated that *all* (*sämmtliche*) living Crinoids have a central mouth and an excentric anal opening. Nearly forty years ago Müller described several *Comatulæ* with an excentric mouth and a central anal tube. These have been since grouped into the genus *Actinometra*, which includes quite one-third of the species of recent *Comatulæ*. Almost the only recent work on the Crinoids to which no reference is made is Ludwig's singular suggestion that the genital plates of the Urchins and Asterids are homologous, not with the genitals of the Ophiurids and the basals of the Crinoids, as hitherto supposed, but with the *oral* plates of both these groups. Probably, however, this is only because Ludwig's paper was published too late to receive the notice which it deserved. To this same category of oral plates Dr. Zittel refers the remarkable "Consolidations-Apparat" in the calyx of *Cupressocrinus* and the corresponding plates which lie above and alternate with the radials in *Cyathocrinus* and allied genera. This appears to us to be a very probable explanation of the homologies of these plates; and we wonder that the so-called "deltoid pieces" of the Blastoids are not regarded by Prof. Zittel in the same light, for they occupy precisely the same position between the radials and the central mouth as the oral plates of *Cyathocrinus*.

Schültze's views as to the subtegminal mouth of the palæozoic Crinoids are of course fully adopted, but the author does not altogether follow Wachsmuth's arrangement of the group according to the three principal plans upon which the vault is constructed; for the vault of the *Taxocrinidæ* is described as resembling that of the *Cyathocrinidæ*, whereas, according to Wachsmuth, the structure of the vault is essentially different in the two families. Prof. Zittel also accepts Schultze's views as to the position of the boundary line between the plates of the arms and those of the calyx; and he brings forward a strong piece of evidence in their favour, namely, that according to Dr. Carpenter's observations the first radials of *Comatula* correspond essentially in their origin and mode of growth with the basals and orals, appearing as plate-like films from the first, and that they therefore belong to the calyx. On the other hand, according to Sir Wyville Thomson, the second and third radials do not, like the first, begin as expanded cribriform films, but first appear as horseshoe-shaped spicula or imperfect rings; and Dr Carpenter has shown that the origin and development of the arm-joints is of essentially the same character. As in the Urchins and Starfishes, therefore, the calyx normally contains but two rows of plates, viz., the radial series above, and below them the inter-radially situated basals; though in some Crinoids there is a third series of plates, the underbasals, which occupy a radial position between the true basals and the top stem-joint.

The author's descriptions of the arms and their appendages do not seem to us to be always quite consistent. In the *Comatulæ* with ramifying arms all the branches are equivalent. Each of the ten primary arms may fork and give rise to two equal secondaries. Each of these again may bear two equal tertiary arms, and so on, the successive divisions forking altogether perhaps five or six times, and the two divisions borne by any axillary being equal to one another. In some of the stalked Crinoids, however, this regular forking ceases with the second axillary, which bears, not two equal tertiary arms, but a smaller one that remains undivided, and a larger one that continues the line of the secondary arm and ends in an axillary joint. This also bears two unequal arm-divisions, and the same mode of branching is continued on each successive axillary. These smaller lateral branches, which may always be on the same side of the main arm trunk, or may alternate on opposite sides, are termed "Nebenäste" by Zittel, who rightly states that they appear when there is no forking. There is therefore a little inconsistency in his describing the arms of *Cyathocrinus* and *Euspirocrinus* as many times or repeatedly forked, while in the diagnosis of the family the arms are described as having "Nebenäste," and the figures of both genera show that this is the mode of division above the secondary axillaries.

Despite Lütken's arguments to the contrary, Müller's division of the true Crinoids into *Tesselata*, *Articulata*, and *Costata* is adopted with but a few slight modifications, on the ground that it furnishes well-defined natural groups.

The grouping of the families in each sub-order is in great part a new one, though based to some extent on the works of Roemer, Angelin, and Wachsmuth. The sub-order *Tesselata* includes twenty-six families which are arranged in five sections, chiefly according to the structure of the vault, and the relations of the oral plates. Seven of these families are new, while some of those which date from an earlier period have been slightly modified in their extent. The *Articulata* fall into seven families, of which two are new, viz., the *Eugeniacrinidæ* and *Plicatocrinidæ*, while the limits of Roemer's family, *Holopodidæ*, are slightly altered. The recent *Hyocrinus*, which is referred by Sir Wyville Thomson to the *Apiocrinidæ*, is regarded by Prof. Zittel as most probably identical with *Plicatocrinus*, and the well-known genus *Rhizocrinus* of M. Sars is identified with the very imperfectly described *Conocrinus* of d'Orbigny, the latter name being resuscitated on grounds of priority, while *Rhizocrinus* is reduced to the rank of a synonym. We venture to think that this is somewhat inexpedient, for Sars's name is now universally employed, and there can be no possible doubt as to the characters of the type to which he gave it; whereas Zittel himself admits that d'Orbigny's diagnosis of *Conocrinus* is incomplete and even partially incorrect.

Among the *Comatulidæ* the fossil *Solanocrinus* with external basals, is retained as a type distinct from that of the recent and fossil *Antedons* which lack this peculiarity, although Schlüter, like others before him, has recently attempted to merge *Solanocrinus* in *Antedon*. There is one portion of the diagnosis of this type in which clearness has been too much sacrificed to brevity. It is as follows. "Dorsal organ (heart) round, without radial pits." The meaning which these words are intended to convey is that the centrodorsal piece has a round central cavity in which the chambered organ (the so-called heart) was lodged, and that there are no radial pits around its opening. In recent *Comatulæ*, however, the presence or absence of these pits is far too irregular within specific limits to be of any systematic value, while Quenstedt has found them to be sometimes present in *Solanocrinus*, although, according to Zittel, they should be absent.

The Cystids and Blastoids are classified according to the systems proposed by Müller and Roemer respectively. *Agelacrinus* is referred to the Cystids, and not made the type of a new class as is sometimes done in this country; while *Codonaster* is transferred from the Blastoids to the Cystids, in accordance with the views of the late Mr. Billings. *Stephanocrinus*, on the other hand, placed by Roemer among the Cystids, is here regarded as a Blastoid.

The Starfishes are all grouped together into one class, the *Asteroidea*, which contains the two orders *Ophiuridæ* and *Stelleridæ*. The palæozoic forms of the latter, with alternating ambulacral plates, are in accordance with Bronn's classification, separated as *Encrinasteriæ* from the true Stellerids or *Asteriæ veræ*. These are classified chiefly according to the system of Müller and Troschel, which has been the basis of almost all palæontological work on the group, though the author admits that it requires much revision as regards the recent forms.

The classification of the *Echinoidea*, however, contains some new features. The name *Echinocystites*, proposed by Wyville Thomson in 1864 for a remarkable palæozoic form which he regarded as intermediate between Cystids and Echinids, is discarded in favour of *Cystocidaris*, Zittel, on the ground that Hall used the same name three years later for a true Cystid from the Upper Silurian of Wisconsin. *Cystocidaris* is made the type of a new order which, together with the *Bothriocidaridæ* and the *Perischoëchinidæ*, constitute the sub-class *Palechinoidea*, Zittel. Lovén's arrangement of the *Perischoëchinidæ* is the one adopted, except that the family name *Palaëchinidæ*, M'Coy, gives way to *Melonitidæ*, Zittel. The other Urchins constitute the sub-class *Euechinoidea*, Bronn, the regular forms being grouped into four families, viz., the *Cidaridæ*, *Salenidæ*, *Echinothuridæ*, and *Glyphostomata*, this last including the sub-families *Diadematidæ* and *Echinidæ*. In view of the observations of Lovén and Ludwig on the mobility of the plates of the hinder interambulacrum in the *Spatangidæ* and *Holasteridæ*, the author does not regard the *Echinothuridæ* as so clearly related to the *Perischoëchinidæ* as has been supposed by some writers, but considers the characters of their ambulacral and interambulacral areas to indicate the *Diadematidæ* as their nearest allies.

The primary classification adopted for the irregular Urchins is that of de Loriol, which depends upon the presence or absence of a dentary apparatus. Each of his sub-orders, *Gnathostomata* and *Atelostomata* is made to include three families, those of the first being the *Echinoconidæ*, d'Orb., the *Conoclypeidæ*, Zitt., and the *Clypeastridæ*, Ag., while in the *Atelostomata* are included the *Cassidulidæ*, Ag., *Holasteridæ*, de Loriol, and the *Spatangidæ*, Ag., as arranged by de Loriol.

The illustrative woodcuts, like those in the earlier Parts of the "Handbook," are remarkably clear and effective, though in a few cases they might, with advantage, have been a trifle larger. Many of them are new and original, while others, especially in the Crinoid section, are copied from the works of the American palæontologists and from Angelin's "Iconographia." The figures of Echini in the latter half are mostly of exceeding merit, while many beautiful analytical diagrams are reproduced from Lovén's "Echinoid Studies."

This Part of the "Handbook," which seems to us fully to keep up the high character of its predecessors, concludes with p. 564 of the first volume. The chapters on the *Vermes*, *Mollusca*, *Arthropoda*, and *Vertebrata* have yet to appear, and will do so, we trust, at no very distant date.

MEDICINE PAST AND PRESENT

Pharmacology and Therapeutics; or, Medicine Past and Present. By Dr. Lauder Brunton, M.D., &c. (London: Macmillan and Co., 1880.)

DURING the last two or three decades, and especially during the last decade, a change has been going on in therapeutics, that is, in the doctrines of remedies for disease, of so fundamental a character, that it may with reason be called revolutionary. The change, however, is one which so far is but little "understanded of the people," is one, in fact, of which they are almost entirely ignorant. If the question were put to the several members of either House of Parliament, What reasons determine a doctor to give such and such a drug for such and such a disease, and what led to the drug being first used for such a purpose? the answer would in all but a few exceptional cases run somewhat as follows:—"A doctor gives a particular drug in a particular case, because he knows from the experience, either of himself or of others, in similar cases, that it is more likely to do good than anything else (or than nothing at all). As to the first use of a drug, that I believe is in most cases lost in obscurity; and I am told that the use of more recent drugs has either been stolen from some village crony or borrowed from some savage, or suggested by the instinctive actions of some domestic or wild animal. I understand that some doctors are fond of 'making experiments,' *i.e.*, of giving new drugs in this or that disease to see if they can cure it. I don't know what reasons lead them in a particular case to experiment with a particular drug, but I suppose they have some reasons. I dare say accident sometimes suggests a possible cure, and I have a sort of an idea that very often one remedy after another is tried at random, in the hope that one of them at least may prove beneficial." To judge from the speeches and writings put forth at the time of the framing of the Vivisection Act, neither the legislators themselves nor even the more intelligent and educated doctrinaires who pressed for legislation, to say nothing of the common ignorant agitators, had any conception that the use of many popular and successful remedies was the result of the recent labours of able and zealous men who had devoted themselves to the *scientific* investigation of the action of drugs and other agents on the animal economy.

In former times undoubtedly therapeutics were to a large extent purely empirical and indeed traditional. But, in spite of the ignorance of the ruling classes and public in general, in spite of the obstructions caused by a clumsy legislation, a great change is taking place. It can no longer be said, as was once said, that a doctor is "one who puts into a body, of whose actions and powers he knows little, a substance of whose actions and powers he knows less." While physiologists in general have been gaining fuller and fuller insight into the mysterious working of the living economy, a number of men have for years past been investigating, with the help of the most exact methods and appropriate instruments, and with all the light afforded by modern chemistry and physics, the more special problems, still, however, physiological in essence, concerning the nature of the changes induced in living bodies by the substances known as drugs or poisons. Already even many precious hints as to therapeutic utility have thus been gained; already many previously obscure bodies have thus become popular remedies, and in a double sense "in everybody's mouth." Sufficient has been done to show that for the new remedies of the future we shall have to apply, not to some wandering gipsy or sagacious dog, but to the experimental pharmacologists, whose duty it will be to subject to a rigorous inquiry every newly-discovered chemical body or natural product, with the view of estimating its therapeutic promise.

It cannot of course be said that the science of pharmacology or of therapeutics is at present ripe and complete; the knowledge is as yet in the early fermentative stage; a great deal of the work done is of a tentative, preparatory kind; and the results cannot as yet be fairly judged. But to those who know what has been done and what is being done, the importance and greatness of the change in therapeutics which is thereby being inaugurated, seems almost incapable of exaggeration; they look forward with confidence to a future, and possibly not far distant, mastery over disease, compared with which the practice of to-day will seem hardly more than blind stumbling.

Distinguished among English workers in this line of inquiry is Dr. T. Lauder Brunton; and in the present little volume, which consists of the Goulstonian Lectures, delivered before the Royal College of Physicians in the spring of 1877, he lays before his readers a sketch of therapeutics past and present, with the view of showing "how the progress of therapeutics is aided by an exact knowledge of the action of drugs obtained by experiment."

Though addressed primarily to the medical profession, the work is written in a graceful popular style, and might be read with pleasure and profit by laymen. The first few chapters are occupied with a survey of the progress of medicine in the past, and though agreeably written, and suitable for the purpose intended, viz., as introductory to an understanding of the true method of therapeutic research, are somewhat slight and sketchy. In one or two points we should feel inclined perhaps to dispute Dr. Brunton's criticisms and judgments. The rest of the work is taken up with a more or less detailed and expository account of the mode of action of certain drugs, such as strychnia, urare, casca, digitalis, &c., the methods of investigation being described with characteristic clearness and the therapeutic indications of the results being judiciously discussed. The book is one which may be studied with benefit by all medical men, and those not belonging to the profession who desire to have an insight into some of the tendencies of modern medicine will find it a trustworthy and intelligent guide.

THE COMSTOCK LODE

The Comstock Lode; its Formation and History. By John A. Church. 4to. (New York: John Wiley and Sons, 1879.)

THE great interest attaching to the mines of the Comstock lode has led to their being carefully and minutely studied by competent observers at different times. Prominent among these is the original investigation of Baron von Richtofen, published at San Francisco in 1866, who, bringing to the task an unusual knowledge of the class of volcanic rocks in which the lode is inclosed, was enabled to sketch out the broad features of the subject in so masterly a manner as to leave little more for later explorers than the filling in of details. These were supplied in very full measure in the magnificent volume of Clarence King and James D. Hague, forming part of the United States Survey of the 40th parallel, copies of which, by the enlightened liberality of the United States Government were freely supplied to the geologists and engineers of other countries. The rapid increase of the mines in depth, from 500 to 2,000 feet and upwards during the last few years, has, however, to some extent superseded, or rather rendered a supplement necessary to the earlier accounts, and this is supplied by the volume under consideration. The Comstock lode was discovered in 1859 by some gold miner in a pit sunk for a water-hole, and "milling," or reduction of the ore, commenced in the same year, but during the first twelve months the amount of precious metals produced did not exceed 20,000*l*. in value. Since then it has become the largest gold and silver producing locality in the world, the yield during the nineteen years of its history having been, according to different estimates, from 60,000,000*l*. to 70,000,000*l*. in gold and silver. The ore is of two kinds, poor or low grade, averaging in yield from 4*l*. to 7*l*. per ton, and rich, worth from 8*l*. to 22*l*. per ton. These richer ores occur in large bodies or "bonanzas" recurring at irregular intervals both along the course of the lode and in depth. One of the most remarkable, that of the Consolidated Virginia and California mine, discovered in 1873, at 1,300 feet below the surface, measuring 500 feet in depth, 700 feet in length, and 90 feet in thickness, yielded in six years over a million tons of ore, averaging 19*l*. per ton value. The metal or bullion produced is worth from 9*s*. to 10*s*. per ounce, representing a composition of about 94 per cent. silver and 6 per cent. gold. The author discusses the various conditions under which these great masses may have been introduced into the lode, distinguishing the periods of eruption of the different volcanic rocks forming the walls from the so-called "chemical periods" when the strata of diorite, andesite, and propylite were attacked by water containing silica and dissolved or disintegrated, the hollows formed being filled up by masses of quartz without metallic minerals of value. Subsequently a great eruption of trachyte took place, accompanied by movements of the walls of the lode, opening fissures more steeply inclined than those of the first period. These in the "second chemical period" were filled by quartz in the same manner as before, but this time accompanied by gold- and silver-bearing minerals, a trace of this action being still recognisable in the hot waters of the Steamboat Springs about twelve miles distant, which, as shown by Mr. J. A. Phillips and others, deposit a siliceous sinter containing at times cinnabar and metallic gold. On an extensive study of the various phenomena presented by the distribution of the ore bodies both in length and depth, the author, like a true miner, takes a hopeful view of the future, and considers that the prospect of finding a second and lower zone of ore-production within attainable depths is very good. The spirit with which the explorations are followed is best shown by the statement that some half-dozen new vertical shafts are now sinking to cut the lode at depths of 2,500 feet and upwards, one of them being expected to attain a perpendicular depth of 4,500 feet.

Of almost equal interest to the mineral wealth of the Comstock lode are the peculiar heat phenomena observed in the workings, which are very fully described by the author. The air in the lower levels and deep shafts has in places temperatures of from 110° to 120° Fah., while the rock and the water pumped from some of the flooded workings at times attains 150° and 155°. In one instance 158° was observed in the water of a level at 1,800 feet in depth. The author puts forward the hypothesis that these very high temperatures are due to the kaolinisation of the rock, a large amount of heat being supposed to be evolved by the fixation of water in the production of the great masses of clay which characterise the rocks in the immediate vicinity of the lode, and in his own words: "This theory is advanced with confidence in spite of the disadvantage that no estimate can be made of the specific quantity of heat which is produced by the change mentioned." Under these circumstances it seems scarcely necessary to discuss the point, more especially as it has been pointed out by Mr. Phillips, in a paper recently read before the Geological Society, that the application of the only available numerical test, namely, comparison of the amount of alkalies in the water pumped from the mines with that contained in the undecomposed rock as a measure of the amount of change, gives such impossible results as to prevent acceptance of the hypothesis in the absence of more positive data. The fact of the boiling springs at Steamboat Springs, twelve miles distant, being diminished considerably in their flow with the increased depth of the mines, while the mine water has become sensibly hotter, would appear to point to a natural hypothesis of common origin in the last or solfataric stage of the phenomena that produced the lode. The volume is illustrated by plans and sections taken from the working surveys of the mines of very great interest and value.

H. B.

OUR BOOK SHELF

Micrometrical Measurements of Double Stars made at the Cincinnati Observatory in 1878 *and* 1879, *under the Direction of Ormond Stone, M.A.* (Published by Authority of the Board of Directors of the University, Cincinnati, 1879.)

THE measurement of position and distances of double stars is perhaps one of the most common researches for which a telescope is used, perhaps for the reason that no elaborate apparatus is necessary, and also that almost every one thinks that a double star can be measured without much previous training of the eye. Owing to the high latitudes of most of the observatories engaged on the subject, the stars south of the equator are in a great measure neglected compared with those north of it, and in the volume before us we are glad to see that the southern stars from the equator to − 30° have received the greatest attention, some having been measured on twenty or thirty different occasions. Altogether there are 2,250 different observations of the 1,054 double stars appearing in the catalogue; of these 560 are from Struve's catalogue, 171 discovered by the Herschels, 162 by Burnham, and 85 new discoveries. The results appear to have been corrected with great care and the method of correcting observations for errors due to the position of stars relative to the horizon is set forth at considerable length. We notice that all the observations are made with eyes in such a position that a line joining them would be either parallel or normal to the line joining the stars, a point that cannot be too much impressed on observers of double stars, since the error often occasioned by neglect of this precaution is surprisingly large. We believe the parellel position to be subject to the last error.

It seems to be rather a waste of printing to set forth five columns containing position-circle readings and assumed zeros, together with the actual readings of distance, the resulting positions and distances being all that is wanted. The volume is, however, a valuable addition to double star measurements.

The Ophiuridæ and Astrophytidæ of the "Challenger" Expedition. By Theodore Lyman. Part 2, Bull. Mus. Comp. Zool. Vol. vi., No. 2. (Cambridge, Mass.)

THIS is the second part of the preliminary description of the Ophiuridæ and Astrophytidæ dredged by the *Challenger.* Prof. Lyman issued the first part of the Prodromus some time ago. The Prodromus is of course merely an abridgment. Prof. Lyman's full account of the Ophiuridæ will appear in the large work on the *Challenger* Expedition. To the present part is added an index of species contained in the two parts, together with all others described elsewhere by Prof. Lyman. The whole forms a list of the greater portion of deep-sea Ophiurans and Astrophytons known. The list comprises fifty-three genera and about two hundred and twenty-three species. In the present part two new genera and sixty-three new species are described. Prof. Lyman considers that the Ophiuran which was recently described by Prof. Martin Duncan under the name of *Ophiolepis mirabilis* (*Linn. Soc. Journ. Zool.*, xiv. 460, 479), is a true Ophiopholis, lacking none of its characters, and standing quite near the typical *O. aculeata.* Priority is given in all cases by Prof. Lyman to specimens dredged by the *Challenger* over those obtained by the later series of dredgings carried out by the United States Government under Mr. Alexander Agassiz. A similar priority has been generously given by Mr. Agassiz to the *Challenger* Echinoidea, and Count de Pourtales has shown similar consideration in the matter of the corals. Owing to the delay in the publication of the *Challenger* results, the American naturalists could easily have secured priority for their collections, had they thought fit to do so. They have in their hands almost all the forms of any importance which the *Challenger* obtained, for by their continued operations they have dredged them nearly all on the United States coast and around the West Indies. The thanks of English naturalists is certainly due to the American zoologists for their courtesy in this matter.

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.*]

The Density of Chlorine

THE article on the density of chlorine, bromine, and iodine at high temperatures which appeared in NATURE, vol. xxi. p. 461, places before your readers in the clearest manner the present condition of this important question. The conclusion hinted at in the closing sentences of the article, viz. that these gases are under certain circumstances decomposed, is however scarcely warranted. Dr. Armstrong thinks that these substances may be more liable to decomposition when in a nascent state. It is generally supposed that in this condition the atoms of a substance are separate, having as yet had no opportunity of selecting a mate for their further career; if therefore we could observe the density of a gas in the nascent state, we should find that it was only half the theoretical density. In the case of chlorine evolved from platinum chloride at a high temperature we may readily imagine the emerging atom, set in rapid movement by the great heat, to be unable at any time to join with another to form a molecule; we should thus have the nascent state maintained, if I may be allowed the expression, as long as the temperature was high enough. It is further possible that there may be a wide interval between the temperature at which chlorine gas is molecular and that at which it is entirely atomic, and that in this interval a certain proportion of the gas varying with the temperature is resolved into its atoms, the rest remaining molecular. The gas would then have a density intermediate between the theoretical density 2·45 and its half, 1·23, a density in fact corresponding with that obtained in Meyer's experiments.

It may be urged that this attempt at an explanation, necessitating as it does a density varying with the temperature, is incompatible with the facts, since Meyer obtained a uniform density of about 1·6 in all his experiments. It must however be remembered that these observations cannot lay claim to great accuracy, and that the recurrence in several experiments of the same observed density may often be ascribed to chance.

Of this we have an excellent example in the experiments recently recorded in the *Proceedings* of the Royal Society by Prof. Dewar and Mr. Scott. The densities required were those of the vapours of potassium and sodium. In a first series of experiments which were made in an iron vessel the mean density of potassium vapour (referred to hydrogen) was found to be 40·8, that of sodium vapour 25·33, whence it was naturally inferred that those vapours were normal in character. In a second series of experiments, in which a platinum vessel was used, the densities 21 and 13 were found for potassium and sodium vapours respectively; from this it was with equal reason inferred that these metallic vapours were atomic, and resembled that of mercury. Unless platinum has a special dissociating effect on the molecules it must be admitted that in the one series or the other (since they were both made at similar temperatures) the concordance of the results was due to chance.

That the density of chlorine is really subject to gradual variation as the temperature increases, is rendered very probable by the results obtained by Meyer with iodine; the table of these results given in the article referred to (NATURE, vol. xxi. p. 461) shows clearly that the density of iodine decreases gradually, and there would seem to be no reason whatever for the assumption that it is complete at about 1,500° C.

I fear that I trespass much on your space in thus trying to point out that the otherwise inexplicable density 1·6 most probably represents only a stage on the road to the complete dissociation of the molecules, a stage more readily reached by a nascent gas than by one in which the molecules have to be dissociated; the importance of the subject must, however, be my excuse.

Clifton College, Bristol, March 21 FRED. D. BROWN

The Annual Variation of the Barometer in India

IT has been pointed out by Mr. Archibald, in NATURE (vol. xx. p. 54), that the late Mr. J. A. Broun, F.R.S., was probably mistaken in supposing (see vol. xix. p. 6) that there is no direct causal connection between the annual variations of temperature and atmospheric pressure in India. Mr. Broun appears to have adopted this opinion because, at all places in India where the annual oscillations of temperature and pressure are considerable, their turning points are not the same. The highest pressure usually occurs about the middle of December, and the lowest at the end of June, while the lowest temperature is reached during the first ten days of January, and the highest in the latter half of May.

Having been employed a short time ago in calculating the constants of Bessel's formulæ for the annual variations of temperature and pressure at Allahabad, I noticed that the first term of the pressure formula, which includes nine-tenths of the total variation, reaches its maximum almost exactly at the time of lowest annual temperature. The value of this term at the middle of January is ·271″ sin 101° 32′, and its maximum therefore falls about 11½ days before the middle of January, that is on January 4th or 5th. The same term of Bessel's formula for Benares is represented by ·279″ sin 102° 34′, and for Roorkee by ·258″ sin 103° 12′. The maximum pressure at these two stations therefore falls about the 3rd of January, if we take the oscillation of annual period alone. The first periodic term of the formula for the annual variation of pressure at Bombay is given by Mr. C. Chambers ("Meteorology of the Bombay Presidency," p. 16) as ·1405″ sin 87° 2″, the angle being counted from the 3rd of January at the rate of 30° for a month. This throws the maximum forward to the 5th January.

The pressure oscillation of full annual period may be supposed to represent the most important part of the effect of the annual variation of temperature, freed from all minor inequalities due to changes of wind and other causes. The close coincidence of the time at which this pressure oscillation attains its maximum with the time of the temperature minimum at the earth's surface, and presumably at great elevations also, supports the generally-received conclusion that the pressure variation is an effect of the annual inequality of temperature.

Having thus good *primâ facie* evidence for believing that by far the greater part of the annual variation of pressure may be explained on simple hydrostatic principles, I thought it desirable to test this conclusion by Mr. Archibald's method of substraction, making use of somewhat fuller data than were at his disposal when he wrote the letter above referred to. The observations I have adopted are those of Roorkee, 887 feet above the sea-level; Dehra, 2,232 feet; Chakrâta, 7,052 feet, and Leh, 11,503 feet elevation. The first three stations lie within a few miles of each other, their latitudes being 29° 52′, 30° 20′ and 30° 40′ N. respectively. Leh is at a considerable distance to the north, in latitude 34° 10′ N. The four stations are situated nearly on the same meridian, the difference of longitude between the most westerly and the most easterly amounting to less than half a degree.

The mean annual values of temperature and pressure at these four places are the following:—

Station.		Temperature.		Pressure.
Roorkee	(17 years)	74·9° F.	(12 years)	28·889 inches.
Dehra	(12 ,,)	70·6° F.	(12 ,,)	27·567 ,,
Chakrâta	(10-11 ,,)	56·3° F.	(4 ,,)	23·225 ,,
Leh	(2-7 ,,)	39·3° F.	(4-6 ,,)	19·659 ,,

With the exception of the temperature figures for the winter months at Leh, the data are all for sufficiently long periods to be taken as fairly representing normal values of temperature and pressure. From these the average temperatures and barometric weights of three successive strata of air have been calculated, and the results, together with the variations in each month from the annual average values, are given in the next table.

Strata between	Roorkee and Dehra.		Dehra and Chakrâta.		Chakrâta and Leh.		Roorkee and Leh.	
Vertical thickness.	1,345 feet.		4,820 Feet.		4,431 Feet.		10,616 Feet.	
	Tem.	Bar. Weight	Tem.	Bar. Weight	Tem.	Bar. Weight	Tem.	Bar. Weight
Annual means.	72·8°	1·322″	63·4°	4·342″	47·8°	3·566″	57·1°	9·230″
Variations in January	−17·0	+·067	−15·2	+·129	−17·2	+·092	−20·0	+·289
February	−13·2	+·044	−12·6	+·123	−14·9	+·082	−15·5	+·249
March	− 4·6	+·013	− 5·3	+·050	− 7·5	+·034	− 6·7	+·097
April	+ 6·0	−·018	+ 3·3	−·022	+ 2·1	+·017	+ 3·7	−·022
May	+12·3	−·041	+10·0	−·073	+ 7·5	−·040	+10·2	−·152
June	+14·5	−·050	+13·0	−·138	+13·0	−·074	+15·0	−·262
July	+ 9·5	−·040	+ 8·9	−·108	+14·7	−·070	+15·7	−·217
August	+ 8·7	−·031	+ 8·1	−·097	+13·0	−·048	+13·7	−·176
September	+ 7·2	−·021	+ 6·7	−·075	+ 8·6	−·031	+ 9·2	−·126
October	+ 0·8	−·001	+ 0·6	+·003	0·0	+·004	+ 0·1	+·007
November	− 9·1	+·027	− 6·1	+·085	− 6·4	+·005	− 9·3	+·117
December	−16·0	+·049	−12·1	+·125	−12·4	+·027	−16·6	+·201

From these figures it is evident that when the temperature is above the average the pressure is below it, and *vice versâ*. The only exceptions to this rule, which applies to each separate stratum of air as well as to the whole thickness of 11,616 feet, occur in the months of April and October, when the variations of the barometric pressure from the mean of the year are within the limits of the probable error of the observations.

The variations of the density of each layer of the atmosphere are also very nearly *proportional* to the temperature variations, as they would be if the air expanded and contracted *freely* with changes of temperature. Thus the mean decrease of density for one degree of rise in temperature between Roorkee and Chakrâta is ·00235. At the mean temperature of these two stations, 65·6°, the co-efficient of expansion per degree Fahr. is ·0019. The observed variation of density is thus slightly greater than that which would be caused by change of temperature alone, but the difference may be completely accounted for by the larger proportion of aqueous vapour in the air in the hot than in the cold months.

Taking the mean pressure of the lowest stratum of air (that between Roorkee and Dehra) to be the arithmetical mean of the pressures observed at the top and bottom, and supposing the mean tension of vapour in it to be similarly obtained, we may calculate the ratio of its densities in the hottest and coldest months by the usual formula:—

$$\frac{d}{d'} = \frac{P - \frac{3}{8}f}{P' - \frac{3}{8}f_2} \cdot \frac{460 + t'}{460 + t}$$

With the data P = 28·428, P′ = 27·982, f = ·301, f_2 = ·695, and the temperatures given in the preceding table, the ratio of the density in June to that in January comes out ·921, while the ratio of the barometric weights is ·916. A similar calculation for the stratum between Dehra and Chakrâta gives the ratio of the densities in the hottest and coldest months equal to ·933, that of the barometric weights being ·943.

It follows from these results that the annual variation of the barometer over the plains of India and up to a considerable elevation in the Himalayas may be explained by simple hydrostatic principles. A moment's consideration will also show that the double oscillation observed at the hill stations, which is somewhat puzzling at first sight, may be explained in the same way, without bringing in any hypothetical saturated antimonsoon current.

It is the combination of this, at first sight, anomalous variation in the upper regions of the atmosphere, with the variations due to simple changes of density below, that gives rise to those peculiarities of the annual change of pressure in India which led Mr. Brown to give the weight of his great name in meteorology to an opinion that is clearly erroneous.

Allahabad, 18th February S. A. Hill

Gunnery Experiments

I have read with interest the leading article on Gunnery Experiments in Nature, vol. xxi. p. 437. The question seems to me to be one not alone of build, but—and perhaps principally—of muzzle-loading *versus* breech-loading, and of rifling for or without studs. The Admiralty seem to think so, as appears, I presume, from their resolution to adopt breech-loading for the turrets of the *Colossus*. With breech-loading double loading is an impossibility, as well as jamming of studs, since there are none, at least in the first artilleries of Europe. I dare say Sir W. Palisser's *build* is better than any other known in England; but then with it the best guns would be breech-loaders.

Contrary to the grand practice of Europe, England has hitherto, with characteristic tenacity, retained muzzle-loading for *great* guns. Now she will, I apprehend, have to reform and to pay enormous sums as a penalty, besides enduring the very inconvenient feeling of temporary inferiority in a means of great importance. X.

The Hague, March 15

A Museum Conference

I deprecate as strongly, though not so violently, as "Academicus," an association to talk about museums, but I cannot agree with his reasoning on the subject of museums and their curators. I have had twenty years' daily experience of museum work, and at the risk of being dubbed a pretentious curator I can assert I have brought an average intelligence to bear on my work. With a certain amount of sympathy for the strictures of "Academicus" on the multiplication of conferences, I am yet free to assert that in no department of public work might and could greater public advantage result from close association of officials than from a union of museum curators. A provincial curator must often be oppressed with the conviction that he is spending weeks over a task which is already, in some other locality, done to his hands, and he must likewise know that the labour he is in other instances performing, and the objects he is manipulating would be sufficient for the wants of a dozen institutions like his own. He knows that he wants what others have, and that from his abundance others might be filled. Then again, in a general museum, the presiding officer, to be thoroughly efficient, should be master of the circle of the sciences, and have a familiar acquaintance with all arts and art. But science is all-embracing, art is long, and the arts of to-day are obsolete to-morrow. I say in contradiction of "Academicus" that museum officials only know their business when they know their ignorance, and that proper salaries are not their only or chief want. In a scientific sense the best men would be the worst museum curators, and were the municipalities of Great Britain each to offer the salary of a cabinet minister for the services of a museum superintendent, I do not think the institutions would thereby at once be so much revolutionised as "Academicus" thinks.

I am happy to be able to announce that the Council of the

Society of Arts have resolved to give the projected conference their most cordial support, should an executive committee be formed. The Council have promised to accommodate such a conference in their rooms, and to undertake the publication of Proceedings, &c. Here therefore is a nucleus around which a practical project may well form itself, and following on this step I hope soon another may be taken. Allow me through your columns to thank my various correspondents for their support and suggestions. JAMES PATON

Glasgow, March 29

IN your last number "Academicus" dogmatises thus, "Conferences are not required, but proper salaries for the curators." He leaves us quite in the dark, however, as to where the proper salaries are to come from. Now I presume that a conference would be the best means of ascertaining the existing state of local museums and of eliciting suggestions for their improvement.

I beg therefore to propose that the subject should be brought forward at the next meeting of the British Association, to be held at York. J. ROMILLY ALLEN

"Herschel and Cameron's Practical Astronomy"

I RECEIVED not long ago by post a pamphlet bound, rather takingly, in red cloth wrapper, with gilt letter title, stamped largely diagonal-wise on the side; which title consisted of these words—"Herschel and Cameron's Practical Astronomy." The title-page assigns the authorship to one "Alex. Mackenzie Cameron," and adds "Revised throughout by Capt. John Herschel, R.E., in charge Astronomical Branch of the Great Trigonometrical Survey of India."

I will not waste your space by describing the contents; but as I am wholly and entirely guiltless of any knowledge whatever of the work, and as the use of my name inside, and of my patronymic outside (the intention of which is obvious), are alike unauthorised, I trust you will grant me so much as is necessary to protest formally against so daring a piracy.

Collingwood, March 20 J. HERSCHEL

P.S.—I transmit the work for your satisfaction. Please consign it to the waste basket.

Meteor

A BRILLIANT meteor was seen here at 7.57 this evening. Course nearly north to south, passing near ζ Ursæ Majoris, and disappearing suddenly nearly over δ Leonis. Colour greenish white, like burning zinc, with trace of a reddish train, but no track visible afterwards. B. W. S.

Hampstead Heath, N.W., March 29

The Audiphone

I HAVE received a number of letters on this subject which I cannot reply to singly. So far as my own experience goes any audiphone is a total failure in about two-thirds of the cases of deafness.

The essential difference between my own form and the others is that mine is light, cheap, does not require to be held with the hand, and, for musical purposes, gives the correct timbre or quality of tone. Colladon's form especially gives a very harsh, rough quality, and is offensive to a musician; the same objection applies also to my own, made in thin sheet metal; and for this reason birch veneer is preferable to any other material I have tried. I have no intention of making them for sale, but in case of any difficulty in obtaining or making one I will forward any required for 2*s.* 6*d.* each, which is about the cost of making. The only trouble is in obtaining a curved surface on which the wood can be fastened whilst wet. My first were made by wetting the veneer, fastening it in a curve with strings and bent pins and allowing it to remain until dry. The surface should then be varnished, first with shellac in spirit and afterwards with the same to which a small quantity of ivory black is added. The natural colour of the wood is unpleasant, as it makes the user look like a dog on a hot day, *i.e.*, as if he had his tongue out a considerable distance.

The amount of deafness does not appear to be of any importance. I know cases of totally deaf people who can hear perfectly with a small audiphone, and others of only partial deafness in which it is a complete failure. THOS. FLETCHER

4, Museum Street, Warrington

A COMET OBSERVED FROM H.M.S. TRIUMPH

CAPT. A. H. MARKHAM, R.N., of H.M.S. *Triumph*, the flagship on the Pacific Station, reports that a comet was observed during the voyage from Payta in Peru, to Manta on the coast of Ecuador. The *Triumph* left Payta on February 7. The comet was first seen on the evening of the 7th at about 8 o'clock. The nucleus was distinctly made out, bearing south-west at an altitude of 7° above the horizon. The tail, a long-spreading one, was not very brilliant, but could be clearly traced to an altitude of 35°, the observed termination bearing about south-south-west. The whole phenomenon subtended an angle with the horizon of about 70°. It was situated in the constellation of Argo Navis, and the direction of the tail was in a line almost equidistant between Sirius and Canopus. It set at about 9.30 p.m.

On the next evening it was again seen at about 8 p.m., but nearer the horizon, which proved that it had been travelling with extraordinary rapidity. Although the nucleus was closer to the horizon than on the preceding evening, the altitude of the end of the tail was 40°, showing that it had increased in size. Clouds banking up to the southward prevented Capt. Markham from observing the time of setting. On the 9th, the third evening of observation, it was very hazy, but the tail could still be seen, resembling the streamer of an aurora, in the same position as on the two previous evenings. At the same time a bright luminous patch was observed immediately under Canopus.

SOCOTRA

THE following letter has been forwarded to us for publication:—

"*Gollowan Bay, Socotra, February* 16

"MY DEAR SIR JOSEPH HOOKER,—Just a line to say how I am getting on; we reached here on the 11th. The Sultan has not yet turned up, but we expect him soon. The *Seagull* could not go round to Tamarida, but put in here at the west end of the island; she leaves again to-day.

"All my things are now landed and my encampment is close to the shore. I have to wait here for the Sultan in order to get camels from him.

"The island is well worth examination. I have already over 150 species of plants besides some birds, lizards, and insects. The flora is splendid. All my plants have been collected within a couple of miles of my encampment. Some lovely Orobanches and Dodders, Stapelias, other Asclepiads, *Aristolochias*, *Adenium* in thousands, and plenty of *Rubiaceæ*. I stick about here for some time, as I may as well do one little bit thoroughly before taking a rapid run over other parts.

"My collector has taken to the animals, and I intend to make him look after them. The geology of the island is curious: granite, diorite, and limestone being all mixed up in a most perplexing way. There is plenty of water, but not sufficient surface soil for much cultivation here. My companion from Aden has unfortunately had a touch of some fever, but is now better.

"Excuse this short note, but I did not expect the *Seagull* to go so soon, and I have a lot of specimens under way which will not keep.

"I am well, and expect great results, and if hard work will produce them they ought to be obtained.

"Sincerely yours,

"BAYLEY BALFOUR

"P.S.—Letter just come from Sultan ordering sheiks here to give me camels and men and everything I want."

CHEMICAL EQUILIBRIUM

THROUGHOUT the history of chemistry two lines of advance may be traced. At one time chemists have endeavoured to answer the question, what does this substance do? At another time they have inquired, of what is this substance composed?

Function and composition have been, and continue to be, the two great guides in the development of chemical science.

Chemistry has always had her kinetical as well as her statical problems.

And in recent times, as dynamical reasonings have been more and more applied to chemical phenomena, we find the broad distinction still prevailing.

"We can already distinguish two lines along which dynamical science is working its way to undermine at least the outworks of chemistry. . . . Of these two lines of advance one is conducted by the help of the hypothesis that bodies consist of molecules in motion, and it seeks to determine the structure of the molecules and the nature of their motion from the phenomena of portions of matter of sensible size. The other line of advance, that of thermodynamics, makes no hypothesis about the ultimate structure of bodies, but deduces relations among observed phenomena by means of two general principles—the conservation of energy, and its tendency towards diffusion" (Clerk-Maxwell, Science Conferences, South Kensington, 1876).

In a paper published in NATURE (vol. xx. p. 530), I endeavoured to give a short sketch of the work of Guldberg and Waage on the influence of mass on chemical action. The theory of these naturalists is largely based on the hypothesis of the molecular structure of bodies and is developed by the application of dynamical reasoning to experimentally determined facts. The theory is a most successful attempt to explain the nature of the motion of certain molecular systems "from the phenomena of portions of matter of sensible size."

Guldberg and Waage deduce the conditions of equilibrium of many representative chemical systems; but they do this by simplifying the phenomena, by considering only the force of affinity, and by overlooking the action of all "secondary forces." They show how chemical equilibrium is modified by changes in the value of the coefficients of affinity, and by changes in the masses of the reacting bodies. They regard each chemical change as proceeding through two or more phases, and as eventually returning to its original phase, and thus completing itself, unless prevented by the action of extraneous forces.

The work of the Norwegian Professors is confirmatory of the kinetic theory of chemical action, that theory, namely, which regards molecular decompositions and recompositions as continuously proceeding even in apparently stable chemical systems.

A most important paper by Prof. Willard Gibbs, of Yale College, bearing on the thermodynamical problem of the equilibrium of chemical systems, appeared some time ago in the *Transactions* of the Academy of Sciences of Connecticut (vol. iii.). This paper was summarised and rendered intelligible to the chemist by the late Prof. Clerk Maxwell in one of those marvellously condensed and suggestive sketches which he, perhaps better than any other naturalist of modern times, knew how to draw. (*loc. cit.*)

Prof. Gibbs deduces from the principles of the conservation and dissipation of energy, a general expression for the stability of any phase of matter with regard to any other phase.

If K represent the stability of a given phase A with respect to any other phase B, then the phase A will tend to pass into the phase B if K is negative; but if K be zero or positive, the phase A is absolutely stable.

K varies with the component masses, volume, and entropy (called *the magnitudes* of the system by Clerk Maxwell), and with the temperature, pressure, and the *potentials* of the component substances (called the *intensities* of the system): "the potential of any component substance is the intensity with which the body tends to expel that substance from its mass."

The phase A may be stable in itself, and, nevertheless, "may have its stability destroyed by contact with the smallest portion of matter in certain other phases."

No absolutely unstable phase can exist for any finite time, but such a phase may form an intermediate stage between other relatively stable phases. Indeed, "the region of absolutely unstable phases is in contact with that of absolutely stable phases at the critical point. Hence, though it may be possible by preventing the body from coming in contact with certain substances to bring it into a phase far beyond the limits of absolute stability, this process cannot be indefinitely continued, for before the substance can enter a new region of stability, it must pass out of the region of relative stability into one of absolute instability, when it will at once break up into a system of stable phases" (Clerk Maxwell, *loc. cit.*).

That certain phases of heterogeneous substances were unstable has, of course, been long known to chemists—although such phases have been almost entirely disregarded in chemical investigations—but we are now taught that not only is the existence of such phases recognised by the great principles of the conservation and dissipation of energy, but that the conditions of their existence, and of their relations to stable phases of the same mass of matter, can be deduced from these principles.

Chemists have long groped after some definite connecting link which should bind their more empirical generalisations with the great principles of energy which are so far-reaching in their application to physical science; the genius of a mathematician seems at last to have revealed the bond.

As examples of what might be called strained equilibrium, that is, of systems carried into phases much beyond the limits of absolute stability, and of the sudden overthrow of the equilibrium by small exciting causes, Prof. Clerk Maxwell notices the case of water, freed from air and surrounded by a liquid of high boiling point, remaining in the liquid state at a temperature much above the boiling point corresponding to the pressure, but exploding instantly it comes in contact with any gas; he also cites the equilibrium of a 37 per cent. solution of calcium chloride when cooled below $-37°$, as described by Guthrie in his researches on cryohydrates.

Many other similar cases might be noted. In my own work I have recently met with certain phenomena which may, I believe, be explained by the general principle now under consideration.

In studying the effects of mass, time, &c., on the decomposition which may be formulated—

$$x \, BiCl_3 + x' \, HCl + x'' \, H_2O = (x - n) \, BiOCl + n \, BiCl_3 + \{x' + 2(x - n)\} \, HCl + \{x'' - (x - n)\} \, H_2O,$$ [1]

I noticed that if such a quantity of water be cautiously poured on to the surface of a solution of bismuthous chloride in hydrochloric acid, as just suffices to produce a trace of solid bismuthyl chloride (BiOCl) at the surface of contact of the two liquids, and if the liquids be then mixed, the amount of bismuthous chloride which has undergone decomposition after a given time—provided the time be short—is much more than if the water be added to the bismuth solution with constant stirring.

Indeed, I found that it was possible to arrange two systems, each containing the same quantity of $BiCl_3$, HCl, and H_2O, so that one of these should remain clear, *i.e.*, without formation of BiOCl, whilst in the other a considerable amount of decomposition should occur.

[1] Chem. Soc. *Journal, Proc* 1879, p. 311.

The explanation of this phenomenon put forward in the paper alluded to was founded on the molecular hypothesis; but I think that a fuller explanation is afforded by the results of Prof Gibbs's investigations.

When the water was added on the surface, a small quantity of the matter in the vessel instantly passed into another phase; this being in contact with matter in the original phase, induced therein a phase of relative instability, and this succession of phases proceeded until a new condition of stable equilibrium was attained. The entropy of the system was altered by the production of small quantities of BiOCl; K would almost certainly be negative for the new phase with regard to the original phase, and therefore the original phase would become unstable by contact with it of a small portion of matter in the new phase. If, however, the formation of matter in the new phase were prevented by the special contrivance of adding the water in a peculiar way, then the original phase would be stable; if, however, a somewhat large quantity of water were added, the whole system might be carried much beyond the limits of absolute stability without overthrow of equilibrium, but this equilibrium would necessarily eventually be overthrown, as was indeed always found to be the case.

In a paper recently published in the *Journal* of the Chemical Society in conjunction with Mr. Slater, of St. John's College, I detailed the results of an examination of the influence exerted by variations in the amount of water of dilution on the chemical change formulated—

$$BaCl_2 + K_2C_2O_4 = BaC_2O_4 + 2KCl.$$

It is there shown that the progress of this change is retarded to a proportionately greater extent by a large, than by a small quantity of water of dilution, and that this retardation is especially marked when the action proceeds at low temperatures. In order to explain this result we suggested the hypothesis that when much water is present and a low temperature is maintained various hydrates of barium chloride, especially the cryohydrate ($BaCl_2.37H_2O$ solidifying at $-8°$), are produced, and that these, being formed in presence of a large mass of one of the products of their own dissociation, are comparatively stable. We discuss and illustrate this hypothesis in the paper, and, in our opinion, establish for it a fair degree of probability.

Now, if this hypothesis be granted, I think we have in these experiments another illustration of the general principle laid down by Prof. Gibbs.

If $BaCl_2 + K_2C_2O_4$ be called phase A of the system, then undoubtedly K is negative with regard to $BaC_2O_4 + 2KCl$, *i.e.*, with regard to phase B. Phase A is absolutely unstable, and tends to pass into phase B. But during this passage a phase, or phases, is reached which is only relatively unstable. Could the matter in this phase (which may be called the cryohydrate phase) be separated from that portion already in phase B, the intermediate phase might become absolutely stable; this, however, is not done, and hence the whole system tends to pass into phase B. But it is evident that those conditions which favour the formation of matter in the cryohydrate phase must also retard the passage of the system into phase B. Moreover, while the system is in the cryohydrate phase, it is carried to a certain extent beyond the limits of absolute stability, and if this phase were abnormally extended we should expect to obtain a condition of unstable equilibrium liable to complete overthrow by small exciting causes. In the paper referred to we show that such an expectation can be realised.

A class of reactions in chemistry, hitherto treated for the most part as isolated facts, seems to find its explanation in the generalisation now established by the Yale Professor, viz., that the equilibrium of matter in a relatively stable phase may be overthrown by contact with even very small portions of matter in another phase.

As examples of the reactions referred to may be cited, the decomposition of ozone by silver, and of barium peroxide by platinum; the production of diphenylmethane from benzene and benzylic chloride only in presence of a small quantity of zinc or copper; the action of hydrochloric acid on bismuthous oxide in presence of a small quantity of water;[1] and in general those numerous reactions which are modified by the presence of traces of foreign substances.

In other cases contact with small quantities of matter in another phase appears to retard the passage of the main system from its initial phase to a phase of greater stability. Thus Bunsen and Roscoe showed[2] that the resistance to combination of a mixture of hydrogen and chlorine when exposed to sunlight is increased by the presence even of traces of oxygen.[3]

Every chemical system thus appears to tend towards a phase of maximum stability. If the entropy of the system be decreased, K will be increased in the general equation of Gibbs, and hence the stability of the system will be increased.

All chemical systems not in phases of absolute stability will therefore tend to lose entropy.

This is probably a better method of stating Berthelot's so-called *law of maximum work* than that generally employed.

Moreover, it may be possible to convert a phase of absolute stability into a phase of relative stability, and thence into a phase of absolute instability, by contact with matter in another phase, *i.e.*, in ordinary chemical language, by the action of a reagent.

The readiness with which so many chemical systems undergo change leads one to ask whether chemical systems are not generally in one or other of those phases of relative instability which are so easily overthrown by contact with small quantities of matter in other phases. If this be so, and if it be granted as extremely probable, that even apparently stable systems are passing through cycles of change, then we should expect that slight changes in the values of the "magnitudes" or "intensities" of chemical systems would in many cases induce the overthrow of the stability of these systems.

The considerable differences in the properties of many carbon compounds, as described by different experimenters, may not improbably be due to the changes induced in these bodies by contact with small traces of impurities, *i.e.*, of matter in phases other than that of the main portion of the system.

The more complex the possible actions and reactions in any given system of heterogeneous substances, the more probable will be the occurrence of unstable phases, and the more will the course of what we call the chemical change be turned aside by small variations of the "magnitudes" or "intensities" of the system.

In chemical changes involving few intermediate phases —or to put it in another way, in chemical changes wherein the action of "secondary forces" is small—the course of the change may be followed, and generalisations made concerning it, as was done by Harcourt and Esson for a special case.[4] When the action becomes a little more complex, we appear to gain the conditions under which so-called "chemical induction" becomes possible; while from the study of exceedingly complex actions no generalisations can be safely deduced.

This view of chemical systems as readily undergoing change when in contact with other systems, and of these changes as being dependent on the energy of the systems

[1] Examined by me in Chem. Soc. *Journ.*, 1879; *Proc.*, p. 336.

[2] *Phil. Trans.*, 1856.

[3] The modifying influence exerted on a process of chemical change by the presence of a foreign substance was considered in 1850 by Brodie, in an able paper, in which, speaking of the decomposition of barium peroxide by platinum, he says: "The platinum causes that chemical relation betwee the particles which renders the decomposition possible."

[4] Chem. Soc. *Journ.*, xx. 460.

in different phases, may lead to a fuller explanation of the "acceleration coefficients" of Harcourt and Esson. These chemists found that the change formulated

$$H_2O_2 + 2HI = 2H_2O + I_2$$

was accelerated to a definite extent by addition of sulphuric or hydrochloric acid, but that the accelerating value of each acid was different. The "acceleration coefficients," which they suggested might profitably be found for classes of salts, would measure the changes in the energies of the systems, brought about by the addition of the salts used.

The work of Prof. Gibbs will probably tend to modify the views generally held with regard to the meaning of constitutional or structural formulæ, and to lead us to regard these formulæ as crude representations of the configuration of the molecule when it has passed into the phase preceding that of absolute instability, rather than of its configuration when it is unacted on by matter in a phase different from its own, and is therefore itself in a phase of absolute stability.

Of course the possibility of predicating a general decomposition for a group of compounds, shows that these compounds all tend to pass—under the influence of one and the same reagent—into analogous unstable phases, and that their structure, before contact with the reagent, is therefore probably analogous.

Prof. Gibbs has shown how the laws of energy may be applied to the solution of chemical problems, and in doing this he has opened a new path of advance, and has supplied a guide long sought for by students of chemistry.

M. M. PATTISON MUIR

A LEAF FROM THE HISTORY OF SWEDISH NATURAL SCIENCE[1]

I.

BEFORE the Era of Freedom (1721, 1772) Sweden had produced only four men who had earned for themselves a recognised name in the history of the natural sciences by discoveries in the field of natural research. These were Sigfrid Aron Forsius,[2] unfortunate in his predictions, author of a Mineralogy which had an extensive sale, but is full of superstition, and did not advance the science in any noteworthy degree; the quarrelsome and whimsical Upsala professor, Olof Rudbeck,[3] who, at the age of twenty-five, published his discovery of the lymphatic vessels; the physician of European reputation, Urban Hjaerne,[4] superintendent of one of the first State laboratories established for *scientific* investigation, famous for his researches regarding mineral waters, the increase of weight in metals on their oxidation, and formic acid, the discoverer of several new minerals, &c.; the afterwards so renowned mystic Emanuel Swedenborg,[5] known in the history of the natural sciences for various geological treatises of great excellence, considering the period when they were written, for a remarkable work on atomicity, for several crystallographical researches, for the largest and most complete handbook on metallurgy, &c.

These formed the whole contribution that Sweden, during her period of greatness, was able to make in this field. Here up in the remote north we had, as far as scientific research is concerned, remained completely undisturbed by the discoveries of Copernicus, Descartes, Leibnitz, and Newton, nay, even the original researches of Danish men of science such as Tycho Brahe, Steno, Bartholinus, and Roemer, had awakened no *fruitful* response on our side of the Sound.

There came, however, another period. Our short dream of greatness had come to a bloody termination. Of the Sweden formerly so powerful there remained but a maimed, depopulated nucleus, impoverished by perpetual war, whose part in the labour of the development of the race appeared to have been long ago played out. No glorious interference in the field of politics was any longer possible. But instead there began here, in the peaceful field of science, labours attended with such success that the history of other countries can scarcely show anything corresponding to it.

Our native country, where, as I have just pointed out, there was previously scarcely any scientific research, was for two decades after the peace of Nystad (1721) as fruitful in this field as any cultured state whatever, and some ten years later occupied the first rank in zoology and botany through Linnæus, in mineralogy through Wallerius and Cronstedt, in chemistry through Brandt, Cronstedt, Scheffer, Bergman, Scheele. There were also valuable contributions to the development of physics from Wassenius, Klingenstjerna, Hjorter, Celsius, Wargentin, Wilke, &c., and to the knowledge of our globe through Bergman's excellent "Description of the Globe," and the travels of the numerous pupils of Linnæus. Remarkably enough, this period of greatness in the field of research is almost conterminous in time with that "Era of Freedom" which is often depicted in so dark colours by our writers of history. It was clearly born of the spirit which accompanied the new constitution, and it got its death blow at the revolution by which Gustavus III. is said to have "saved the country."

The object of this paper is to contribute to the history of our civilisation a sketch of the influence which Swedish men of science of that age exerted on the development of chemistry and mineralogy.

The line of the great men of science from that period is headed by George Brandt, Councillor of Mines and Superintendent of the Laboratory of the Mining Board at Stockholm (born 1694, died 1768).

During the seventeenth century and the beginning of the eighteenth most of the writings of authors on chemistry still contain an unintelligible confusion of endless considerations concerning the way in which the bodies on the earth's surface are composed of certain supposed primitive substances, for instance, according to the school of Aristotle, of fire, earth, water, and air; according to Basil Valentine and Paracelsus, of certain elementary principles—salt, sulphur, and quicksilver. The service of having shown the groundlessness of these fancies is to be ascribed to the great English *savant*, Robert Boyle (died 1691). In opposition to his predecessors, he laid down the fundamental principle that the chemist ought to consider every body as simple which with the means at his disposal he cannot chemically decompose, a principle which indeed took from chemistry much of the glitter of learning with which it before was bedecked, and which in the eyes of philosophers reduced this science to an art of cookery, which in any case, when the old creations of fancy, constructed with so much trouble and subtlety, were blown away, gave the science a stable foundation to build on. Boyle's fundamental principle has since been further developed, and now forms one of the corner-stones of the modern chemistry—although it must be admitted that it is little in accordance with the simplicity which otherwise prevails in nature, that the material world should consist of more than sixty different elements. Certain it is in any case that the elements in question, at least for the

[1] Translated from a paper by Prof. A. E. Nordenskjöld, of Stockholm.

[2] Born at Helsingfors after the middle of the sixteenth century; died 1637.

[3] Born 1630, died 1702. His discovery of the lymphatic vessels was published in 1653.

[4] Born 1641; died at Stockholm in 1724.

[5] Swedenborg was born in 1688; died in 1772. The greater portion of his period of activity therefore falls under the Era of Freedom, but most of his scientific works were published before 1721, among them his "Prodromus Principiorum Rerum Naturalium," in which, among other things, he attempts to explain the physical properties of bodies, on the supposition that they are composed of an endless number of minute atoms. His great metallurgic works were first published in 1734. In the *Transactions* of the Royal Academy of Sciences he published, as late as 1763, a "Description of a Method of Inlaying Tables and other Furniture with Marble," free from all mysticism. The table described in this paper is still preserved at the office of the Swedish Board of Trade.

present, cannot be decomposed or transmuted into one another either by the most powerful decomposing agents, by the vital forces of plants, or by fire, or by electricity. They thus form the raw material of which everything in nature, whether living or inanimate, is composed. In such circumstances it is clear that an accurate knowledge of these elements forms the first condition for the development of chemistry, and that the discovery of a new element must often be of such importance as to form an epoch in the history of the science.

This was especially the case at first, when many of the elements that occur most generally in nature, and there play a very important part, were yet unknown, and when nearly every new discovery in that field presupposed a new method of research which could also be employed in other directions. Many questions, too, which now appear self-evident were formerly very difficult of investigation on account of the faulty methods of research which were then generally employed. The history of chemistry during the last century shows that the Swedish school of chemistry was the first that taught the chemist to question nature in the right way, and to arrange his experiments so that to a *proper* question he got a *proper* answer. Urban Hjaerne may be considered as the founder of this school, Brandt as the eldest of his pupils who took part in the development of the science.

The first chemical work by which Brandt gained for himself an honoured name in the history of chemistry was his researches "De Arsenico," and "De semi-metallis," published in *Acta litteraria et scientiarum Sueciæ* (Upsala, 1733 and 1735), in which he showed, among other things, that arsenic, with reference to which the views generally entertained were uncertain and hesitating, must, on account of its physical and chemical properties, be considered a (semi) metal, whose "kalk" is the white arsenic (arsenious acid). Of great importance for the mineral chemistry of that period was also Brandt's research on zinc, by which he showed that galmeja and blende are ores of zinc, and galitzenstein its vitriol.[1] We have him, besides, to thank for important investigations into the causes of cold- and red-shortness in iron, in the course of which he for the first time makes a proper distinction between these two defects, gives a correct explanation of the cause of red-shortness, and, as far as cold-shortness is concerned, comes very near the truth. Further, Brandt published repeated extensive researches regarding the vegetable and mineral alkalies, in which, among other things, he shows (1756) that common salt contains the same alkali as soda, but saltpetre, on the other hand, a vegetable alkali. Thereby the objections were repelled which various chemists had made to the masterly research of the Frenchman, Duhamel du Monceau, published twenty years before, "Sur le base du sel marin."

Brandt, however, is most renowned in the history of chemistry for his discovery of the metal cobalt. The distinguished German mineralogist Agricola, who died in 1555, speaks of certain minerals which, in consequence of their silver-like appearance, were mistaken for silver ores, but which, when an attempt was made to smelt them, only gave off a poisonous smoke, but yielded no noble metal. They were therefore looked upon by the superstitious miners of that time as silver ores which had been changed by mountain goblins or "kobolds," and were thrown away as valueless, until a German glass manufacturer, Schürer, in the middle of the fifteenth century, discovered that they could be used to give a beautiful blue colour to glass. No thorough examination of the blue colouring matter, however, was made until Brandt, in his "Dissertatio de Semi-metallis," published in 1735, showed that it contained a peculiar metal, which he named cobalt. In the cobalt ores formerly known this metal was combined with arsenic, but in 1742 Brandt examined a cobalt ore from Riddarhyttan, in Westmanland, which was found to be free of arsenic, and afterwards obtained the name Linneit. Nearly fifty years after the publication of Brandt's first paper doubts were cast by foreign chemists on the existence of the new metal on the ground of erroneous experiments.

Next in order to George Brandt among distinguished Swedish chemists comes Henrik Theophilus Scheffer, assayer of the mint at Stockholm, born 1710, died 1759. His most famous work is a research on "The White Gold, or Seventh Metal, called in Spain Platina del Pinto" (*Trans.* of the Swedish Academy of Sciences, 1752), in which Scheffer shows by a complete series of experiments that this "wild American variety of silver" forms a new noble metal. Two years before the same substance, which had long been known to the Spaniards, was referred to as a semi-metal, yet without any further clearing up of its chemical properties. In consequence of the many mystic conceptions, not yet completely rooted out, which, from the time of the alchemists, were connected with the idea "noble metal, the ascertaining of the chemical nature of the "white gold" contributed more than could have otherwise been expected to extend and confirm the sound and truly scientific direction which in a couple of decades became predominant in chemical research in our country. We have besides Scheffer to thank for important improvements in the art of assaying gold and silver, and for an excellent series of lectures in chemistry, published by Thorbern Bergman from notes taken by Alströmer, for the first time in 1775, sixteen years after Scheffer's death, and since several times reprinted both in the Swedish and in foreign languages.

A year before the publication of Scheffer's first paper on platinum the *Transactions* of the Swedish Academy of Sciences contained another important research, "Experiments made with a Species of Ore from Loos Cobalt Mines," by Axel Frederic Cronstedt. These mines had a century before been taken in hand by Kalmeter, and the ore at first yielded a good zaffre. But it soon appeared that part of the ore was impure. It was examined by Cronstedt. and found to contain not cobalt, but a new metal. This new metal Cronstedt afterwards found in various other minerals, among others in a German mineral, Kopparnickel, a copper ore changed by a wicked mountain goblin, "Niccol." The new metal, which has now many practical applications, was called nickel, and was immediately, in accordance with the requirements of science, carefully examined, and the tests for it ascertained by Cronstedt. To show what difficulties attended such investigations at that period it may be pointed out that Buffon in 1777 considered platinum an alloy of gold and iron, and that Sage, renowned in France as an analytical chemist, in 1772, and De Lisle even in 1783, considered koppar-nickel a cupriferous ore. Even in 1801 Haüy did not consider it fully established that nickel was a distinct metal. Further, it ought to be mentioned in connection with Cronstedt's chemical activity that he was the first to draw attention to a mineral, "Bastnäs tungsten," from Bastnäs mines in Westmanland, in which Berzelius, Hisinger, and Klaproth in 1803 discovered cerium, and Mosander in 1839 and 1843 lanthanum and didymium. Cronstedt's special greatness, however, did not lie in the field of chemical but of mineralogical research. Here he prepared the way for the new era.

It was natural that a certain practical skill in distinguishing minerals and ores should speedily be developed in a country so rich in mines as Sweden. We scarcely find a trace of it, however, in the older Swedish literature, for the Mineralogy of Aron Forsius is full to overflowing of the sayings of Arabian authors, but contains only notes on nature studies within the land itself. On the other

[1] It is distinctive of the then standpoint of the science, and of the importance which discoveries that now appear of little moment had for its development, that even so late as 1725 the experienced Saxon mineralogist, Henckel, had no suspicion that blende, which is of common occurrence in the Saxon mines, contains zinc.

hand Urban Hjärne's work, "A Short Introduction to Research into Various Kinds of Ores and Rocks, Minerals, &c." (Stockholm, 1694), fortunately written not for the learned but for searchers for ore, unfolds practical views of the subject, and he has in reality connected his name with several new observations in science. Not till after 1720, however, did there commence among us in this field a new period. As early as 1730 Bromell published a little, modest but serviceable Mineralogy, which enables us easily to understand the standpoint of the science at that date. Afterwards Linnæus included the mineral kingdom along with the others in his "Systema Naturæ" (first edition, 1735), and attempted to apply in that branch of knowledge the method of going to work which he had used with such success in describing and arranging the products of the animal and vegetable kingdoms. In this way at a later date he gave the exciting touch to De Lisle's work, which created an era in this field. The method of Linnæus was followed by Gottskalk Wallerius, who published in 1747 the first real Handbook of Mineralogy, a work incomparably better than anything that had been written on this branch of knowledge since the time of Agricola. For not only in it was collected all that was previously known in science, but the work was rich in new discoveries. Yet Wallerius still places among the true species of minerals, petrifactions and stone-like concretions from the animal and vegetable kingdoms, pearls, hair-balls, &c.

It was reserved for Cronstedt to sweep these matters out of mineralogy, and thus draw a correct boundary line between the products of the mineral and animal kingdoms, and to lay the foundation of geognosy by making a proper distinction between minerals and rocks. The work in which these new discoveries were brought together was published, without the author's name, at Stockholm in 1758, under the title, "An Essay on Mineralogy; or, an Exposition of the Mineral Kingdom," afterwards reprinted in a new edition and translated into Danish, English, and German (two editions). In order to give an idea of the revolution in science which Cronstedt carried through, not without violent opposition, I take the following extract from the polemic introduction to his work:—

"Sand is in itself nothing else than small stones, and therefore, if we give sand a place by itself we ought to do the same to pebbles, to earthfast stones, and lastly to rocks. This is just a *multiplicatio entium præter necessitatem.*

"Stones of beasts and fishes are composed partly of phlogiston, salts, and a small proportion of earth, partly of the same matter as the bones of animals, and there is therefore no more reason for including them in a mineral system than the stones of fruits. Soot, tartar, yeast, and such like are too nearly related to the vegetable kingdom. . . . Hair-balls and hat-stuff are so far different that the former is felted together in the entrails of animals *per motum peristalticum*, and the latter by the industry of human hands. May we suppose, then, that hair-balls and animal-stones cannot be included among *relicta animalia?* . . . Meanwhile I flatter myself that those who will follow the introduction here given will not be put to so much trouble with the matters belonging to the mineral kingdom as has happened to myself and others from previously published systems, and that I thus will get some defender against those who are so infected with figuromania and taste for outside work that they are offended at the presumption of passing off marble as limestone, and of placing porphyry among rocks."

This introduction is distinctive of the reform which Cronstedt carried through in mineralogy, and it is distinctive of the standpoint of science before Cronstedt's time that the alteration, so necessary and self-evident as it now appears to be, at first aroused controversy and opposition. To this it conduced in its degree that Cronstedt in general fixed less attention on the outward appearance of minerals than on their chemical properties, to ascertain which he employed the blowpipe with great skill and success. Numerous were the new discoveries with which in this way he enriched the science, and during a quarter of a century his "Essay on Mineralogy" was an unsurpassed *chef-d'œuvre.*

Two years after Cronstedt's death Wallerius retired from his professorship of chemistry in the University of Upsala, and after a lively contest the post was assigned to Thorbern Bergman (born 1735, died 1784), then mathematical assistant. He had not previously made himself known by any *chemical* writings, but from that time he devoted himself with such industry and success to chemical research that within a short time he won for himself a European reputation and the name of being the first chemist of his time. His researches embraced nearly all branches of the chemical science of the period; everywhere he dragged new facts into light or corrected older erroneous statements. Space permits me here only to point to his development of the new chemical analysis in the wet way, and the researches he carried out by the new methods on the most dissimilar substances, for instance on different kinds of iron, by which the composition of pig iron, malleable iron, and steel was first ascertained, on precious stones and siliceous minerals, on a number of salts, &c.; to his comprehensive research on carbonic acid (called by him atmospheric acid), whereby the discoveries of Black, Macbride, and Cavendish relating to this exceedingly important substance were considerably extended and the foundation of the chemistry of carbonic acid laid; to his analyses of mineral waters, in which even their gaseous constituents were estimated; to his examination of the salts of bismuth, zinc, lead, nickel, gold, platinum, and magnesia; to his services to organic chemistry; and finally to his laborious investigation of the laws of chemical attraction, which are still recognised in the science, though in a form much altered, by the labours of Berthollet and others. Bergman also did great service to mineralogy by his comprehensive analytical researches and by his "Sciagraphia Regni Mineralis," the best systematic work on mineralogy since the time of Cronstedt.[1]

Finally, we may further state that Wallerius and Bergman were the founders of agricultural chemistry, the former by his disputation, "Agriculturæ fundamenta Chemica," published in 1761, in Latin and Swedish; the latter through a work, "De Terris Geoponicis," which was communicated to the Academy at Montpellier, and for which he received a prize in 1773. An incalculable service has also been conferred by the Swedish chemists on the development of scientific agriculture by their pointing out the common occurrence of phosphorus in nature, in the mineral kingdom by Gahn in 1780, in the bones of animals by Gahn or Scheele before 1771.[2]

Carl Wilhelm Scheele lived and worked at the same time as Bergman. He did not possess the many-sided learning and deep theoretical insight of the Upsala professor, but, instead, an unsurpassed power of scientific divination, which enabled him, the young apothecary, to mark nearly every year of his short period of activity by "original contributions to chemical science, which, by the influence they exerted on industry, metallurgy, and agriculture, contributed more powerfully than diplomatic negotiations or pitched battles to the development of the

[1] Bergman's works were for the most part published in the first place as academic disputations or in the *Transactions* of the Swedish Academy of Sciences, but they were afterwards collected in "Opuscula Physica et Chemica," 6 vols., Upsala, 1779. There are numerous translations into foreign languages.

[2] Phosphoric acid, as is well known, forms a constituent in most manures. It was first discovered by the Hamburger Brand (not to be mistaken for George Brandt) in 1669, and, when he kept his discovery secret, a second time by Kunkel (German chemist, for the last twenty-five years of his life mining counsellor in Stockholm, and ennobled by Charles XI. under the name of Löwenstern). That the generally-occurring mineral *apatite* contains phosphoric acid was discovered by Klaproth and Proust in 1788. That bone, horn, &c., may be used as manures was known to Bergman (see *Opuscula*, v. page 106).

last hundred years, and secured him, the modest apothecary of Köping, a place in the first rank of the men of science of all ages and of all countries."

In a succeeding paper I propose to give a sketch of the work of Scheele, and to return at the same time to the chemical labours of Bergman.

(*To be continued.*)

THE TEMPERATURE OF SPACE AND ITS BEARING ON TERRESTRIAL PHYSICS

FEW questions bearing directly on terrestrial physics have been so much overlooked as that of the temperature of stellar space, that is to say, the temperature which a thermometer would indicate if placed at the outer limits of our atmosphere and exposed to no other influence than that of radiation from the stars. Were we asked what was probably the mid-winter temperature of our island 11,700 years ago, when the winter solstice was in aphelion? we could not tell unless we knew the temperature of space. Again, without a knowledge of the temperature of space, it could not be ascertained how much the temperature of the North Atlantic and the air over it were affected by the Gulf Stream. We can determine the quantity of heat conveyed into the Atlantic by the stream, and compare it with the amount received by that area directly from the sun, but this alone does not enable us to say how much the temperature is raised by the heat conveyed. We know that the basin of the North Atlantic receives from the Gulf Stream a quantity of heat equal to about one-fourth that received from the sun, but unless we know the temperature of space we cannot say how much this one-fourth raises the temperature of the Atlantic. Suppose 56° to be the temperature of that ocean: this is 517° of absolute temperature which is derived from three sources, viz.: (1) direct heat from the sun, (2) heat from the Gulf Stream, and (3) heat from the stars. Now unless we know what proportion the heat of the stars bears to that of the sun we have no means of knowing how much of the 517° is due to the stars and how much to the sun or to the Gulf Stream.

M. Pouillet and Sir John Herschel are the only physicists who appear to have devoted attention to the problem. The former came to the conclusion that space has a temperature of – 142° C. or – 224° F., and the latter, following a different method of inquiry, arrived at nearly the same result, viz., that its temperature is about – 239° F.

Can space, however, really have so high a temperature as – 239°? Absolute zero is – 461°. Space in this case would have an absolute temperature of 222°, and consequently our globe would be nearly as much indebted to the stars as to the sun for its heat. If so space must be enormously more transparent to heat rays than to light rays. If the heat of the stars be as feeble as their light, space cannot be much above absolute zero, and this is the opinion expressed to me a few weeks ago by one of the most eminent physicists of the day. Prof. Langley is also of this opinion, for he concludes that the amount of heat received from the sun is to that derived from space as much as four to one; and consequently if our luminary were extinguished the temperature of our earth would fall to about – 360° F.

It must be borne in mind that Pouillet's Memoir was written more than forty years ago, when the data available for the elucidating the subject were far more imperfect than now, especially as regards the influence of the atmosphere on radiant heat. For example, Pouillet comes to the conclusion that, owing to the fact of our atmosphere being less diathermanous to radiation from the earth than to radiation from the sun and the stars, were the sun extinguished the radiation of the stars would still maintain the surface of our globe at – 89° C., or about 53° C. above that of space. The experiments of Tyndall, however, show that the absorbing power of the atmosphere for heat-rays is due almost exclusively to the small quantity of aqueous vapour which it contains. It is evident, therefore, that but for the sun there would probably be no aqueous vapour, and consequently nothing to protect the earth from losing its heat by radiation. Deprived of solar heat, the surface of the ground would sink to about as low a temperature as that of stellar space, whatever that temperature may actually be.

But before we are able to answer the foregoing questions, and tell, for example, how much a given increase or decrease in the *quantity* of sun's heat will raise or lower the *temperature*, there is another physical point to be determined, on which a considerable amount of uncertainty still exists. We must know in what way the temperature varies with the amount of heat received. In computing, say, the rise of temperature resulting from a great increase in the quantity of heat received, should we assume with Newton that it is proportional to the increase in the quantity of heat received, or should we adopt Dulong's and Petit's formula?

In estimating the extent to which the temperature of the air would be affected by a change in the sun's distance, I have hitherto adopted the former mode. This probably makes the change of temperature too great, while Dulong's and Petit's formula adopted by Mr. Hill (NATURE, vol. xx. p. 626), on the other hand, makes it too small. Dulong's and Petit's formula is an empirical one, which has been found to agree pretty closely with observation within ordinary limits, but we have no reason to assume that it will hold equally correct when applied to that of space, any more than we have to infer that it will do so in reference to temperature as high as that of the sun. When applied to determine the temperature of the sun from his rate of radiation, it completely breaks down, for it is found to give only a temperature of 2130° F. (*Amer. Jour. Science*, July, 1870), or not much above that of an ordinary furnace.

But besides all this it is doubtful if it will hold true in the case of gases. From the experiments of Prof. Balfour Stewart (*Trans.* Edin. Roy. Soc., xxii.) on the radiation of glass plates of various thicknesses, it would seem to follow that the radiation of a material particle is probably proportionate to its absolute temperature, or, in other words, that it obeys Newton's law. Prof. Balfour Stewart found that the radiation of a thick plate of glass increases more rapidly than that of a thin plate as the temperature rises, and that, if we go on continually diminishing the thickness of the plate whose radiation at different temperatures we are ascertaining, we find that, as it grows thinner and thinner, the rate at which it radiates its heat as its temperature rises becomes less and less. In other words, as the plate grows thinner its rate of radiation becomes more and more proportionate to its absolute temperature. And we can hardly resist the conviction that if it were possible to go on diminishing the thickness of the plate till we reached a film so thin as to embrace but only one particle in its thickness, its rate of radiation would be proportionate to its temperature, or, in other words, it would obey Newton's law. Prof. Balfour Stewart's explanation is this: As all substances are more diathermanous for heat of high than low temperatures, when a body is at a low temperature only the exterior particles supply the radiation, the heat from the interior particles being all stopped by the exterior ones, while at a high temperature part of the heat from the interior is allowed to pass, thereby swelling the total radiation. But as the plate becomes thinner and thinner, the obstructions to interior radiation become less and less, and as these obstructions are greater for radiation at low than high temperatures, it necessarily follows that, by reducing the thickness of the plate, we assist radiation at low more than at high temperatures.

If this be the true explanation why the radiation of bodies deviates from Newton's law, it should follow that in the case of gases where the particles stand at a considerable distance from one another, the obstruction to interior radiation must be far less than in a solid, and consequently that the rate at which a gas radiates its heat as its temperature rises, must increase more slowly than that of a solid substance. In other words, in the case of a gas, the rate of radiation must correspond more nearly to the absolute temperature than in that of a solid; and the less the density and volume of a gas, the more nearly will its rate of radiation agree with Newton's law. The obstruction to interior radiation into space must diminish as we ascend in the atmosphere, at the outer limits of which, where there is no obstruction, the rate of radiation should be pretty nearly proportional to the absolute temperature. May not this to a certain extent be the cause why the temperature of the air diminishes as we ascend?

If the foregoing considerations be correct, it ought to follow that a reduction in the amount of heat received from the sun, owing to an increase of his distance, should tend to produce a greater lowering effect on the temperature of the air than it does on the temperature of the solid ground. Taking, therefore, into consideration, the fact that space has probably a lower temperature than $-239°$, and that the temperature of our climate is determined by the temperature of the air, it will follow that the error of assuming that the decrease of temperature is proportional to the decrease in the intensity of the sun's heat may not be great.

In estimating the extent to which the winter temperature is lowered by a great increase in the sun's distance there is another circumstance which must be taken into account. The lowering of the temperature tends to diminish the amount of aqueous vapour contained in the air, and this in turn tends to lower the temperature by allowing the air to throw off its heat more freely into space.

JAMES CROLL

THE RUSSIAN GEOGRAPHICAL SOCIETY

IT is no easy matter to render an account of the proceedings and publications of the "Imperial Russian Geographical Society." So numerous are its sections, and so prolific is each of them, that to master the whole of the information yearly made available by them would be no easy task, even for a reader possessing the amount of leisure which most Russians enjoy. Some of its volumes, however, are intended merely as works of reference, books which are not meant to be read through, but which serve as useful storehouses of facts and figures. Of such a nature is the huge collection now before us of *Pistsovuiya knigi*, the rent-rolls, as it were, of the estates of ecclesiastical and lay proprietors of the soil in the sixteenth century. Some idea of the magnitude of the work may be gained from the fact that the second part alone of its first volume contains 1,598 large and closely printed pages. As a general rule, the publications of the Society are of no use to foreigners who are unacquainted with Russian. But there are a few exceptions, such as the monograph by Prof. Oswald Heer, of Zurich, on the fossil flora of the coal-fields of East Siberia. In 1859 a rich collection of fossil plants was made in the Amur district by F. Schmidt, but it was burnt in the great fire of Blagoveshensk the year after. In 1862 a fresh collection was made, and submitted to Prof. Heer. The results of his investigations are given in the second division of "the geological part" of the third volume of "the physical section" of the Records (*Trudi*) of the "Siberian Expedition" of the Society, under the title of the "Jurassic Flora of the Irkutsk Government and the Amur Territory." The greater part of the text is in Russian. But as the descriptions are in Latin, and they are accompanied by thirty-one quarto plates, printed at Winterthur, the book is available for Western scholars. The expedition of the late A. Tchekanovsky to the Lena in 1875, says the editor, F. Schmidt, in his preface, has contributed new and important additions to our knowledge of the Jurassic flora of Siberia. "The Jurassic plants collected around Bulun and Ayakit, Lower Lena, serve as a link between the Jurassic flora of South-East Siberia and the same flora of the Spitzbergen Isles, and prove the unity and comparative uniformity of the Jurassic flora over a great part of the northern hemisphere, namely from Spitzbergen to England (Yorkshire) and beyond the Lena to the Irkutsk Government and the Amur." Much valuable information about Siberia is given also in the voluminous supplements to Ritter's "Asia," "serving as a continuation of Ritter's work, based upon materials rendered available since 1832."

Among the subjects treated at greatest length in the *Transactions* (*Zapiski*) of the Ethnographical Section of the Society are "The Shores of the Frozen and White Seas," "The Church Calendar of the Common People," and the "Popular Juridical Customs of the Russian Empire." The treatise on the first gives a full account of the various tribes inhabiting the inhospitable northern shores. In speaking of the Samoyeds, it may be worthy of remark, the author does not even so much as allude to the absurd explanation (dear to many English minds) of their name as meaning cannibals. *Lyudoyed*, in Russian (from *lyudi*, men, and *yest'*, to eat), signifies a cannibal. A false analogy has resolved Samoyed into the same meaning. If it meant anything in Russian, it would mean a "self-eater," whatever that might be. Russian philologists explain it in different ways. Some, as Lerberg, consider it a Russian word, corrupted from Semgo-yed, a salmon-eater. Byelyavsky says that the Samoyeds employ, in speaking of each other, a common tribal or family designation Khasovo, from *Khaz*, self (in Russian *sam*) and *ovo*, one (in Russian *odin*). From these Russian equivalents of the Samoyed words, sprang, he supposes, a designation Sam-odin or Sam-yedin. In some old documents the Samoyeds are called Suiroyadtsui, from their habit of eating raw (suiroe) meat. But there seems to be no reason for supposing that the two names have any connection. Much more probable is the surmise that the word is of Finnish origin, the land belonging to some Ugrian neighbours of the Samoyeds having been called Samoyanda or Samoyedna, from which the Russians formed the name Samoyed. The Calendar gives a detailed account of the Saints' days observed by the Russian peasants, and of the various superstitions and rites connected with them. It begins with September, which was officially chosen as the first month at the Council of Moscow in 1342. In ancient days March was among the Russians, as it was among the Israelites, the commencement of the new year. Its modern name, *Mart*, was derived from Rome through Byzantium; the heathen Slavs knew it as Sukhy, "the Dry," or Berezozol, from its effect on the *bereza* or birch-tree.

The volume devoted to the juridical institutions of the common people, their civil and criminal law courts, is full of interest; and the information it contains is thoroughly trustworthy, having been carefully collected and sifted by the members of a Commission appointed for the purpose in 1876. It embraces not only the village-jurisprudence of the Russians themselves, but also that of the strangers within their gates, and the wild tribes of their outlying provinces. Of great interest also are the numerous volumes of Reports (*trudui*) issued by the members of the Ethnographical-Statistical Commission appointed to explore the western provinces of Russia. The seven large volumes devoted to the south-western governments give an exhaustive account of Little-Russia, entering into most minute details concerning the physical and moral character of the inhabitants of that part of the empire, between whom and the

Great-Russians so considerable a difference exists. Vol. I. deals with the superstitions of the peasants, especially as regards witchcraft, to which subject Prof. Antonovich of Kief has devoted a long and interesting essay. According to him, the popular ideas about the subject are "not demonological, but pantheistic." And the authorities seem to have looked upon wizards and witches with some indulgence. In a hundred trials of persons accused of witchcraft in the eighteenth century, he finds scarcely any trace of such cruelty as was shown at an earlier period by British or German legal officials, or by the Inquisition in the south of Europe. Burnings were unknown. Convicted warlocks were generally mulcted in a fine paid to the Church. In the few cases in which they were punished more severely, the unusual harshness of the court was due to the fact that the complainant belonged to the class of nobles. The second volume contains a valuable collection of 146 skazki or folk-tales, 31 of which are classed as "mythical." It forms an important supplement to Rudchenko's excellent "Collection of South-Russian Tales." Vols. iii.–v. contains an immense number of folk-songs, and a list of days to which the peasants pay special attention. The sixth volume is devoted to popular jurisprudence in general and the village courts in particular, and the seventh to statistics, giving a complete account of the Little-Russians themselves, and of the rest of the population, whether of Polish, Jewish, or other extraction.

TEMPERATURE OF THE SOIL DURING WINTER

THE French physicists, Edmond and Henry Becquerel, took advantage of the intense cold prevailing at Paris last December, to study the changes in temperature below the surface of the soil under various conditions. It is a widely-spread belief among farmers, that when protected by a layer of snow, crops sown in the autumn are effectually guarded against freezing. This opinion, however, must lose much of its weight in view of these late observations, which we will briefly summarise.

The observations were made by means of Becquerel's electric thermometer, which consists simply of two wires isolated by a coating of gutta percha, and soldered together at their extremities. Differences in temperature between the two places of junction cause electric currents varying in intensity with the greatness of the difference. A magnetic needle, brought under the influence of the current, registers on a dial these differences. The wires were inserted in the Jardin des Plantes at various depths varying from 5 to 60 centimetres, and observations were made from November 26 to the close of December. Frost first appeared in the Garden November 26. December 3 snow fell in abundance, and the temperature of the air sank to -11° C. The layer of snow was 25 centimetres deep. December 10, the temperature had sunk to -21°, and commenced then gradually to rise. December 15, the snow was 19 centimetres in depth.

Coming now to the observations made below the surface of the ground under the above circumstances, we find at once a striking difference between the results obtained in soil covered with grass, and those obtained below a bare surface of the ground. In soil protected by grass, before as well as after the snowfall, at all depths below that of 5 centimetres, the temperature never descended below 0° C. Registering $3^\circ\cdot5$ at the depth of 5 centimetres on November 26, it slowly sank to $0^\circ\cdot18$ on December 14. The presence of grass would appear, then, to effectually protect the earth beneath it from freezing at the lowest temperatures attained in our climate. Quite different results, however, are yielded in the absence of grass. In this case at a depth of 5 centimetres the thermometer sank below zero on November 27. Two days later it registered $-2^\circ\cdot6$. On December 3, just before the snowfall, it reached its minimum of $-3^\circ\cdot17$. After being covered with snow it registered $-0^\circ\cdot8$, and later $-1^\circ\cdot4$. The snow here appears to act in a certain measure as a screen against changes in temperature, but its conductive properties are still too marked to prevent these changes from being felt sensibly at a certain depth in the earth. In the case of the agriculturist, this slow conduction, when united to the still slower conductive properties of a tolerably thick layer of dead shoots of cereal crops sown in autumn may frequently insure immunity from freezing to the roots below the surface.

T. H. N.

NOTES

WE regret to have to announce the death of P. W. Schimper, the well-known Professor of Palæontology in the University of Strassburg, and of Dr. R. H. C. C. Scheffer, the amiable and accomplished director of the Botanic Garden, Buitenzorg, Java, at the early age of thirty-five. Also of two foreign entomologists —Herr Hellmuth von Kiesenwetter at Dresden, in the sixtieth year of his age, and Dr. Snellen van Vollenhoven, formerly Conservator of the Leyden Museum, one of the foremost entomologists of Holland, and author of "Faune Entomologique des Indes Orientales."

WITH reference to Prof. Smyth's communication in regard to the exhibition of aurora on March 17 (NATURE, vol. xxi. p. 492), we are informed that the photographic records of the Royal Observatory, Greenwich, show that there was also magnetic disturbance on that day.

DR. W. FARR has been made a C.B.

DR. C. WILLIAM SIEMENS has been elected an honorary member of the American Institute of Mining Engineers.

THERE has just appeared, as Vol. XII. of the Report of the United States Geological Survey of the Territories under Dr. F. V. Hayden, an important monograph on the Freshwater Rhizopods of North America by Dr. Joseph Leidy, the eminent comparative anatomist of Philadelphia. It is a well-printed quarto, and sumptuously illustrated with a series of forty-eight coloured plates. Containing the results of an investigation of materials partly collected during the prosecution of the Survey, it shows the broad scientific spirit in which the operations of Dr. Hayden's Survey were conducted. Dr. Leidy, almost elbowed out of the field of research among the fossil vertebrates of the West, where he was the earliest pioneer, has left that field in possession of his younger friends, Professors Cope and Marsh, and has betaken himself to another and very different domain of scientific research, with which he has long been familiar. To the monograph which he has now issued we hope to call attention in an early number of this journal.

A NEW School of Agriculture is to be opened, to be called the South Wiltshire and Hampshire Agricultural College, at Downton, near Salisbury, on April 26. Among the teaching staff will be: Prof. Wrightson for Agriculture, Prof. Church, Chemistry; Prof. Fream, Natural History and Geology; and Prof. Sheldon, Dairy Work. Attached to the college is a mixed farm of 540 acres, to be worked by the students themselves.

AT the Royal Institution on Tuesday next (April 6) Prof. Huxley will give the first of a course of two lectures on Dogs and the Problems connected with them; on Thursday (April 8) Prof. Tyndall will give the first of a course of six lectures on Light as a Mode of Motion; on Friday evening (April 9) Prof. Huxley will give a discourse on the Coming of Age of the Origin of Species; and on Saturday (April 10) Mr. James Sully will give the first of a course of three lectures on Art and Vision.

THE large glass disk which has been cast by M. Feil of Paris is not, we are informed, intended for Paris, but for Pulkowa; the Paris glass is already in the hands of the opticians. The exact weight of the Pulkowa disk is 195 kilog. The annealing will be finished next week, after a duration of about twenty-one days. After the completion of the operations M. Feil will begin the casting of the great Pulkowa flint lens. It will weigh 220 kilog., and the time of annealing will be about five weeks.

BY permission of M. Hervé Mangon, M. Raoul Pictet has given, in the great amphitheatre of the Conservatoire des Arts et Metiers, a lecture on the Artificial Production of Cold, a question which has become exceedingly practical in Paris, to the discussions raised by the impending transformation of the Morgue. MM. Dumas, Fremy, and other scientific notabilities of Paris were present at the lecture, which will be followed by others, the intention of M. Hervé Mangon being to give similar privileges to any competent person wishing to promulgate any scientific theories.

THIS week the French scientific world is very busy in Paris. The French Association for the Advancement of Science and the delegates of the Sociétés Savantes are holding their meetings at the Sorbonne and other places on the occasion of the Easter holidays. On Friday evening the Société de Physique will hold their annual meeting. The long-expected and deferred reception of Nordenskjöld will very likely give a new interest to all these demonstrations.

MR. PHILIP MAGNUS, B.Sc., B.A., has been elected to the post of Organising Director and Secretary of the City and Guilds of London Technical Institute. The number of applications was fifty-eight. The Drapers' Company having offered a sum of 10,000*l.* towards the new buildings projected for a school of applied science at Cowper Street, conditionally upon an equal sum being raised to meet it, 5,000*l.* is already provided, and it is thought that other companies will be not unwilling to assist in this matter by contributing the remaining portion.

THE court of assistants of the Clockmakers' Company, to encourage the highest excellence in the production of the marine chronometer, have determined to award annually two prizes to the makers of the two chronometers which shall perform with the greatest accuracy under the conditions prescribed by the Astronomer-Royal at the annual trials at the Royal Observatory, Greenwich. The first prize will consist of ten guineas and the freedom of the company, and the second prize five guineas.

VESUVIUS, the Naples correspondent of the *Daily News* telegraphs last Friday, as usual during full moon, shows greatly increased activity. Two new mouths opened last night at the foot of the new cone, sending jets and red-hot stones to a great height, while the lava issued from the central crater. The same correspondent gives some details as to the railway up Vesuvius. The station is situated on a level spot on the west side of the mountain, about half-an-hour's walk from the observatory. The constructors of the railway have adopted the American double iron rope system. There are two lines of rails, each provided with a carriage divided into two compartments and capable of holding six persons. While one carriage goes up the other comes down, thus establishing a counterpoise which considerably economises the steam of the stationary traction engine. The incline is extremely steep, commencing at 40°, increasing to 63°, and continuing at 50° to the summit. Every possible precaution has been taken against accident, and the railway itself is protected against possible flows of lava by an enormous wall. The ascent will be made in eight to ten minutes, while before it required from one to two hours. To obtain the necessary supply of water, large covered cisterns have been constructed, which in winter will be filled with the snow that often falls heavily on Vesuvius. This snow will be quickly melted by the internal heat, and, besides the water thus obtained, the frequent rainfall will also be conducted into the cisterns.

THE Naples correspondent of the *Daily News* gives, in yesterday's issue, an interesting account of the rise and progress of the zoological station at that city; with most of the facts our readers are already familiar. Several Governments—Italy, Prussia, Russia, Holland, Belgium, Switzerland, Bavaria, Saxony, Würtemburg, Baden, Hesse, Hamburg—have each one or more tables, the British Government being conspicuous by its absence. The Italian Ministry of Marine thinks of hiring a table for the use of the marine officers, to enable them to learn the methods of fishing and preservation of specimens, in order to make collections during their long voyages. Altogether nineteen tables are engaged, which represent an income of 40,000 francs. The income arising from the public aquarium has never yielded more than a sum of 20,000 francs per annum. The remaining expenses have hitherto been covered by subventions from the Imperial German Government, and it is to be hoped that a new yearly subvention of 40,000 francs, which has been petitioned for by the most celebrated scientific men of Germany, and granted by the German Parliament, may be consented to by the Government. The correspondent gives several facts to show the wide utility of this station and its influence on the progress of science.

ON Sunday week a shock of earthquake was felt throughout Moldavia.

A GENERAL meeting of the Mineralogical Society of Great Britain and Ireland will be held in the University of Edinburgh on Monday, April 5, at 3 p.m. (by permission of the *Senatus Academicus*), Prof. W. F. Heddle, F.R.S.E., president, in the chair. The following paper, with others, will be read:—"On the Microscopic Structure of some Vitreous Basalts," by Prof. A. Geikie, F.R.S. On this occasion the attendance of gentlemen interested in mineralogy is invited, whether Members of the Society or not.

THE *Photographic News* is responsible for the following:—Everybody knows how jealously the gates of the Royal Observatory are guarded, and what difficulties even scientific men have to gain admission. But Mr. Glaisher, the worthy President of the Photographic Society, and who was until lately Superintendent of the Meteorological Department, tells a story that goes far to prove that nothing is impossible to a resolute man. A vast star shower had been anticipated and its coming heralded in every newspaper. The staff at Greenwich, with the Astronomer-Royal at their head, remained the whole night through making observations and counting the bright meteors as they fell. The weary night passed, and the small hours of the morning came, only to find the jaded observers still pursuing their duty. "That makes 10,704," said our friend Mr. Glaisher. "Beg pardon; how many?" exclaimed a voice behind him. "10,704," repeated the President of the Photographic Society; and then, not recognising the voice, he turned and saw a stranger: "Who are you, and where do you come from?" At first, the only possible conjecture was that the stranger had fallen from the clouds along with the star shower; but it was not so, for, closing a little note-book, he simply replied, "I am the special correspondent of the *New York Herald*. Thank you very much. Good morning." How that special managed to get through the park gates and elude the vigilance of the keepers; how he got inside the walls of the Observatory; how he pressed into the sanctum of the Astronomer-Royal is a mystery to this day; but within a few hours of his interview with Mr. Glaisher the readers of the *New York Herald* printed a correct account of the marvellous star shower, together with many interesting details of the Observatory itself.

CONSUL LAYARD sends us the following notes of literary or scientific blunders, brought to his recollection by the article on "Subject-Indexes" in NATURE, vol. xx. p. 554. We rather think the Cape story is a replica of a still older one in the mother country:—"Some years ago, when we moved into the combined South African Library and Museum buildings, several volunteers assisted in placing the books in the shelves. One morning the librarian, with an amused smile on his face, showed me a book he had found among the medical works; it was Burton's 'Anatomy of Melancholy!' Next day it was back again! and while we were wondering who had so placed it, the culprit came forward and applauded himself for mending the work of 'some stupid fellow' who did not know where to place medical books! A friend sent me Miller's 'Old Red Sandstone.' It burst its cover in the post-bag coming from England, and a discussion arose as to whom it might have been sent. At last some one suggested I was the most likely owner of a work of that class, and I was summoned. On arriving at the P.O. with the sender's letter, I accosted the P.M.G. with the remark that I believed the book then in his hands was mine. 'It is,' I said, 'the "Old Red Sandstone," by Miller, who wrote'—I was going to adds 'The Testimony of the Rocks,' when my old friend cut me short with—'Yes, yes, I know, the jokes, the jokes'!! Shades of old Joe! I gravely acquiesced, and walked off with my book."

THE observations in which Prof. Pavesi of Pavia has been lately engaged on the pelagic fauna of the lakes of Tessin and of Italy have yielded interesting results (of which there is an account in the *Archives des Sciences*, February 15). Some twenty-one lakes were examined, mostly in Italy. The tables show that *Leptodora* is found almost everywhere. *Daphnella brachyura, Daphnia hyalina, D. galeata, Bosmina longirostris, Cyclops minutus*, &c., are very common; on the other hand, *Sida crystallina, Daphnia quadrangula, Bosmina longispina*, and *Bythotrephes* are rare; lastly, *Daphnia magna*, and *D. crystallina* are localised in the single Lake of Idro. It is a curious fact that of two lakes, near each other and of the same geological origin, and frequented by the same aquatic birds, one may present hardly any pelagic forms, while the other may have many. Such are the small Lake of Candia and the Lake of Viverone (they also show a difference of the opposite kind in algological flora). The latter lake, indeed, is triple that of the former, and about five times as deep. Still, great depth is not necessary to existence of pelagic animals, though it is more favourable to their development; *e.g.*, they multiply in the lakes of Brianza and Endine, which are only ten metres deep. Some forms, as *Bythotrephes*, are found only in the deepest lakes. As to the bathymetrical limits of the fauna, *Leptodora* lives generally, by day, at about 15m. depth. At 10 and 30m. it is generally rare, though in some cases it has been found even at 100m., and in shallow lakes is common at 5m. *Daphiura cristata* of Lake Idro is common at 5 to 15m., very rare at 50m. *Daphnia magna* is most abundant at 30 to 50m. On stormy days few forms were found at 5m. depth. The almost absolute absence of crustacea in the Lake of Garda, at 5 m. even in calm weather, is attributed to the great transparency of the water. Prof. Pavesi thinks the influence of temperature nil or inappreciable. He assigns a marine origin to the fauna in question; fiords changed to lakes, part of the isolated species dying out, others becoming adapted to new conditions of life, diffusion of these forms, by various means of transport, to neighbouring lakes of different epoch and origin, such as the lakes of Switzerland, Bavaria, and Lake Trasimeno. This confirms Stoppani's theory of the origin of the lakes in Upper Italy.

THE *Journal of Applied Science* draws attention to a statement that has recently been made to the effect that in Thuringia, in Germany, over 1,000 tons of dried beetroot leaves are annually passed off as genuine tobacco. Beetroot, chicory, and cabbage are largely used for a similar purpose in Magdeburg and in the Palatinate. The "Vevey" cigars, which are in such favour in South Germany, contain no tobacco at all, but are entirely composed of cabbage and beet-leaves, deprived of their natural smell and taste by a special form of cultivation, and subsequently steeped in tobacco water for a lengthened period.

THE importance of the German element in the United States is evidenced by the publication of a *Deutsch-Amerikanische Apotheker-Zeitung*, the first number of which we have received.

THE West Kent Natural History Society present a satisfactory *Report* for 1879; it contains the address of the president, Mr. R. McLachlan, F.R.S., in which he finds something new to say about the house-sparrow.

THE Report of the Bristol Museum and Library for 1879 shows that the institution suffered somewhat in its income from the general depression, though otherwise it continues to meet with favour. The museum especially has received several valuable additions.

IN the last number of the journal published by the Newcastle-on-Tyne Chemical Society is a paper by Mr. W. G. Strype on "An Apparatus applicable to the Continuous Testing of Chamber Escapes."

AMONG the papers in No. 3 of the *School of Mines Quarterly* of Columbia College, to which we referred some time ago, we may mention Prof. Newberry's on "The Origin and Classification of Ore Deposits;" interesting notes on Mexican Mining, by Mr. J. C. F. Randolph; "Aërostation," by Mr. J. A. Navarro; and a paper on "Soap," by Mr. A. L. Colby.

THE Rev. W. Clement Ley asks us to state that in his letter in NATURE, vol. xxi. p. 48, he wrote "the Hon. R. Abercromby," not "Sir R. Abercromby."

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. J. R. Cullin; two Striped Hyænas (*Hyæna striata*) from Arabia, presented by Capt. the Hon. F. G. Hay and Mr. Wylde; an American Red Fox (*Canis fulvus*) from North America, presented by Capt. Russell; a Carpet Viper (*Echis carinata*) from India, presented by Capt. C. S. Sturt, C.M.Z.S; two Golden-Headed Parrakeets from Brazil, an Eyton's Tree Duck (*Dendrocygna eytoni*) from North-West Australia, purchased; a Crested Pigeon (*Ocyphaps lophotes*) from Australia, a Vulturine Guinea Fowl (*Numida vulturina*) from East Africa, deposited; a Sambur Deer (*Cervus aristotelis*), an Eland (*Oreas canna*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE SOUTHERN COMET.—Dr. B. A. Gould, Director of the Observatory at Cordoba, publishes the results of hasty observations of the head of the southern comet on the evening of February 4. It appeared "like a coarse, ill-defined mass of dull light 2′ or 3′ in diameter, and without visible nucleus." Two determinations of position were made by placing it in the middle of the field of the large equatorial and taking the readings of the circles. Thus Dr. Gould obtained the following place after correcting for refraction, and it should be mentioned that at the second observation the comet's altitude was less than 2° 42′; right ascension, 22h. 24m. 10s.; declination, − 31° 29′·1 at 5h. 27m. 55s. Cordoba sidereal time, which corresponds to February 4 at 12h. 46m. 25s. Greenwich mean time. Mr. Finlay's orbit, which appeared in this column last week, gives the right ascension greater by 1° 29′ and the declination further south by 21′; though the Cordoba observation is called a rough one, under the circumstances it will hardly be liable to such errors, and may be at least comparable in accuracy with the approximate positions received from the Royal Observatory at the Cape. If we combine it with the Cape places on February 10 and 15 for the determination of the orbit, the following remarkable elements result—we say remarkable from their being almost identical with the elements of the grand comet of 1843, as will be seen from the orbit annexed :—

	Comet of 1880.	Great comet of 1843 (Hubbard's parabola).
Perihelion passage	Jan. 27·6027	
	° ′	° ′
Longitude of perihelion	279 6·8 ...	278 35·1
,, ascending node ...	4 1·9 ...	1 20·6
Inclination	35 39·8 ...	35 38·2
Log. perihelion distance	7·77371 ...	7·74123
Motion	Retrograde ...	Retrograde

If this close resemblance is the result of accident, and the true orbit of the comet more like that published last week, the coincidence is a very unusual one in such computations, and in fact not far from an unique case.

Prof. Hubbard, from his rigorous investigation of the orbit of the great comet of 1843, concluded that the period extended to several centuries, though before the comet was beyond reach of the telescope it was conjectured that the revolution might be comparatively short, and from a similarity in the appearance of the comets of 1668, 1702, and 1843, a period of about thirty-five years was considered probable by many astronomers. Pending the arrival of accurate observations from the southern hemisphere, which may decide the true form of orbit, it may be worth while to examine with large telescopes the vicinity of positions calculated from the orbit which so closely resembles that of the comet of 1843, as, in the event of identity, observations of position made now would have great value. For 8h. Greenwich mean time the above orbit gives the following places:—

	R.A.	N.P.D.	Log. distance from Earth.
	h. m.	° ′	
April 2 ...	4 59·6 ...	98 22 ...	0·2978
4 ...	5 3·2 ...	97 58 ...	0·3104
6 ...	5 6·7 ...	97 36 ...	0.3224
8 ...	5 10·0 ...	97 15 ...	0·3338

PHYSICAL NOTES

M. Ducretet has made the important observation that "toughened" glass is less easily penetrated by the electric spark than ordinary glass. He proposes to apply this discovery in the manufacture of superior Leyden jars. It is almost needless to point out that a means of making powerful condensers of more compact form is afforded by the employment of the toughened article. The very important bearing of the matter upon the whole question of dielectric strain and the elastic recovery of bodies is a point which will probably receive due attention at the hands of physicists.

The residual charge of the Leyden jar has been recently investigated afresh by Herr Giese (*Wied. Ann.*, No. 2). It seemed desirable to follow the course of formation of this charge under conditions more amenable to analytical treatment than has hitherto been the case, and to make the phenomenon independent of external influences. This he sought to attain by determining the quantity of electricity which flowed to the coatings when the difference of potential was kept constant. His method is fully detailed in the paper referred to, and the result he is led to is that the formulæ of Riemann (who offered the hypothesis of an antelectric state of matter, at a meeting of scientists in Göttingen in 1854) are not in harmony with experiment.

A paper by Prof. Rammelsberg, "On the chemical monography of the mica group," has lately appeared in Wiedemann's *Annalen* (Nos. 1 and 2). As to the kind of relations that exist between the chemical nature of micas and their other properties, he remarks that there are differences in corresponding angles, though the amount can be ascertained only in few cases. Optical differences can be determined with more certainty; in this respect all alkali-micas, whether containing sodium, potassium, or potassium and lithium, are alike. The plane of the optic axes is at right angles to the plane of symmetry. Pure magnesia-micas are the opposite in this respect. Among the iron-magnesia-micas there are some which are optically like the alkali-micas, but more which are like the pure magnesia-micas. In the lithium-iron micas of Zinnwald the axes are as in the last-mentioned micas. The baryta-mica of Sterzing is optically like the alkali-micas. From all this it results that any classification of micas can only be a chemical one. But so long as we do not know whether the (qualitative) chemical nature coincides with the subdivision hitherto adopted (muscovite, phlogopite, biotite, &c.), which however rests only on physical differences, we cannot exchange the certain chemical names with those which are derived from some special physical character, *e.g.*, the position of the plane of the optic axes.

To the scientific applications of centrifugal force which have been made since the time of Musschenbroek, who, in his treatise on Physics, calls attention to the utility of it, Prof. Thury of Geneva (*Arch. de Sci.*, January) thinks the following might be added:—Measurement of the adhesion of liquids and solids; separation, total or partial, of a dissolved body from its solvent; separation of the constituents of alloys (kept in fusion by means of Bunsen burners); separation of liquids of different densities; production of high vacua; modification of crystalline forms (possibly); depolarisation of electrodes in some circumstances of electrolysis; modification of the organisation of embryos in the egg; observation of a body in very rapid circular motion, as if it were motionless.

Signor Agostini finds (*Natura*, 3) that if through a drop of mercury, lying on a surface not wet by it, a current be sent in vertical direction, it rotates under the influence of the earth's magnetism, as may be seen if a few particles of lycopodium powder be strewn on it. Similarly a mercury drop rotates when placed on the surface of a steel magnet, and *e.g.* the magnet connected with the positive pole of a very weak element, while an electrode penetrating the drop from above is connected with the negative. From the strength and direction of rotation of a number of such drops one may in general make visible the distribution of the magnetism, the neutral points, &c., both in the magnetic bars themselves, as when an iron bar is brought coaxially near to one end, or into contact; also in the latter. The results of previous experimental measurements are thus confirmed.

GEOGRAPHICAL NOTES

Prof. Nordenskjöld reached London on Friday last, several days after he was expected, thus upsetting all the arrangements which were made for his reception. He is, we understand, to leave for Paris to-day to receive the Great Gold Medal of the Geographical Society and the distinction of Commander of the Legion of Honour. While here he has been entertained in a quiet way by various distinguished people; among others by the Swedish Minister, the Earl of Northbrook as president of the Geographical Society, Mr. Spottiswoode, president of the Royal Society, Sir Allen Young, and others. Doubtless he will return to London at a time more convenient to give him the public reception which he merits.

It is stated that Lieut. Bove, who accompanied Nordenskjöld in the *Vega*, has gone to Rome to submit to the King of Italy and the cabinet a plan for an Italian expedition to the South Pole.

A letter recently received from Capt. Howgate mentions that, whether aided or not by the (U. S.) Government, he is determined to start an expedition to the Arctic regions this year. The s.s. *Gulnari* is now on the "ways," being fitted up for ice navigation under the superintendence of Capt. Chester, who was with Hall in the *Polaris*. A house of wood—double boarded—21 × 68 feet, modelled after those used by the Hudson's Bay Company, is being constructed for the men to winter in on the shores of Discovery Harbour, and will be ready by April 1. A steam launch will probably form part of the expedition.

The Japan papers state that the Russian Government have determined to despatch a man-of-war to make a hydrographical survey of the Japanese seas and the Sea of Okhotsk. The Geographical Society of St. Petersburg have been invited to send a representative with the expedition, and it is believed that Prof. Amantevitch will be selected on account of his knowledge of the Japanese language and the dialects spoken on the east coast of Siberia.

Mr. G. F. Easton, the agent of the China Inland Mission at Tsin-chow in the Kansu province, has sent home an account of a journey which he made last summer to Si-ning-fu and other almost unknown cities on the north-western frontier of the empire. After leaving the main road he travelled west to Ho-chow, and thence pushed along the border country to Shun-hwa-ting on the bank of the Yellow River, crossing which he moved on to Ba-rung and thence to Si-ning-fu, where he stopped six days, returning by way of Lan-chow-fu. It may be interesting to note that many of the places visited by Mr. Easton are not marked on European maps, though he says they are shown on a Chinese map published in book form at Wu-chang. Near the Yellow River Mr. Easton found himself amongst the Sah-la, who differ little in appearance and habits from the Chinese, though they have an entirely distinct language; he also met a few Tu-ren—usually called the Tu-li tribe—who are also Mohammedans, and within a few miles of Si-ning-fu there are several other tribes. To his surprise, at Si-ning Mr. Easton found Count Bela Szechenyi, Lieut. Kreitner, and Mr. Loczy, of the geological department at the Vienna Museum. Mr. Easton states, presumably on the authority of Count Szechenyi, that the altitude of Si-ning-fu is 8,600 feet, and that of Tsing-hai, or Koko-Nor, 10,500 feet, while Lan-chow is about 5,000 feet above sea-level. The correct position of Si-ning is stated to be 36° 33′ 32″ N. lat., 102° 24′ 35″ E. long. Some Germans had recently arrived at Lan-chow-fu to commence a woollen manufactory there for the Chinese, but Mr. Easton does not speak hopefully of their condition or prospects.

FROM a native Japanese paper we learn that the idea of opening Shimonoseki, on the Inland Sea, to foreigners has been abandoned, and that Nairi, in the province of Buzon, Kiushiu, has been selected as an open port in its place.

DURING his recent journey from the head of Lake Nyassa to Lake Tanganyika, Mr. James Stewart, C.E., who is now permanently attached to the Livingstonia mission of the Free Church of Scotland, visited four different tribes, of whom but little has previously been heard. The first was the Chungu tribe, on the lake-shore and inland up to the head of the Songwe valley; their country is described as good and cattle are numerous; iron, too, is abundant and much worked. This tribe, however, is by no means strong, owing to nearly every village being independent. The next tribe visited was the Anyamauga, whose country extends to the Mera River. To the west of them is Mambwe, under a young and intelligent chief, whose people are industrious ironworkers. In the hills round the south end of Lake Tanganyika are the Akandi tribes, all speaking different dialects. They are much harassed by the Babemba. To the north, near the Fipa Mountains, the people are Basukuma, who are separated from the Anyamauga by the River Saisa. At Lake Hikwa, the name of which has hardly been heard of before the journeys of Messrs. Stewart and Thomson, and the position of which is not at present fully identified, the people are Abanda and Apimbwe, while the Chosi River is the boundary between the Mambwe and Babemba. We are glad to learn that Mr. Stewart promises to send home immediately a map and section of his route, together with additional data, which cannot fail to be of interest from a geographical point of view.

THE French Exploring Expedition for the Trans-Saharan Railway has left Wargla for the interior of Africa.

THE METEOR SHOWER OF JANUARY 2

FROM amongst the extensive number of annually recurring meteoric displays there are few comparable, either in point of richness or brilliancy, with the January meteors. The Leonids, Perseids, and Andromedes severally form showers of greater intensity at the epochs of their periodical returns, and there can be no question that the Perseids, as an annual phenomenon, stand unsurpassed, but with the exception of these special instances, perhaps none of the many streams of shooting stars deserve a higher place than that which heralds the opening of the year. The Lyrids, Orionids, and Geminids are entitled to be considered of equal importance as affording an annual spectacle of much interest, though the former system appears during its last few returns entirely to have lost the splendour which characterised its exhibitions in former years. The January meteors, while thus meriting whatever significance is attached to a shower of the first order, have not, it must be admitted, been observed with half the diligence awarded to some other streams of similar nature. An explanation is probably to be found in the circumstance that it does not become thoroughly well visible until the morning hours. The radiant point situated at 230°·5 + 51°·3° (15° following η Ursæ Majoris) in a region comparatively bare of stars, though never below our horizon, is yet, during the first half of the night, at a very low altitude, and thus its operations are limited, though not sufficiently so to cause the apparent extinction of the display. In the early evenings of January, 1879 and 1880, it furnished many fine meteors ascending in long courses from the direction of the northern horizon, and appearing in sufficient numbers to cause remark amongst ordinary persons quite unaware of the progress of a notable star shower.

I have been speaking of this phenomenon as one of annual occurrence, but it is fair to conclude that it also possesses the elements of periodical fluctuations, as in the case of the Leonids and Perseids. Prof. Kirkwood, in a paper read before the American Philosophical Society on November 21, 1873, remarked upon this shower as one giving evidence of recurring brightness. He found, chiefly by the comparison of observations made during the present century, that its principal manifestations took place in the years 1825, 1838, and 1864, from which he inferred a periodic time of thirteen years. This would have indicated a maximum in 1877, but nothing of it was seen, though the shower has been very active since that period. Whether or not the investigations of Prof. Kirkwood have allowed the determination of its periodical maxima is a point to be settled by future observations. The history of the shower, as recorded in past years, is too incomplete to afford the materials for anything like a reliable estimate of the period of its revolution. Many times it has wholly escaped record, and even during its visible returns it is seldom witnessed with success. The state of the sky, the time and manner of observation, all affect the results to a considerable degree, and will often occasion apparent variations in the annual appearances of a shower which have no real existence. And it must be borne in mind that from the indefinite descriptions of former showers, it is sometimes impossible to ascribe a fair weight or to detach actual facts from the wild and often exaggerated notices of such phenomena.

Though no good correspondence has yet been detected between a cometary orbit and the orbit of this stream, it is none the less important that the precise centre of divergence of its meteors should be ascertained. Mr. Greg placed it at 232° + 49° from an average of seven independent observations (see his catalogue of the radiant points and durations of meteor-showers in the B.A. Report, 1876), and found a closely adjoining shower of rather later date, which he regarded as distinct at 225° + 54° for the period January 1 to February 6. The mean of the two is 228°·5 + 51°·5, which presents a singularly near agreement with the centre of the shower as I have recently determined it from all the available observations of the radiant point, which have been compared together as follows:—

Radiant Points of January Meteors.

No.	Epoch.	Radiant. α δ	Observer.
1.	Dec. 15–Jan. 15	231° + 53°	E. Heis.
2.	Jan. 15–31	227 + 54 *	E. Heis.
3.	Jan. 2, 1863	238 + 46·5	S. Masters.
4.	Jan. 2, 1864	234 + 51	A. S. Herschel.
5.	Jan. 2, 1867	228 + 55	Herr Bornitz.
6.	Jan. 29–Feb. 6	223 + 54 *	Greg and Zezioli.
7.	Jan. 2–3	238 + 45	Greg and Herschel.
8.	Jan. 2–7, 1870	229 + 51	G. L. Tupman.
9.	Jan. 2–3, 1872	227 + 49	A. S. Herschel.
10.	Jan. 2, 1872	228 + 52	T. Crumplen.
11.	Jan. 1–15, 1872	228 + 53	W. F. Denning. From the Italian Observations.
12.	Jan. 2–3, 1873	234 + 48	T. W. Backhouse.
13.	Dec. 12 and 21, 1876	221 + 53 *	W. F. Denning.
14.	Jan. 4, 1877	231 + 54	W. F. Denning.
15.	Jan. 20, 1877	220 + 52 *	W. F. Denning.
16.	Jan. 2, 1878	222 + 55	A. S. Herschel.
17.	Jan. 2, 1879	230 + 51	W. F. Denning.
18.	Jan. 2, 1880	228 + 54	W. F. Denning.
19.	Jan. 2, 1880	232 + 55	H. Corder.
20.	Jan. 2, 1880	230 + 48	H. Corder.

Mean position = 229°·0 + 51°·7 from twenty observations, but the four positions distinguished by asterisks are not sufficiently accordant in epoch to be considered as certain displays of the same shower. Omitting them, the resulting mean from the remaining sixteen estimates is = $230°\cdot5 + 51°\cdot3$, which seems the most reliable centre for the true shower-meteors of January 2, and nearly coincides with the radiant (No. 8) observed by Major Tupman in 1870 and that (No. 17) determined by the writer in 1879.

That this meteor-cluster is comparatively seldom witnessed, arises from several causes. Cloudy weather offers a frequent impediment. The presence of the moon is also, in some years, a great drawback to successful observation. Moreover, the unfavourable situation of the radiant point in the evening hours considerably lessens the splendour of its display at the most convenient period for observation. In the clear, frosty mornings at the beginning of January the enthusiasm of amateur meteor-observers is seldom sufficient to keep them long out of doors. Yet a few interesting observations of this shower have been made during the past few years both in the morning and evening hours. In 1872, on the night of January 2, between 10.15 and 11.15, Mr. W. H. Wood of Birmingham descried "a fine shower of bright meteors at the rate of twenty per hour for one observer; 42 per cent. were from the usual radiant point. The meteors were of slow apparent speed, train-bearing and vari-coloured." It was also well observed that year by Prof. Herschel and Mr. Crumplen at London. In 1873 Mr. Backhouse re-observed it in the morning of January 2, between 5 and 7 A.M., when meteors were appearing at the estimated rate of thirty-seven per hour. During the three ensuing years this stream appears to have eluded observation. On the evening of January 4, 1877, it was slightly seen by the writer, and on the morning of January 2, 1878, 4 to 4.30 A.M., Prof. Herschel at Hawkhurst in Kent, noted seventeen of its meteors, indicating a very active though transient return of the shower, for a similar watch on the nights before and after its visible display revealed no sign of its appearance. It was seen again in 1879 by Prof. Herschel on the evening of January 1 and morning of January 2, and again with almost equal brightness on the evening of January 2, producing eight or ten fine shooting-stars per hour in each watch. The shower was also recorded by the writer on the morning of January 2. Watching the sky between 6.15 A.M. and 6.35 A.M., no less than fourteen of its meteors were traced, though the greater part of the heavens was veiled in clouds.

The last return of the shower was witnessed by Mr. Corder at Chelmsford on the evening of January 2. He maintained a watch of about 3¼ hours between 6 and 10 P.M., seeing 66 shooting-stars, of which 48 were conformable to Quadrans (15 per hour). The radiant point appeared double at the points $232° + 55°$ (36 ⁎ s) and $230° + 48°$ (12 ⁎ s).

At Bristol the writer saw 25 meteors before 9·30 P.M., but frequent clouds interrupted regular observations—19 of the meteors observed diverged from the usual radiant point in Quadrans (at $228° + 54°$). Generally they were of more than ordinary brilliancy, with paths averaging 15½°. Three bright meteors were registered as follows:—

Date.	Time. h. m.	Mag.	Path. α from δ	α to δ	
Jan. 2, 1880	... 6 16	= ♃	... 253° + 44°	... 261° + 38°	Slow.
,,	... 7 50	= ♃	... 138 + 41	... 126 + 29	,,
,,	... 9 8	= ♃	... 32 + 60	... 353 + 56	,, Train.

The third belonged to a radiant either in Perseus or Auriga. Mr. Corder appears to have obtained a duplicate observation of the second, and he gives the path as recorded by him from $248° + 70°$ to $290° + 79°$. The projected radiant from the combined observations is at $232° + 52°$. A smaller meteor recorded later (at 8.40) at both stations may also supply another accordance:—

Bristol ...	308° + 73° to 358° + 54°	Radiant point
Writtle ...	328 + 52 to 343 + 41	at γ Boötis.

The meteors of this special shower present some varieties of appearance which are, no doubt, to be explained by differences in the sensible position of the radiant point and by their apparent distances from that centre. In the evening the meteors traverse long flights with moderately slow motions, but in the morning hours their paths are short and the velocity seems increased. They are sometimes accompanied by trains and occasionally faint streaks remain on the courses, but they obviously belong to a different class to the swift, streak-leaving meteors of Perseus, Leo, and Orion.

There is a good radiant point not far south of that of the true January meteors which the writer has seen several times in December and January at $221° + 42°$, and Zezioli traced it on January 19, 1869, $220° + 39°$. The meteors are extremely swift and leave streaks, but the shower is of far less intensity than the Quadrantids of January 2, from which it may always be dissociated without much difficulty.

W. F. DENNING

ON THE ASIATIC ALLIANCES OF THE FAUNA OF THE "CONGERIAN" DEPOSITS OF SOUTH-EASTERN EUROPE[1]

THE molluscan fauna of Lake Baikal, lately made known by MM. Dybowski and Gertsfeld, is altogether different from the Palæarctic fauna, and is connected by many of its forms with the fresh-water fauna of the "Congerian" deposits of South-eastern Europe; thus it may be regarded as the northernmost outpost of a peculiar south-and-east molluscan fauna. On the other hand the fauna of the Amoor region, quite Palæarctic on the whole, includes some members that approach North American types; while some Chinese *Viviparæ* are conspicuously different from their Palæarctic congeners, and come near both to American forms and to those of the "Congerian" Paludina-beds. In R. P. Heude's "Conchyliologie fluviatile de la Province de Nanking," descriptions and figures are given of thirty-nine species of *Unio*, twenty of *Anodonta*, and five of *Mycetopus*. In Anderson's "Zoological Results of the two Expeditions to Western Yunnan," pl. lxxx., fig. 5, shows a gigantic knobbly-ribbed *Vivipara*, from Lake Tali, quite analogous to its Slavonian congeners. It is concluded that the Upper Miocene flora of Eastern Europe as well as [the fauna of the Paludina- and Unio-beds, bears a Chino-Japanese rather than a North American character.

Besides the "Congerian" beds, with their abundance of *Congeria* and *Cardium*, and the Paludinal deposits, characterised by the prevalence of *Vivipara* and *Unio*, a third zone is distinguishable among the upper freshwater tertiaries of South-east Europe, namely, the "Melanopsis-marls," with ornate *Melanopsides* and abundant *Neritinæ*. The only known localities of these marls are the Balkan Peninsula and some of the Greek islands. Even from this limited region we have already thirty-six species of *Melanopsis* and ten of *Neritina*, besides the eleven species of *Melanopsis* and nine of *Neritina* from the South-east European "Congerian" deposits. The genus *Neritina* seems to be especially associated with islands. Lovel Reeve enumerates eight species from Tahiti, eleven from the Sandwich Islands, and thirty-nine from the Philippines; Gassies numbers forty from New Caledonia; Kobelt eleven from the Mediterranean region; about twenty species, nearly all highly ornate, belong to this region. L. Reeve mentions seven species from the West Indies, and ten from Central America. The two or three known North-American species are from the south frontier regions; New Zealand numbers only two species. Extensive continental groups of strata are deficient in *Neritinæ*. The genus is wanting in Africa, East India, the Malayan Archipelago, Australia, and nearly the whole of America.

The species of *Melanopsis* found in the East-European deposits point, by their alliances, to the Mediterranean region; the *Neritinæ* rather to the Philippines and New Caledonia. This last island has many species of *Melanopsis*, and its fauna is somewhat analogous to that of the "Melanopsis-marls." In both cases a great number of species of both genera abound in a limited area; whilst the Mediterranean species are spread over a far wider region.

The fauna of the "Congerian" deposits is known to be closely allied to that of the Caspian; and the facts above-mentioned indicate that the alliances of the uppermost South-east European tertiaries are to be looked for within the Asio-Australian region, the supposed affinity to North America having been suggested in absence of a better knowledge of the Chino-Japanese fauna and flora.

The total absence of the African type of elephant in the upper-terrestrial tertiaries of South Europe is very remarkable, especially as the mammalian fauna of that period has a decidedly African character. As to the flora of the tertiary period, Europe had a succession of Australian, Indian, Japanese, and Mediterranean floras, but never one of African character. The tertiary terrestrial and freshwater molluscs of Europe are analogous to those of New Caledonia, India, China, and Japan, but not to

[1] By Th. Fuchs, Imper. Geolog. Instit. Vienna, Report of September 30, 1879.

those of Africa, although this continent is so near to Europe, and its mammalian fauna at the diluvial period was in intimate connection with that of Southern Europe.

ON THE ORIGIN OF THE MINERAL, STRUCTURAL, AND CHEMICAL CHARACTERS OF OPHITES AND RELATED ROCKS[1]

THE authors, beginning with (A) "The different kinds of rocks treated of," in their memoir, divide them into two groups. The first, "Silacid Ophites," is represented by serpentinite (common at the Lizard) and other rocks, essentially composed of serpentinous minerals: it includes a sub-section, comprising peridolites and some others, all slightly hydrated. The second, "Silocarbacid Ophites," consists of rocks, which, in addition to serpentinous minerals, contain a mineral carbonate—for example, ophi-calcite; its sub-section is represented by hemithrenes. The relation of the first group, through its sub-section, to ordinary metamorphic rocks, also of the second group, through its sub-section, to carrarites and dolomites is pointed out.

As regards (B) "Their mineral character," it is stated that ophites, &c., embrace some fifty or more different minerals, all containing more or less hydrous silicate of magnesia, in addition to which dry silicates and carbonates are often present. The relation of these minerals to others, essentially anhydrous, as hornblende, diallage, and peridote, is noticed.

Treating on (C) "The structural character of ophites, &c." the protean nature of their essential mineral, serpentine, is shown by a description of its fibrous, arborescent, coccolitic, platy, and other allomorphs.

With reference to (D) "The origin of certain mineral, structural, and chemical characters of ophites, &c.," the subject is treated of under different heads:—1. Fibrous layers in peridote from Elfdalen, in "graphic granite" from Harris, in perthite from Siberia, and in other instances. 2. The alternation of different minerals in laminated ophicalcite and ophimalacolite has its parallel in other and totally different rocks. 3. The change of the fibres of chrysotile into aciculæ, separated by calcareous interpolations, is illustrated by figures taken from decalcified and polarised specimens of this allomorph from Canada; also from a characteristic specimen of the same from the type-locality, Reichenstein. 4. Branching configurations, such as are assumed by serpentine, are common in hemithrenes from widely different regions; the authors refer to examples, showing that they are residual, resulting from the waste of crystalloids of malacolite. Beautiful examples occur in the calcaire saccharoide (a hemithrene) of St. Philippe, near St. Marie-aux-Mines, in the Vosges, rivalling those in Canadian ophite; and not only are the associated lobulated grains of pyrosclerite covered with a fibrous layer, closely resembling chrysotile in structure; but its fibres are occasionally converted into aciculæ, separated by films of calcite. 5. The presence of calcite under the latter condition, and in connection with configurations of serpentine and malacolite, as well as lobulated grains of these and other minerals, the authors ascribe to chemical changes similar to pseudomorphism among minerals. 6. It is contended that no minerals are incapable of resisting changes of the kind, even those regarded as the most insoluble. The experiments of Bischof, the Professors W. B. and R. E. Rogers and others, show that hypersthene, enstatite, serpentine, and various mineral silicates, digested in water containing carbonic acid, are convertible into carbonates. 7. Cases are mentioned of rocks, essentially composed of mineral silicates, which have thus become changed; as diorite from Jersey, granite and a porphyritic feldsite from near Galway, which have had certain of their mineral silicates replaced by serpentine and calcite.

The latter cases bring on a chapter (E) "On rock-metamorphism generally." The authors divide metamorphic rocks into two groups—mineralised, and methylosed; the former consisting of members which have had their original sedimentary components mineralised into gneiss, hornblende-schist, &c.; and the latter of members thus mineralised, but which, through the intervention of chemical reactions, have been converted into ophites, &c.; methylosis is to rocks the same as pseudomorphism to minerals. After briefly referring to the theory promulgated by Leibnitz in his "Protogæ," which anticipated many points now generally held as to the origin of the metamorphics, they examine the doctrine advocated by Sterry Hunt; and contend that it is altogether untenable, both from his own arguments, and a body of unquestionable counter-evidence. Repudiating a doctrine which regards the rocks in question as still being in their original or quasi-original condition, formed at the bottom of a primæval ocean, through the chemical precipitation of substances which it held in solution, the authors express themselves in accordance with the prevailing opinion that they were originally ordinary argillaceous, arenaceous, and other sediments, which, through being buried at great depths, have undergone various changes—some ending in their mineralisation, and others in their methylosis. Sterry Hunt's doctrine is further contested by evidences adduced of regional metamorphosism pertaining to various post-Archæan periods, whose crystalline or mineral effects are identical with those which he restricts to pre-Cambrian ages, and which he presumes to have been produced by chemical precipitations from seas of the time.

The mineralised metamorphics having thus far principally engaged their attention, the authors next touch upon the (F) "Methylosed metamorphics—ophites." Taking, as their standpoint, the carefully worked out conclusion of Blüm, Bischof, Rose, and others, that serpentine, as a mineral, is in all cases the product of pseudomorphism, it is contended that rocks essentially made up of it, adding other secondary minerals in certain kinds, have necessarily undergone chemical changes. Cases are cited, such as the serpentinite of the lizard, which they were the first to show, from its containing pseudomorph crystals after augite, had been originally a porphyritic dolerite. One of the Cannover Isles, in Lough Corrib, contains a mass of serpentine, which is shown to be a methylosed diorite or tremolitic rock.

The evidences offered by Bischof, Heddle, and other writers, as to the conversion of serpentinous and other siliceous rocks into calcareous masses are adduced by the authors in confirmation of their view respecting (G) "The methylotic origin of hemithrenes, &c." Additional original evidences are brought forward with the same purport. A volcanic or doleritic dyke intersects gneiss on Mr. Frederick Twining's estate, adjacent to Cleggan Bay, Connemara; where, not only is the gneiss converted into hemithrene, consisting of malacolite, peridote, serpentine, calcite, and other minerals, but the dyke itself is charged with calcitic matter. Another case occurs at St. Philippe, Vosges, where gneiss incloses dyke-like masses of hemithrene, as to conclusively prove, in the opinion of the authors, that the latter are chemically changed products of the former, effected by permeating streams of heated water containing a carbonate in solution. The labours of Delesse have shown that the region around abounds with masses of the kind.

The rocks described having undergone such remarkable changes, the authors have been induced to make investigations as to (H) "The origin of the minerals characteristic of ophites, &c., especially peridote." With certain exceptions the minerals referred to are considered to be of secondary origin, the exceptions being those remaining unaffected by secondary agencies. Serpentines, malacolite, phlogopite, chlorite, enstatite, and a number of others are all considered as secondary minerals. Peridote, notwithstanding that it is generally considered to be an original mineral in the same sense as the hornblende, feldspar, mica, &c., of granite and other plutonic rocks, is regarded by the authors as a product of alteration in all its relations, and circumstances of occurrence. Its presence in granites, basalts, and lavas has given rise to the belief that it is of igneous origin: nevertheless, its occurrence in mineralised and methylosed rocks (gneiss, and ophite of the sedimentary section) is held as proving the contrary; and the authors feel themselves justified in assuming that it is as much a secondary product as the zeolites and pseudomorphs found in granites, basalts, and lavas. Many of the crystals occurring in basalts and lavas, which have been taken for peridote, are in their opinion pseudomorphs after augite and hornblende.

Repudiating the doctrine that the Archæan rocks are the result of chemical precipitations, and entertaining the strongest doubts that life has been to any extent concerned in their formation, the authors, in a chapter (I) "On the origin of the Archæan crystallite limestones of Canada," apply their views on hemithrenes to the present subject; and they arrive at the conclusion, from various considerations, that the rocks in question are methylosed products; but which, before this change took place, existed as gneisses, hornblende-schists, and other mineralised silacid metamorphics.

The question (J) "Why limestones are so rare in formations

[1] Paper read at the Royal Society by Professors W. King, Sc.D., and T. H. Rowney, Ph.D.

immediately succeeding the Archæans," is discussed in connection with the facts that calcareous organisms are rare or not present in the formation referred to, and that calcareous rocks are abundant in the preceding systems—the Archæans. These facts are held to be in unison with the authors' conclusions stated in the last chapter, and to favour the view that the Archæan limestones with their present constitution were not available as materials for the production of calcareous rocks in the earliest Cambrian age.

(K) "The genetic difference between mineralised and methylosed metamorphism" is explained by assuming that water has been an important factor in both cases; but as the minerals in the first group are for the most part anhydrous or dry species, it is assumed that the original (? hygroscopic) water, which its members contained in their condition as sediment, was sufficient for their mineralisation; on the other hand, as the minerals composing the members of the second group are chiefly hydrous, it is contended that their methylosis has been effected by additional water penetrating them, and flowing from extraneous or foreign sources. Compared with each other, mineralised rocks may be classed as xerothermal, and methylosed as hydrothermal.

Various evidences are adduced to show that (L) "Some ophites have been originally igneous, and others sedimentary rocks"—a conclusion favouring their secondary, and consequently their methylotic origin.

(M.) "Some crystalline limestones are simply mineralised," such as carrarite; though rocks closely related to them—viz., "Dolomites have undergone methylosis." With regard to the latter, however, the authors do not accept von Buch's theory of dolomitisation in its general application. Admitting various kinds of this phenomenon, they conceive the change in certain well-known cases has been effected by the action of the magnesian constituents of sea-water on subjacent beds of limestone; for example, during the closing portion of the Triassic period, as strongly supported by geological evidences, determined by Ramsay and others, the seas in certain European regions became dried up or reduced; and their water, loaded with magnesian salts, sank through the subjacent sandstones and marls into the Permian limestones, thus converting them into dolomites. Irish corroborative cases are mentioned. The dolomites of the Tyrol are held to have originated in the same way; but it is admitted to be probable that the predazzite of the Canzacola Mountain, Val di Fassa, was dolomite that became hydrated by the heated wazer which accompanied the eruption of the immediately adjacent and overlying monzonite. "Serpentinisation effected in deposits without the intervention of mineralisation" is admitted in the production of the magneso-argillite at Vallecas, near Madrid, also of that in the Paris Basin, and other localities; for Sullivan and O'Reilly have shown that it was originally a non-magnesian deposit.

The authors conclude by treating of (N) "The chrono-geological range of ophites, &c., and the age of their methylosis."

Offering merely possible suggestions as to the age in which this phenomenon took place in what may be regarded as the oldest ophites (as the subject is beset with considerable difficulties), instances referable to secondary periods, as the dolomites and serpentine rocks of the Tyrol, &c., are briefly noticed; but they refer more confidently to the methylosed euphotides, &c., of Northern and Central Italy, which, having burst through cretaceous limestone (alberese), eocene sandstones and schists, have incontestably produced gabbro verde during late tertiary ages. Moreover, it would appear from the discoveries of Achiardi, that argillaceous schists, in Tuscany, are now being serpentinised by the action of magnesiated water. And, taking the wide range of evidences which have been adduced into consideration, it can scarcely be doubted that the same process is still in operation in deep-seated rocks, permeated by heated waters.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 2.—On the course of formation of residual charge in Leyden jars, with constant difference of potential of the coatings, by W. Giese.—On a relation between pressure, temperature, and density of the saturated vapours of water and some other liquids, by A. Winkelmann.—On Newton's dust-rings, by K. Exner.—Remarks on the electrodynamic fundamental laws of Clausius, Riemann, and Weber, by J. Fröhlich.—General theory of the damping exercised by a multiplier on a magnet, by K. Schering.—Chemical monography of the mica group, by C. Rammelsberg.—Modulus of elasticity of ice, by L. Reusch.—The cross-pendulum, an apparatus for graphic representation of curves of vibration, by P. Schönemann.

Gegenbaur's Morphologisches Jahrbuch, vol. vi. part 1, 1880.—A. Rauber, continuation of first section of his treatise on transformations and their causes in the development of vertebrata (pp. 1-48).—G. Born, postscript to former papers on the carpus and tarsus in amphibia and reptiles, plate 1 (pp. 49-78).—W. Geisbrecht, histology of teeth in echinoids, plates 2-5 (pp. 79-105).—Leo Gerlach, a case of tail-formation in a human embryo, with careful histological drawings, showing an indubitable notochord, plate 6 (pp. 106-124).—M. von Davidoff, on the skeleton of the hind-limbs of holostean ganoids and physostomous teleosteans.

THE *Bulletin de l'Académie Royale des Sciences de Belgique*, No. 12, 1879.—On the variations of the specific heat of carbonic acid at high temperatures, by M. Valerius.—Red spot observed on the planet Jupiter during the oppositions of 1878 and 1879, by M. Niesten.—Denominations given to the spots of the planet Mars, by M. Terby.—Method for determining all the ordinary singularities of a locus defined by k algebraic equations containing $k - 1$ arbitrary parameters, by M. Saltel.—The classification of birds since Linnæus, by M. de Selys Longchamps.—The development of the vegetable kingdom in geological times, by M. Gilkinet.—Jury report on the sixth period of quinquennial competition in the mathematical and physical sciences.

No. 1, 1880.—Existence of a double apparatus and of two sanguineous liquids in Arthropoda, by M. van Beneden (sealed packet).—Remarks on the existence of evolution in curves of the third order and fourth class, by Prof. Weyr.—Description of an isochronous elliptic governor, the speed of whose action can be varied at will, by M. van Rysselberghe.

Archives des Sciences physiques et naturelles, February 15.—Swiss geological review for 1879, by M. E. Favre.—On the time required for surveys of the heavens made with different magnifying powers of the telescope, by M. Thury.—On the constitution of naphtaline and of its derivatives, by MM. Reverdin and Nölting.—Directive ideas for the history of the vegetable kingdom since the tertiary epoch, by Dr. Engler.—Variations of the magnetic declination deduced from regular observations at Moncalieri, in the period 1870-71, by Père Denza.—A series of researches on the pelagic fauna of the lakes of Tessin and of Italy, by Dr. Pavesi.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xiii. fasc. i.—The *mal nero* and the phylloxera at Valmodiera, by S. Trevisan.—Congenital syphilis by direct paternal influence, &c., by Prof. Scarenzio.—On new facts proving the ability of ascarides to perforate unaltered membranes within the abdomen, by Prof. Sangalli.—Contribution to the histology of the voluntary muscles, by Prof. Golgi.

Cosmos, February.—Prof. Dr. Fritz Schultze, on the history of the origin of the conception of soul.—Dr. C. Forsyth Major, on quaternary horses (translated from *Archivio per l'Antropologia*, 1879), A. W. Buckland.

THE *Atti della R. Accademia dei Lincei*, January.—On the chemical composition of the soil of the serpentine of Tuscany, by S. Cossa.—On the cranium of a crocodile discovered in the eocene strata of Veronese, by Baron de Zigno.—Revindication on some correlations between the thermal and other physical properties of bodies, by S. Cantoni.

THE *Revue Internationale des Sciences biologiques*, February.—M. Vulpian, physiological study of poisons, No. 3.—On jaborandi (conclusion).—M. Debierre, on the origin and the evolution of societies, and of the civilisation following contemporary science. Notices of scientific works; scientific societies; book notices.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, March 18.—Prof. Allman, F.R.S., president, in the chair.—The President said that before entering on the ordinary business of the meeting it became his melancholy duty to announce the death of Prof. Thos. Bell at the age of eighty-seven. Prof. Bell was the oldest Fellow of the Society, having been elected into it in the year 1815. He had held the presidential chair for many years, and under his judicious and able guidance the Society had marvellously advanced in prosperity.

He was a distinguished zoologist, and by his researches had largely advanced our knowledge of the fauna of the British Isles. His labours have left their mark on the zoology of Britain, and it is hard to say who can take his place in the department of natural history, in which he had shown himself so loving and conscientious an observer. He was known personally to many here present, and by reputation to all of us, and the meeting will receive with sorrow the sad announcement that he has his place no longer among the Fellows.—Mr. Thos. Christy exhibited a collection of dried flowers from Western Australia, made by Mrs. Bunbury. She observes that the once common native flowers are becoming rapidly scarce in the pasture land of the colony, and that it is even difficult to propagate them by culture.—There was also shown for Mr. J. T. Carrington a male and female example of the Northern Stone Crab (*Lithodes arctica*), which had lived in the Westminster Aquarium. The peculiar asymmetry of the abdominal segments in the female was adverted to, and from this and other reasons an affinity with the Hermit Crabs pointed out.—The Secretary read a communication from Mr. H. M. Brewer, of Wanganui Acclimatisation Society, on the indigenous timber and on plants introduced into New Zealand. Among the former, "Manaka" (*Leptospermum ericoides*) is useful for spokes, tool handles, &c.; "Korohai" (*Sophora tetraptera*) forms admirable material for carving, &c.; "Totara" (*Podocarpa totara*) is most durable for piles, railway sleepers, &c.; red birch (*Fagus fusca*), on account of its strength, is well adapted for beams and framework; and the "Matai" (*P. spicata*) is so durable that a prostrate tree found in damp bush and supposed to have lain there for a couple of centuries still retained its soundness when cut up. Of plants introduced quite a host thrive out of doors. Among others the coral tree (*Erythrina caffra*), with its brilliant scarlet flowers. *Fourcroyia gigantea*, which produces a fine fibre and grows well without any cultivation on the waste clay hills; also *F. flavoviridis*, another fibre-yielding plant. *Chamærops excelsa*, *C. humilis*, *Musa textilis*, and *M. sapientum*, equally thrive, the banana ripening good fruit. *Broussonetia papyrifera*, from which paper is made in Japan. The pomegranate (*Punica granatum*) and the olive (*Olea europæa*) hereafter are likely to become important as commercial products. The Natal plum (*Arduina grandiflora*), the fig (*Ficus carica*), custard-apple (*Anona muricata*), *Eriobotrya japonica*, ginger (*Zingiber officinalis*), the tallow tree (*Stillingia sebifera*), cinnamon, camphor, orange, lemon, and citrons, besides many other sub-tropical plants, afford sufficient proof of the mildness of the climate and capabilities of the country ultimately to depend on its own resources. Of araucarias and pines a great number of introduced species have thriven well, some only requiring a little shelter at first. Oaks, elms, poplars, &c., all take naturally to the New Zealand soil, but sufficient has been said to indicate the great variety of flora indigenous and introduced into this flourishing though distant colony.—A paper by Prof. J. O. Westwood, on a supposed polymorphic butterfly from India, was also read by the Secretary for the author. The conclusions arrived at are: (1) of *Papilio Castor* being males of a species whose females have not yet been discovered; (2) that the typical *P. Pollux* are females of which the male with rounded hind wings having a diffused row of markings has yet to be discovered; and (3) that the coloured figures given by the author represent the two sexes of a dimorphic form of the species.

Physical Society, March 14.—Dr. Huggins in the chair.—New members—Prof. Minchin, Mr. Hulme, Mr. A. Stroh, Prof. D. E. Hughes, Lieut. Wingfield, Mr. J. Macfarlane Gray. Mr. W. Chandler Roberts, F.R.S., drew attention to an explanation which has recently been suggested by Dr. Van Riemsdijk of Utrecht to account for the "flashing" which attends the solidification of cupelled buttons of gold and silver. He showed experimentally that at the point of solidification the metals emit a flash of greenish light, which Dr. Riemsdijk thinks is probably due to the globules being really in what is known as the superfused or surfused state; that is they fall some degrees below their points of solidification without setting, and the change from the liquid state is accompanied by the liberation of the latent heat of fusion, which again heats the globule and renders it incandescent. In an attempt to obtain inductions as to the state of certain fused metals by the aid of the induction balance, Mr. Roberts was able to show that the resistance of silver in the molten state is far greater than when the metal is solid, and on the other hand he had confirmed De La Rue's statement that the resistance of molten bismuth is less than that of the solid metal, and he also obtained evidence that bismuth in cooling may be made to pass through a superfused state similar to that which occurs in the buttons of gold. Mr. N. Lockyer thought the greenish tint of the light might be due to a solid film on the surface of the globule.—The Secretary then read a paper by Prof. W. F. Barrett, announcing that he had found a current of electricity to be generated by the rotation of the prepared chalk cylinder in the receiver of the Edison telephone. When the platinum stylus which rubs on the cylinder is connected through a galvanometer to the brass axle on which the cylinder is mounted, a current is observed whose E.M.F. is over $\frac{1}{2}$ volt. This current falls off as the rotation continues, owing, Prof. Barrett assumes, to the electrification of the surface of the chalk. Prof. Barrett attributes the current to friction solely, and seeks to account for the receiving action of Edison's telephone by this frictional current being modified by the transmitted currents, and not by the electrolytic action to which it is usually ascribed. These experiments originated with a suggestion of Prof. Sylvanus Thompson that the Edison receiver might act as a transmitter. Prof. Barrett had at length succeeded in making it act in this capacity by means of the frictional current.—Mr. Shelford Bidwell exhibited some experiments bearing on Prof. Barrett's observations, which tended to show that the source of the current in the Edison receiver was due to the fact that a voltaic element is formed by the platinum rubbing-point, the brass axle, and the prepared chalk. This chalk is usually impregnated with phosphate of soda, or, as in the author's experiments, with caustic potash and acetate of mercury. The cylinder seems to be dry, but is probably moist; wetting it greatly increases the current. There is a very feeble current when no motion of the cylinder takes place, but rotation of the cylinder greatly increases it. Platinum is electro-negative to brass, and hence the positive current flows from the platinum to the brass through the galvanometer. This was demonstrated by substituting zinc for platinum, when the current was reversed and flowed from the brass to the zinc, owing to the fact that brass is electro-negative to zinc. Mr. Bidwell showed, by means of a simple pile of copper and tin foil separated by a moist cloth or paper, that the motion of the tin across the paper increased the current of the cell. In the case of a cell made of *two* tin plates separated by moist paper, the current was set up by moving one plate over the other. The plate which moved relatively to the paper was always electro-negative to the other. Mr. Bidwell also showed by a simple experiment that the action of Edison's receiver was electrolytic. He caused the mere passage of a current to lessen the friction of a metal strap on a drum covered with moist paper, and thereby released the drum by the evolution of hydrogen. Prof. Ayrton pointed out that the rubbing action in these experiments assisted the current by bringing up fresh electrolytic matter, a fact which had been taken advantage of in the construction of several batteries. Prof. Adams remarked that this action did not seem to explain how the current was *reversed* in the cell composed of *two* tinfoil plates.—Prof. Guthrie then demonstrated by experiment a curious anomaly in frictional electricity. When flannel is rubbed with ebonite the flannel is + electrified; when ebonite is rubbed with glass the ebonite is + electrified; and we should therefore expect that when flannel is rubbed with glass the flannel would be still more + electrified; but instead of that it is really feebly negative. Perhaps the fact that the heat of friction enters into one substance more than the other affected such results.—The Secretary then read a note from Mr. Ridout, stating that he had succeeded in Dr. Guthrie's funnel experiment mentioned at last meeting, and by means of a stream of water flowing out of a glass funnel had attracted a glass cone towards the mouth of the funnel. The angle of the cone was greater than the angle of the funnel.

Victoria Institute, March 11.—Prof. Hughes, of Cambridge, read a paper upon the movements of elevation and depression in the British Isles, in which he continued his argument against the existence of preglacial man.

Edinburgh

Royal Society, March 1.—Prof. Geikie in the chair.—Sir William Thomson communicated to the Society his new method for measuring temperatures by means of "steam-pressure thermometers of sulphurous acid, water, and mercury"—a method which will be found fully described in the article "Heat," in the forthcoming volume of the "Encyclopædia Britannica." The system here proposed is essentially a *manometric* one as opposed to the ordinary *volumetric* one. Any given temperature is definitely measured by the pressure exerted by the *steam* of a convenient liquid which is kept at the required temperature, where by steam is meant vapour in presence of its liquid. The range of temperature through which sulphurous acid can be so employed, with a moderate column of mercury (the *manometric column*) to measure by its height the pressure exerted, is from − 40° C. to + 20° C. Below this inferior limit carbonic acid may be substituted, and above the superior limit water is eminently suitable, and can be made to stand a temperature of 140° C. For still higher temperatures the steam-pressure mercury thermometer is required, a water manometric column being used for temperatures below 280°, and a mercury manometric column for temperatures above that limit and below 520°. The water manometric column is necessary for the lower range, so as to give the thermometer sufficient sensibility for registering small increments of temperature throughout that range. A sulphurous acid cryophorus was also exhibited, its structure being the same as the differential steam-pressure sulphurous acid thermometer, which is simply a U-tube closed at both ends and filled with sulphurous acid in the liquid and gaseous states. This instrument was the type upon which the steam-pressure water thermometer and the steam-pressure mercury thermometer for the highest range were constructed.—Sir W. Thomson also communicated a paper on the vibrations of a columnar vortex, in which he proved that the velocity of propagation of a longitudinal wave along an infinitely long vortex column was about one-third the velocity of the surface of the column in its undisturbed state. He also discussed the case of transverse vibrations, and pointed out the importance of such investigations as probably throwing some light upon the nature of the sudden gusts which accompany great storms.—Prof. Turner read a paper on the structure of the comb-like appendages and teeth of the basking shark. These comb-like appendages, though differing remarkably in many ways from whale-bone, seemed to serve a very similar function.—Sir Wyville Thomson communicated a preliminary report, by Mr. Herdman, on the *Ascidiæ* of the *Challenger* Expedition, from which it appeared that of the sixteen new species discovered by the *Challenger*, only two had been previously known.—Prof. Tait laid before the Society a few notes regarding his application of rotatory polarisation to the determination of the position of bright lines in feeble spectra.

BOSTON, U.S.A.

American Academy of Arts and Sciences, March 10.—Charles Francis Adams in the chair.—Prof. Edward C. Pickering read a paper on Huggins's recent photographs of the spectra of stars, and gave a formula based on the molecular constitution of matter, which apparently explained the peculiar grouping of lines observed by Huggins.—Mr. Albert A. Michelson, of the United States Navy, explained a plan for obtaining the velocity of the solar system through space. He proposes to measure the velocity of light by a method which obviates the necessity of having the ray of light pass back and forth over the same path, and by the employment of the revolving mirrors, which are maintained at the same speed of revolution, the velocity of light can be obtained in the direction of the movement of the earth through space and in the opposite direction. Mr. Michelson is about to undertake experiments to determine the question of the movement of the solar system.—Prof. J. P. Cooke, of Harvard University, gave the results of various methods which have fully confirmed his value obtained for the atomic weight of antimony.

PARIS

Academy of Sciences, March 22.—M. Ed. Becquerel in the chair.—The following papers were read:—On the origin of the solar system, by M. Faye.—On some applications of elliptic functions, by M. Hermite.—On the compensation of temperatures in chronometers, by Mr. Phillips.—On the tritoxide of silver, by M. Berthelot.—Observations on the decomposition of permanganate of potash by oxygenated water, by M. Berthelot. He is led to the hypothesis of a tritoxide of hydrogen (HO_3) resulting from oxidation of oxygenated water by the permanganate.—On electric regulation of the hour in Paris, by M. Tresca. The system comprises (1) a certain number of horary centres distributed on two telegraphic systems; they are good clocks, with action regularised every second; (2) the clocks of the town kept in their present state, but true in time. Of the former, six have been in action since January 3; and six others, on a distinct system, are to be set up.—Report to the Academy on the results obtained during the voyage of the *Magicienne*, for observation of the transit of Mercury, by Admiral Serres. This includes information about transport of time, differences of longitude in South America, observations on magnetism, measurement of the force and direction of winds, the transit of Mercury, description of an electric log, &c.—On the curves defined by a differential equation, by M. Poincaré.—On the integrals of algebraic functions, by M. Pellet.—On a class of functions of several variables drawn from inversion of integrals of solutions of linear differential equations, the coefficients of which are rational functions, by M. Fuchs.—Analysis of luminous phenomena produced by electric discharges in rarefied gases, by M. Fernet. The discharges in a large vertical tube were viewed by reflection in a rotating mirror behind a slit in a screen. The peculiar appearances of the bright curves occurring between the poles is described.—On the thermal laws of electric sparks produced by ordinary, incomplete, and partial discharges of condensers, by M. Villari.—On a case of remanent polarity of steel opposite to that of the magnetising helix which produces it, by M. Righi. Theory led him to believe that with a series of bars of the same steel and diameter, but decreasing lengths, a certain length would be reached which would not give magnetisation, while, with less length, a remanent polarity would be got, opposite to that of the coil. He states how he realised the latter.—On the photography of the solar spectrum, by M. Conche. His method is long exposure of bromised gelatine plates.—On the density of iodine at high temperatures, by MM. Crafts and Meyer.—On a mode of production of acetal, by MM. Engel and Girard.—Specific heats of solutions of potash and of soda, by M. Hemmerl.—On the alkalies of pomegranate, by M. Tanret.—Artificial production of a leucotephrite identical with the crystalline lavas of Vesuvius and La Somma; nascent crystalline forms of leucite and nepheline, by MM. Fouqué and Levy.—Artificial reproduction of spinel and corundum, by M. Meunier. Chloride of aluminium, steam, and metallic magnesium (or zinc) were brought together in a heated tube.—On the normal presence of copper in plants which live on rocks of the primordial formation, by M. Dieulafait.—Researches on the vaso-motor innervation, the circulation of the liver and of the abdominal muscles, by M. Laffont.—On the anatomical character of the blood in phlegmasias, by M. Hayem.—On the godrooned cells of the intravaginal hyaline system of the nerves of Solipedes, by M. Renant.—On the nervous system of *Idothea entomon* (an isopod crustacean), by M. Brandt.—On the caducity of the hooks, and even of the scolex in Tænias, by M. Mégnin.—M. Larrey presented, from M. da Cunha Bellem, a Portuguese work, entitled "Medical Life on the Battle-field," and gave an analysis of it.

CONTENTS

THURSDAY, APRIL 8, 1880

MUSICAL PITCH

ALTHOUGH the outside world knows little about it, the question of musical pitch causes great anxiety to the public singer, to the conductor of operas and choirs, and to musical instrument-makers generally. Musical instruments are divided into two classes: those with fixed and those with variable tones. The first comprises organs and pianos and most brass and wood wind-instruments. The trombone, the bowed instruments, and the human voice are variable. Even the latter, however, can vary only within narrow limits, so that they cannot extend their compass at will. In the voice especially, although a few exceptional singers can, so to speak, acrobatise in music to the wonder of the public, yet the really good and usable part of even their compass for every-day work is comparatively limited, and if they are called upon frequently to sing either at their highest or lowest, the voice rapidly deteriorates, and wonder is changed to compassion. Violins even cannot afford to be "screwed up or down" too much, and rather prefer altering the thickness of their strings, with by no means a general improvement of effect. The thin strings are particularly objectionable in instruments only too prone to be played cuttingly. And clarinets and oboes, and even trumpets, when they are made short and narrow for high pitch, are only fit to be heard out of doors, as in military bands.

The whole secret of the difficulty lies in this: musical notes do not represent fixed and determinate sounds. The sounds collectively, when once the system of the scale is determined, are indeed fixed relatively to one sound, but that one has varied and does vary immensely. It has become quite an antiquarian problem to determine what sounds the writer of a piece of music attributed to his notes. This problem has to a great extent been solved by Mr. Alexander J. Ellis in a paper recently read before the Society of Arts and abstracted below, and we wish here to draw attention to the practical result of his labours.

Very little turns upon the music of more than three hundred years ago. It must be transposed, as is common with Orlando Gibbons's church music, and written in notes which at the current value will indicate sounds lying within the power of the singer. There is comparatively little of such music, and hence it is not difficult to reproduce it in the required form. It is only convenient to note in passing how very widely the meaning of the notes then differed from ours, Gibbons using a pitch which Mr. Ellis estimates as a whole Fourth above Handel's. But this does not apply to the great mass of classical music which has appeared since the beginning of the eighteenth century. When equal temperament (a babe of less than forty years old in England, as Mr. Ellis's facts establish) has a notation of its own, as has recently been proposed in Germany, and ceases to wear the clothes which Salinas designed in 1577, then it will become necessary to transcribe these works. In the meantime we must use what we have to the best advantage, and as much as it is possible in the sense which the composers intended. And what was that? The principal historical fact which Mr. Ellis seems to have established is that all over Europe, for two centuries, down to 1816 at earliest in Vienna, later in the rest of Germany and in France, and down to 1828 in England (taking the Philharmonic Concerts as the standard), the sound assigned to the tuning A did not vary above one-sixth of a tone above or below the value of Handel's own fork, now in the possession of the Rev. G. T. Driffield, Rector of Bow, and that hence this well-known fork represents the mean pitch of Europe for all classical music. What is that pitch? It is five-eighths of a tone below the pitch of the great concert organs at the Crystal Palace, the Albert Hall, and Alexandra Palace. When during a hot June or July day at the Crystal Palace on a Handel Commemoration the temperature, and hence the pitch of the organ, is driven up, Handel's music has to be sung three-quarters of a tone at least, sometimes a whole tone, higher than he imagined when he wrote it. The strain thus laid on the sopranos and tenors, especially in the choruses, is out of all reason, and the music, deprived of its proper fullness and richness, loses greatly in effect. Of course such a practice can only be excused on the ground of ignorance, and that is a plea which can no longer be raised after the proofs which have been adduced.

But what is to be done? Much music, considerably less in quantity, and perhaps in quality, if we except Mendelssohn's, has been written to a much higher pitch. Thus the celebrated Gewandhaus Concerts at Leipzig, representing Mendelssohn's pitch, were a whole semitone sharper than Handel's fork, as is shown by Mr. Ellis. Are we to destroy the new music for the sake of the old, as we now destroy the old for the sake of the new? Or are we to have two sets of instruments—two organs at the Crystal Palace and Albert Hall, or at least two sets of stops in the same case? Of course such ideas are wild, though not so wild as they look, for Dresden has two sets of instruments, and old churches (as the cathedral at Lübeck and the Franciscan Convent at Vienna) have two organs in different pitches, nay one German organ certainly had stops in two pitches differing by a minor Third. We have however no need to have recourse to such devices. The French Commission on pitch in 1858 has given a satisfactory answer to the question. It has settled a value for A nearly half-way between the old and the new, but, as is just, rather nearer to the old, and has fixed this pitch by a beautiful standard fork properly preserved in the Musée du Conservatoire at Paris, the only real standard of pitch in the world. This Diapason Normal is exactly two-eighths of a tone above Handel's fork, and about three-eighths of a tone below the Crystal Palace organ at mean temperatures, that is below our highest concert pitch. An important resolution was passed at Dresden in 1862 by eminent conductors (quoted by Mr. Ellis), saying that such "a lowering of pitch to the new Paris standard appears equally desirable and satisfactory for singers and for orchestra; that quality of tone would gain, the brilliancy of the band would not be lost, and the power of the singers would not be so severely taxed or strained."

The rise in pitch since 1816 has been the result of a series of accidents. Nothing approaching to scientific or musical thought appears in it. The most that can now be done is to recognise its existence by adopting the French compromise. And, by the way, this is by no means French except in name, for in 1828 Sir George Smart, then conductor of the Philharmonic, adopted what was practically the same pitch in England, and the greater number of so-called Philharmonic forks sold down to thirty years ago gave the C of the later French pitch. It has left its impress, too, on numerous organs which during this period were tuned to "Smart's pitch," as it was then called. It is in fact a long tried English pitch, displaced only by accidental circumstances during Costa's conductorship of the Philharmonic. In France its use is universal, in Germany it was generally accepted, though a fresh rise is there perceptible, in Madrid it has lately been adopted, and even in Belgium, the only country in Europe which approaches the English heights of pitch, a recent commission reported in its favour for both concerts and military bands. Finally, the enormous inconvenience felt by singers accustomed to this pitch, when coming over for a London season or special concerts (as at the recent Wagner festival, according to Wagner's own statement), have induced the Covent Garden Opera to revert to it again this season, so that musicians will have an excellent opportunity of judging of its effect.

A strong argument usually brought against a change of pitch is the difficulty of getting new brass and wood instruments. The French pitch has now lasted long enough for good instruments to be made in it, and it is in fact more easy, out of London, to obtain instruments in that pitch than in any other. But considering that it was used in England and in France for about twenty years prior to 1850, and that the bands accommodated themselves to the gradual change then, there seems no reason why they should not do so now. Organs present a difficulty, but no mercy should be shown to them. Organs sharpen so much by temperature in a concert room crowded or lighted up, or in summer, that it is really inhuman to build organs that even at mean temperatures strain the voice of a singer of Handel to follow. They are essentially solo instruments. French pitch is the highest admissible pitch for organs which have to lead voices, and those which are sharper should be flattened forthwith. Church organs are even now usually constructed but a trifle sharper than French pitch. As for pianos, it is well known that the concert grand pianos improve in richness and quality of tone by being brought down to French pitch. It is a mere matter of stringing and tuning, not of construction.

Besides the importance of having a uniform pitch to the singer and the manufacturers of instruments, there is a theoretical advantage to the listener. With equal temperament when properly carried out, the relations of the intervals in different keys remain precisely the same, and the effect of change of key therefore is due to the change of pitch of the tonic and its related notes. When the ear is accustomed to one pitch it easily recognises the key. When the pitch varies from time to time and place to place, the sense of key becomes deadened and lost, and even the most experienced ears become confused. Hence, both theoretically and practically, uniformity of pitch is imperative. Practically an intermediate pitch between the old pitch of Handel, Haydn, Mozart, and Beethoven, and the new pitch of Mendelssohn, Costa, and Verdi, is the only one feasible to allow of both kinds of music being played by one organ or one band. And such a pitch is the French, the pitch of all French and most German modern music, the pitch in which the works of Wagner can alone be properly heard.

FARMING

Farming for Pleasure and Profit. Fourth, Fifth, and Sixth Sections. By Arthur Roland. (London: Chapman and Hall, Limited.)

THE publication of a work bearing such a title, naturally commands special attention at a time when farming is looked upon as anything but a pleasant and profitable business. Although it is evidently written by one practically acquainted with agricultural operations, a perusal unfortunately shows that it is very imperfectly adapted for meeting the needs of farmers in times of difficulty like the present. It has a great defect in its oversight of many of the improvements which have been introduced during the last twenty or thirty years, so much so, indeed, as to lead to a doubt whether there has not been a clerical error in the date of publication, and 1880 substituted for 1850.

The Fourth Section of this work is devoted to "Stock Keeping and Cattle Rearing." The economical production of pork is evidently one of the details of practice on which the author prides himself. He says, "Nettles grow in great profusion in our hedges, the somewhat sandy soil which chiefly prevails apparently being favourable to their growth. These I have all cut down with a bill-hook by one of the men, and they are brought to the pigstyes—unless we boil some up with other green stuff, which we do when they are young—and the pigs eat the nettles as freely as they will cabbages. My economical contrivances in this way, as may be expected, provoked the scorn of the labourers at first, and does at all times upon the occasion of a new man being engaged; but the success of the plan has been proved to demonstration, over and over again, to my old hands, who have got into my ways and system, and it is upon the adoption of these economical contrivances that the profits of farming mainly depend."

If this were true clean hedgerows are a great mistake, and uncultivated weeds have been sadly undervalued, hence, possibly, even the present depression in agriculture. But the author has evidently not acted upon the advice which he subsequently gives, for he says: "The old labourers of a district are often better acquainted with the peculiarities of the soil and other matters, the result of long observation, than the farmer himself; and although it is by no means necessary to act upon their advice, which would often mislead and cause ignorance and prejudice to reign instead of sound principles, yet there is often much that may be learned from them and turned to profitable account." Practical experience, whether obtained by the labourer or by the farmer, is undoubtedly of great value, and should be justly prized; but it is open to question whether the author has here shown that discretion which will not allow "ignorance or prejudice to reign instead of sound principles."

In dealing with our various breeds of cattle the author falls into some grievous errors; for example, he remarks that the North Devon cattle "do not possess any particular qualities as stock animals for the grazier or feeder;" and in reference to the Hereford cattle, says: "They are seldom met with out of their native district; and . . . it is doubtful whether the partiality they have succeeded in exciting with some persons does not arise from unjustified preference." Rarely, if ever, has any writer upon agriculture expressed views on this subject with less judicial care than has been shown in these quotations. The Shorthorns, which are evidently the author's favourites, have undoubted merits and many staunch advocates, but they have no monopoly of those good qualities which distinguish our improved breeds of cattle; and thus throughout the world Herefords and Devons become competitors with the Shorthorns, and in many cases successful competitors.

The Fifth Section includes "the Drainage of Land, Irrigation, and Manures." The action of burnt lime in the soil is probably as commonly understood by those who have given any attention to the use of manures as the action of any one of our fertilisers. Instead of giving any distinct and useful information upon the subject the author contents himself by such explanations as the following:—"Upon sandy soils, which seldom abound to any considerable extent in vegetable matter, the mechanical action of the ('burnt') lime is to combine with the finer particles of the soil and thus give additional consistence to the staple of the land; attracting the moisture from the atmosphere, it causes it to be less liable to be hurt by drought in those seasons when the crops suffer so greatly upon sandy soils, exercising a cooling influence upon hot land, although the lime itself be hot and of a warm nature to a cold soil. Upon these dry soils, however, it is necessary to give liberal dressings of putrescent manures, for seeds could obtain no nourishment from either the lime or the sand."

Here then we have an extraordinary mixture of ideas, arising from the action of burnt lime being confused with lime which has not been burnt, as, for instance, when chalk or marl has been used. The author is fully sensible of the important influences of manures, for he remarks: "The whole subject of the proper application of manure is one of the most important departments of successful husbandry, as is generally acknowledged, yet, unfortunately, in only too many instances is it one that is very much neglected beyond the most ordinary system of 'rule of thumb,' followed according to the 'custom of the country' which may prevail in each shire." Surely no stronger plea could have been advanced for the author giving his readers some clear explanation of the action of various manures, so as to aid them in exercising their thoughts on the subject, rather than simply following "the custom of the country." In this respect the work is certainly very defective.

The Sixth Section deals with "the Labourer, Root-Growing, and Hops." Of the various suggestions given for the benefit of the labourer, the author certainly deserves credit for one novelty. He proposes that, "instead of allowing the men to keep pigs themselves, let the smallest out of a litter be given to each man as they come round—not the smallest pig that is born, for this particular pig would be found to thrive in a mysterious manner, so that he overtook and beat all the others—but the smallest when they are killed or sold. By this means all the pigs will make equal progress, and an arrangement of this kind will cause an extraordinary amount of interest in the various kinds of stock." We may certainly take it for granted that none of the labourers on the farm would have any objection to such an arrangement, but it is by no means equally obvious how the men who are attending to the horses, or engaged on the land, can contribute to the welfare of the pigs, except by contributions of corn intended for the horses, or by supplies of nettles from the hedgerows.

With curious inconsistency the author almost immediately after, in noticing the importance of a supply of milk, remarks, "The milk should be sold at a cheap rate, *not given*, so that the independence and self-respect of the labourer is preserved." In this latter recommendation we cordially agree; but is the larger gift of a pig of such a thoroughly substantial and consolatory character as to prevent any loss of self-respect? It would doubtless be a matter of rare occurrence, but however frequent it might be, if the master should find it consistent with the pleasure and profit of farming, the labourers would probably not complain at their independence being thus far overlooked. It is undoubtedly desirable to promote feelings of independence and self-respect amongst labourers, but we fail to detect in this section any indications of a definite policy likely to lead to this result.

The chapter on the growth of Hops is the most valuable of the entire series, and is quite a redeeming feature in the work. Nor must it be supposed that other parts ot the several sections are devoid of merit; on the contrary. the work contains many valuable statements, which manifestly come from a mind practically acquainted with some of the subjects brought under consideration. It is however much to be regretted that these grains of good corn have not been more perfectly winnowed, so as to present a purer and more marketable sample to the public.

LETTERS TO THE EDITOR

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

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

Mr. A. R. Wallace's "Australasia"

ALTHOUGH somewhat late in the day, I beg to offer a few remarks on this work supplementary to the critique which appeared in the columns of NATURE, vol. xx. p. 598. The facts that "Australasia" is the only compendious work which we have in English on the subject of which it treats, and that the high authority of Mr. Wallace's name will be equivalent with the majority of readers to a guarantee for the accuracy of the maps and letter-press, render it important that such errors as exist in the book should be rectified at once. For this reason I venture to make the following brief observations on those sections of the work treating of the Philippines and Borneo, with which districts I chance to be personally familiar.

1. In the map of the Philippines the islands of Sulu and Balabac, and the halves of the islands of Palawan and Mindanao, are shown as Mahometan native states, whereas they are all as undoubtedly Spanish possessions as is the interior of Luzon. In Barilan the Spanish have long had a naval station and arsenal; at Port Royalist they have a naval station and penal settlement; and the same at Balabac; and they have within the last few years firmly possessed themselves of the chief Sulu island. They

have also the settlements of Pollok and Cota Batu in Ilana Bay. The whole of the above-named places are in regular steam-communication with Manila.

2. In the map of the Malay Archipelago the geography of the north-west coast of Borneo is so inaccurate as to be quite valueless. The great Rejang River should run to near the head of the Koti, and therefore the Sarawak Territory be prolonged much further eastwards. The Limbang is brought down far into the Sarawak territory; and the Baram, a river nearly as large as the Rejang (up which I have myself steamed 200 miles), is entirely omitted. The Brunei Territory should extend as far as Marudu Bay. All the old errors in nomenclature which have long been corrected appear afresh. Considering Mr. Wallace's local knowledge, it is surprising that he should have inserted a map of Borneo which is quite the most inaccurate as regards the physical geography of the island of any that have come under my notice.

3. In the summary of the mammalian fauna of the Philippines (p. 272) only three species of insectivora are enumerated, the two quite distinct species of *Tupaia* inhabiting Palawan and Mindanao respectively being unnoticed. Speaking of the avifauna (p. 273), Mr. Wallace mentions the absence of pheasants as one of its negative characteristics—but he includes the Palawan group in the Philippines, and this group has *Polyplectron*. Mr. Wallace also states that there are deer in Palawan. It would be interesting to know on what authority this statement is made, for I believe that Dr. Steere and myself are the only naturalists who have visited Palawan, and to myself both Spaniards and natives strenuously denied that any kind of deer existed on the island. With regard to the observation that the Malayan indigenes have more or less frizzled hair (p. 293), I may remark that the only tribe with which I came in contact—the Tagbenũa of Port Royalist—were straight-haired. I inquired about a Negrito race, but could hear nothing of any in that part of Palawan. The Spanish capital of Palawan and residence of the Governor is Puerto Princesa (Port Royalist of our charts), not the older settlement of Taitay (p. 274).

4. Tibang Mountain in Borneo (p. 349) is by common report of the natives the source of the Rejang, Kapuas, Banjar-Masin, and Koti rivers. It is said to have a *white* summit. The rhinoceros (p. 354) is by no means confined to the head of the Koti river. It is quite common on the east coast of Borneo, in the Kinabatañgan valley especially, and is found also in the upper waters of the Kapuas and Rejang. Wild cattle can hardly be said to be confined to the northern part of the island. They abound in the Upper Rejang, are found on the shore near Bintulu, and have been seen as far west as Batang Lupar. There are possibly two species. They are certainly *not* the descendants of Spanish cattle, though these exist, and they may have interbred locally. At p. 356 Mr. Wallace writes: "The Dusun or Idãan tribes—the Kanowits and Pakatans—correspond to the Land-Dyaks of Sarawak, while the Milanows correspond to the Sea-Dyaks." This is a most extraordinary statement. Dusuns, Kanowits, and Land-Dyaks may correspond to one another—though this has yet to be demonstrated—but there are as radical differences in language, customs, and physical characters between Milanows and Sea-Dyaks as between any two tribes in North-west Borneo. Pakatan, by the way, should be written Bakatan (*bukit*, a hill).

5. I add a few notes on the Appendix. The Balow Dyaks (p. 629) people the Lower Batang, Lupar, and Liñgga rivers. There are only a few immigrants in Simunjon. The Sea-Dyaks of Borneo (p. 634) are clearly distinct from the Kayan tribes, as much so as they are from Milanows, who are related to the Kayans. The Sea-Dyaks have within the last thirty years become the dominant race of North-west Borneo, but the Kayan tribes seem to be decaying. The correct spelling of Ilanun (p. 637) is, I believe, Irãnun (cf. Maludu = Marudu). It is worthy of note (p. 638) that the indigenes of Basilan style themselves Jakuns. The Idãan (p. 647) inhabit the vicinity of Kina Balu, but the Muruts the Padas and Limbang rivers, with intervening districts inland.

A. HART EVERETT

Papan, North Borneo

Nicholson's Palæontology, 2nd Edition, 1879

MAY I ask the favour of your inserting in NATURE the following remarks on the second edition of Prof. Nicholson's "Manual of Palæontology," which has but lately reached us in India.

First of all, I desire to express my sense of the obligations which are undoubtedly due by all palæontologists to Prof. Nicholson for the amount of labour which he must have expended in bringing together such an amount of facts as are contained in the work before us. Such a labour can be only fully appreciated by those who have experienced the difficulty of keeping pace with the discoveries even in one branch of the subject.

In a work like the "Manual" there must, almost inevitably, be many sins of omission, and some of commission, and it is accordingly with a full sense of the difficulties of Prof. Nicholson's task before me that I venture to point out certain errors and omissions in the part devoted to the palæontology of the vertebrata, and more especially in regard to India.

In his preface Prof. Nicholson observes that the greater part of the work was written in the early part of the year 1878, and consequently that his readers must not expect to find notices of discoveries made after that date. No one can, of course, take exception to that statement, but there are to be found in the text numerous omissions not covered by this saving clause, as will be seen from the following instances:—

The first point I have to notice is in relation to the Siwalik rocks of India. It was surely due to Prof. Nicholson's readers to know that those who had most recently studied the newer tertiaries of India were of opinion that the Siwaliks are in great part of pliocene, and the Narbuda rocks of pleistocene, age. Whenever Prof. Nicholson alludes to the latter, they are termed pliocene, while the former, except in two places, are termed upper miocene. I may add that these newer views as to the age of the rocks in question were published in India as far back as 1876.

Again, whenever any reference is made to the Siwalik fauna, no notice is taken of any of the additions made to it since Falconer's time, though many of them were published before 1878.

The succeeding remarks bear reference to some of the more striking of the omissions and errors occurring in the part of the work under consideration (vol. ii.).

P. 136.—When treating of the *Lepitosteids* no mention is made of the occurrence of several genera of this group in the Gondwána rocks of India, and of their being possibly older than their European representatives.

P. 169.—It would surely have been well to have made mention of the occurrence of three species of *Ceratodus* in the probably triassic rocks of India.

P. 209.—The Indian genus *Parasuchus* (as yet undescribed) ought to have been referred to, when mentioning the division Parasuchia, of which it is the type.

P. 222.—We find the sentence, "*Dicynodon* and *Oudenodon* are known only from strata of supposed triassic age in India and South Africa." The inference from the above would be that both genera occur in India, whereas the former only has been found there.

P. 256.—"In the miocene and pliocene tertiary we have no remains of *Cursores* to notice." *Struthio asiaticus* of Milne Edwards is ignored.

P. 300.—No mention is made of any fossil species of *Manis*, though one was described from India in 1876.

P. 324.—We again meet with the old statement as to the "hexaprotodont" character of *Rhinoceros sivalensis*, although it was shown in 1876 that there was no ground on which such statement could be supported.

P. 346.—No mention is made of the Siwalik species of *Sus*, nor of the peculiar Siwalik genus *Hippohyus*. The well-known and widely-distributed genus *Listriodon* is not mentioned in the book. The very peculiar genus *Tetraconodon* (described in 1876) is also omitted.

P. 348.—The genus *Anthracotherium* is stated to be exclusively European, no mention being made of the Indian species described in the "Records of the Geological Survey of India" for May, 1877.

P. 349.—*Hyopotamus* is stated to occur only in the eocene and lower miocene; the Sind species, described in the above-quoted paper, being unnoticed.

Pp. 379–80.—The dentition of the elephant seems to be a source of stumbling to Prof. Nicholson. He observes: "The first three teeth of the grinder series, which would ordinarily represent premolars, are supposed to be milk-molars, as they have no predecessors or successors." If any inference could be drawn from the above, it would be that the teeth in question were true molars; it is on quite different grounds that these teeth are classed as milk-molars. In the next sentence we find: "None of the molars, in fact, undergo vertical displacement," and immediately afterwards it is stated that premolars occur in

Elephas planifrons. In that species the premolars do vertically displace the milk-molars, as is shown in the "Fauna Antiqua Sivalensis."

P. 389.—*Dinotherium* is not mentioned as occurring in India, and *D. giganteum* is said to be the only species. Two species were named by Falconer in India!

P. 395.—We read: "The earliest remains of *Melidæ* are from the upper miocene deposits of the Siwalik Hills in India, in which we meet with the living genus *Mellivora* (comprising the Honey-Badgers), and the allied but extinct *Ursitaxus.*" *Ursitaxus* is not an extinct genus, but the generic synonym given by Hodgson for *Mellivora indica!* There is only one species of *Melidæ* from the Siwaliks, *Mellivora* (*Ursitaxus*) *sivalensis.*

P. 396.—*Ictitherium* is mentioned as occurring only in Attica, no notice being taken of the Indian species described in our Records for February, 1877.

P. 402.—*Pseudælurus* is only mentioned from Europe and America, the Siwalik species described in our Records for May, 1877, being ignored.

Other instances of omission occur in the book, which might be noticed here, but sufficient have been quoted to show that as regards Indian vertebrate palæontology, even up to the beginning of 1878, the work is not trustworthy. It is to be presumed that a writer would not willingly disfigure his own work, yet what can be said of a compiler who, in writing on Indian palæontology, omits to refer to the publications of the Geological Survey of that country. RICHARD LYDEKKER

Indian Museum, Calcutta, February 3

The Mean Free Path of Molecules

MR. CROOKES estimates that a bulb 5¼ inches diameter, attenuated 1,000,000-fold, would contain a trillion of molecules.

Assuming in round numbers such a space to contain 100 cubic inches, there would be 10,000 billions per cubic inch.

The molecules, considered as mathematical points, would have a mean distance apart of less than ·000005 inches.

The cube of 200,000 gives 8,000 billions instead of 10,000; therefore a linear inch would contain more than 200,000 in any direction.

How then can the mean free path of actual molecules be considered as from 2 to 6 inches? S. E. P.

The Zoological Station, or Aquarium, at Naples

WHEN, last week, you referred to the account in the *Daily News* of the above-named institution, you omitted what you probably did not know, which is, that, as you will see by the accompanying copy of a letter from Dr. Anton Dohrn to Dr. W. B. Carpenter, it was I who devised all the *aquarium* portions of the place, and that my ideas were carried out by the engineers, Messrs. Leete, Edwards, and Norman. But I had nothing to do with the *laboratory* part of the establishment.

We are now so accustomed to aquaria, as being useful adjuncts to biological studies, that it may surprise many persons to be informed that in the earliest published official notice of the Crystal Palace, Sydenham, a now very rare duodecimo of thirty-five pages, dated September 22, 1852, it is stated on pages 22 and 23 that, owing to the difficulty, amounting to what seemed to be impossibility, of exhibiting living marine animals inland, in sea-water, they, the fish, crustacea, mollusca, zoophytes, &c., would be shown dead, but, "*on a plan not hitherto tried, that of making them appear to be swimming in very large glass vessels containing a sufficient quantity of some preservative fluid having the appearance of water.*"

Something of this kind was attempted by Dr. Bowerbank, but it was not till the year 1870, after applying for fifteen years, that I, assisted by the same engineers, was permitted to arrange the aquarium now existing there, and which possesses the same sea-water, never since renewed, nor has it been changed in marine aquaria, which I set up in Paris in 1860 and Hamburg in 1862.

It is a pity that no one in Britain seems inclined to work our British aquatic animals, marine and fresh-water, as Dohrn exhibits and studies those of the Mediterranean and the rivers adjoining it; and British creatures of the same range of organisation, viz., sponges to fishes, are quite as interesting and almost as brilliant as those of the South of Europe.

We can, with modern appliances, possess these forms of life in perfect health, even inland, especially as recent improvements in manufacturing artificial sea-water causes it to be quite as good and as lasting as water from the sea. In Berlin and Hanover it has been so used for years on a large scale. In a small way it was employed long ago by Warington, Gosse, and by myself, and now, in the February, 1880, number of the *Midland Naturalist*, can be seen how wonderfully successful Mr. H. W. Jones has been with it in a great aquarium, in conjunction with me, in a place where water brought from the ocean would have cost more than six times as much. W. A. LLOYD

4, Zingari Terrace, Gipsy Road, Lower Norwood, April 6

Ice Crystals and Filaments

SOMETHING very like the "comb-like masses of ice" appears upon the surfaces of plaster-models such as dentists make, after they have been coated with a preparation called *Liquid Silex*; except that it is finer and *woolly*. It seems to be caused by the contraction of the models forcing out very fine jets of water or watery vapour, which dissolves the coating and spins it out until dried and fixed in the shape we find it. The varnish is readily soluble in water. S. T. BARRETT

Port Jervis, New York, U.S., March 20

Ozone

WILL you please allow me to make a suggestion concerning an additional element of observation at climatological stations? I refer to the observing of ozone. As the salubrity of a district to a great extent depends on this powerful factor, would it not be well to include ozone in climatological observations, especially in the case of hill and valley stations? The tests would, I think, at least enable *some* conclusions to be drawn as to the *purity* and *salubrity* of the atmosphere at the different health resorts, and in my opinion *present means*, even though imperfect, *should on no account be neglected* until better are found. They might be exposed on a hook in Stevenson's thermometer screen, as recommended by Mr. Buchan; but I find that this plan is only of service during dry weather, and I think Clarke's ozone cage is preferable. CLEMENT L. WRAGGE

Farley, near Oakamoor, Cheadle

Meteors

ON the night of April 4, between 10.5 and 10.25 p.m., I observed the following four meteors, viz.:—

1. Crossing the "Chair of Cassiopœia," at an angle of 45° with the horizon, from the direction of *Ursa Minor.* Course about 20°, time about 2 seconds, leaving a train.

2. From 10° east of *Capella* to 10° below *Regulus*, nearly parallel with the horizon, passing below *Castor* and *Pollux* and above *Procyon.* Course about 80°, time about 5 seconds, leaving a train, and breaking up into several fragments before its final disappearance, the fragments travelling one behind the other in the same direction. I have never before seen a meteor of this kind with so long a course.

3. From 10° west of *Castor* and *Pollux*, to 5° west of them, leaving a train. The trains of these three meteors were all of the same bluish white colour. Their radiant points would probably be somewhere between *Ursa Minor* and *Cassiopœia.*

4. In exactly the contrary direction, just above *Castor* and *Pollux.* Course about 5°, leaving no train, or a very faint one.

Birstal Hill, Leicester F. T. MOTT

THE meteor described by your correspondent "B. W. S." was also observed by me at Bristol traversing a long path of 59° from 247° + 42 to 200° ± 0°. It was brighter than Jupiter, and travelled very slowly, the estimated duration being 7 or 8 seconds. The nucleus cast off a tail of sparks as it went along, and varied very perceptibly in brightness. At mid-course it seemed near extinction, but suddenly revived to its previous brilliancy, which was then sustained until near the end point.

A comparison of the meteor's track, as recorded at the two places, shows it to have been directed from a radiant near ψ Cygni (at 297° + 52°), and it is important to know whether any observations were made at additional places. The long duration of the meteor and its very conspicuous apparition in the evening sky must have brought it under the notice of a host of observers.

Ashley Down, Bristol, April 5 W. F. DENNING

Anchor-Ice

On looking over some old papers I find a few notes on a rather curious instance of the mode of formation of anchor-ice which was accidentally brought to my notice.

When at Repulse Bay on the Arctic Circle many years ago, I went out one morning in the latter part of September to shoot deer, and on my way forded a stream of no great size, dry shod, having on Eskimo waterproof boots, the water being little more than a foot deep. The parts of this small river which had a slow current were already covered with ice, but not strong enough to bear my weight. For so early a date the day became extremely cold, and on my way home, after an absence of about eight hours, I was surprised to find, when recrossing the stream, that the water came high over my knees, filling my boots.

On examination I discovered that this rise of water was produced by an accumulation of *frozen water* fully eight or nine inches deep, adhering to the stones at the bottom of the rapid, all of which must have been formed, since the morning, at the rate of not less than one inch in the hour. The foot sank readily into this "slushy" formation, a lump of which rose buoyantly to the surface at each step.

Unfortunately I could not wait to study the process of construction as it was getting "dusk," and my wet clothes—which had to be cut off when I got to my fireless tent—began speedily to freeze.

I have seen "anchor-ice" in rivers many times, and believe that two or three conditions are requisite for its formation, namely:—

1. A rocky or stony bottom.
2. Shallow water as compared with that higher up the stream.
3. A swifter current and rougher water in comparison with a smooth and slower motion immediately above.

All these conditions existed in the present case.

The ford was a rapid, and as I have already mentioned, shallow, whilst immediately above there was a pool of nearly still water, three or four times as deep, which was ice-covered to within a few yards of the ford. On the surface of this almost still water, close to the rapid, where it was yet unfrozen, numerous small crystals of ice were forming and floating, indicating that the water was at—perhaps colder than—the freezing point.

When these ice-crystals and surface cold water get into the turmoil of the rapid, they are brought into contact with the rocks and stones at the bottom, which are thus cooled down to the freezing point, and become convenient nuclei for ice-formation.[1]

Supposed anchor-ice is often found at the bottoms of shallow lakes and ponds, and also in the quieter pools of rivers; but this, as far as my experience goes, is not true anchor-ice, but is formed in the usual manner, beginning at the surface and increasing in thickness *downwards* until it reaches the bottom, to which it freezes firmly and remains attached during the spring and early part of summer—perhaps longer—with two, three, or more feet depth of water over it, as it slowly thaws.

The manner in which anchor-ice is formed may be well known; if so, the fact that no satisfactory description of the process has come under my notice is the only apology I have to offer for troubling you with this communication. J. Rae

4, Addison Gardens, Kensington, W., March 25

[1] The way in which masses of ice, yards in extent, which have been floating on the surface in the smoother and slower current of a river, disappear when they enter a rapid and remain under water for some time, may be noticed in any country where the winters are cold enough, at the breaking up of rivers in the spring.

Diatoms in the London Clay

I regret to find that there are some beautifully mounted slides in circulation in London that have been sold, and are labelled as diatoms from the London clay, which are not what they purport to be. To prevent further disappointment to microscopists, will you allow me to say that arrangements have been made for slides of the London clay diatoms to be procurable shortly at any of the usual places? Due notice will be given by advertisement in this paper, when and by whom slides can be supplied to the trade. W. H. Shrubsole

Sheerness-on-Sea

Carnivorous Wasps

In Nature, vol. xxi. p. 417, there is the statement that common wasps are carnivorous. I can prove this fact also by my own experience. I observed, one summer, in a country house, where wasps were shut in a room, that from lack of their usual food, and probably forced by hunger, they caught flies and devoured them. I saw several times wasps with a fly between their mandibles creeping on the window-glass, or eating them. Generally the wings and the head of the flies were mangled. I was one day so happy as to see a wasp catch a fly on the window, and observed how cleanly it picked the wings of the fly in order to hinder its flying away, and after having done so, how the wasp ate the head. I saw also some wasps quite prostrate and dying of hunger at last. I think that this fact could easily be verified by experiments. Lewis Bod

Hungary, Stuhlweissenburg, March 20

TWO ENTOMOLOGISTS

The brief notices that appeared in the *Times* and in our last number of the death of two of the most prominent Continental entomologists, were scarcely sufficient, and we therefore give a slightly more extended account of the lives and labours of both.

Ernest August Helmuth von Kiesenwetter, born in 1820, was a member of the Saxon Privy Council, and was highly esteemed in his native country. Although only sixty years old at the time of his death, his first recorded published paper dates so long back as 1842. He was one of the most accomplished and conscientious German entomologists, and one of the hardest workers—a considerable traveller, so far as entomological journeys in different parts of Europe are concerned, a close observer, and a man above suspicion as to the nature of his work. Though chiefly a coleopterist, he attended more or less to all orders of insects, but limited his studies principally to the European fauna. The greater part of his memoirs appeared in the *Stettiner entomologische Zeitung* and the *Berliner entomologische Zeitschrift*, and the list is very long. But his principal work is undoubtedly concentrated in the part he took in the "Naturgeschichte der Insecten Deutschlands," commenced by Erichson, and completed so far as the greater portion of the Coleoptera are concerned. How far Kiesenwetter's decease may render even this portion incomplete, and prevent the realisation of the original scheme, we know not. It was a grand idea with an unfortunate title. Few works on systematic entomology have rendered so much service to workers occupied on those groups already attended to, and it will remain a monument to the industry of all concerned. Its title has brought upon it the reproach of being a natural history in which there is no natural history, a severe criticism which a little forethought on the part of the originator should have avoided. Kiesenwetter had to assist in carrying out a set programme. He did his part of it well and faithfully, and his other writings prove that the biological side of the question was always prominently before him.

In S. C. Snellen van Vollenhoven Holland has lost its Westwood. He was born in Rotterdam on October 18, 1816, and not even his intimate correspondents here knew of anything likely to cut short the career of so prominent a man. Attached for many years to the Natural History Museum at Leyden as Director, he retired from that position a year or two ago, and so much was he respected that a medal was struck in his honour upon that occasion. Van Vollenhoven was a naturalist in the fullest sense of the term. It has been said of him that his principal work was his "Faune entomologique des Indes Orientales," meaning thereby (principally) of the Dutch Indies. This work was sufficient to base a reputation upon, but it was, from a biological point of view, not the most important. He occupied himself especially with the insects of Holland, and it is for the works he produced upon them that his memory will be everlastingly respected by Dutchmen, and by all other entomologists who think there is yet much to be done in working out the fauna of Europe. Indeed we fancy the exotic work was forced upon him by the necessity of his position, rather than done *con amore*.

He published a fine volume on the "Hemiptera-Heteroptera of Holland," finally in a separate form, but originally in the pages of the *Tijdschrift voor Entomologie*, the *Transactions* of the Dutch Entomological Society, of which he was the leading spirit. Through the same medium he offered a series of biological memoirs on the Dutch Saw-flies, probably unparalleled for completeness. He continued Sepp's "Beschrijvingen en Afbeeldingen van Nederlandsche Vlinders," which remains without an equal. And in the latter decade of his life he produced a remarkable work (now incomplete) on the Ichneumonidæ of North-Western Europe, under the title of "Pinacographia." No man was more universally esteemed when living; no man will be more thoroughly missed amongst entomologists. For Holland his loss appears to be irreparable.

In concluding this notice it should be remarked that all Van Vollenhoven's own works (and those of some other Dutch entomologists) were illustrated by beautiful and faithful drawings from his own pencil.

A LEAF FROM THE HISTORY OF SWEDISH NATURAL SCIENCE [1]

II.

SCHEELE was born at Stralsund on the 9th December, 1742, the fifth in order of a numerous family. His father was a merchant of limited means who did not intend to give a *learned* education to his son Carl Wilhelm, who besides, like Linnæus and Berzelius, is said in his youth to have shown so little disposition for the common classical school studies that he was in danger of being considered the stupidest among his fellows. The Stralsund gymnasium accordingly was soon exchanged for the post of pupil to the apothecary Bauch at Gothenburg. Here Scheele was not kept very long at servile drudgery and mechanical hand labour; his attention to his duties and industrious reading of approved chemical authors soon gained him a place in the laboratory itself, where he not only distinguished himself by steady application and special skill in the accurate making-up of the preparations which belonged to the establishment, but also experimented in the silence of the night in order to satisfy his curiosity. He had now come to the right school bench, and with an experience led astray by no learned theories for his teacher, he laid the foundation of the chemical views and of that skill in chemical manipulation which were to gain for him so famous a name in the history of the natural sciences.

After the close of his six years' apprenticeship Scheele remained three years more at Gothenburg, after which he was employed in an apothecary's shop at Malmoe. From Malmoe he removed three years after, in 1768, to Stockholm. According to Wilcke's statement Scheele had by this time made several important discoveries, without however having succeeded in obtaining any direct acknowledgment of the accounts of the experiments relating to them which he had communicated to the Swedish Academy of Sciences. He was not, besides, satisfied with the employment he had obtained in the capital at the apothecary's shop, "Korpen," because he had nothing to do with the laboratory work proper. He therefore removed in 1770 to Upsala, attracted by the famous name of Bergman, to undertake the charge of the laboratory at one of the large apothecary's establishments there.

During his stay in Stockholm Scheele had given in to the Academy of Sciences several chemical papers which, after having been submitted to Bergman, were not printed, and it is even supposed that the learned professorof Upsala did not think it worth his while to read the productions of the young apothecary. At first, therefore, a certain coldness is said to have prevailed between these two men, of whom one was, and the other was soon to be, recognised as one of the greatest scientific geniuses of the century. An accident however soon brought them together, and the coolness gave place to a mutual friendship and admiration, of which the writings of both, and numerous letters from Scheele to Bergman, preserved in the Library at Upsala, bear witness. These pleasant relations exerted a great and fruitful influence on the scientific activity of both. The sharp-sighted experimenter and discoverer, Scheele, required the support of Bergman's regard and comprehensive learning in order to win recognition, and Bergman's organising genius was brought by Scheele's discoveries in contact with new fields of research before untouched by any man of science.

While residing at Upsala Scheele published (1770-75) some of his most important researches, for instance, on fluor spar, on black oxide of manganese, on arsenious acid, on the composition of the air, &c., and thus gained for himself almost at once a great reputation, not only in Sweden, but also in foreign countries. He was soon after chosen a member of the Swedish Academy of Sciences, in whose circle he took his place on an equal footing with the first men of the realm. From this time the young chemist was honoured by this scientific association in a way that always will form one of its fairest memories, and which under similar circumstances could scarcely have happened to him so early in any other country,—a circumstance which shows that no credit is to be given to the story which has been repeated in several of the sketches of his life, that Scheele was so little known to the leading scientific men of Sweden that a distinction intended for him by Gustavus III. was by mistake conferred upon another person of the same name. On the other hand it may have been true, and if so, it showed the little interest that Gustavus III. and his court entertained for Swedish natural research, that the King of Sweden on the 21st March, 1784, while present at a meeting of the Turin Academy of Sciences, for the first time heard the name mentioned of the only person with a truly world-historical name who then lived in Sweden. Little also does he appear to have suspected that in his own capital there was an Academy which, in respect of the influence it exerted on the progress of natural research, occupied a position quite equal to that of any other academy whatever.

From 1777 Scheele obtained from the Academy an annual grant of 100 rixdollars specie (about 40 guineas), to assist him in carrying on his chemical researches. He was present however at the meetings of the Academy only once, on the 29th October, 1777, when on his admission he read a paper "On a method of preparing *Mercurius dulcis* in the wet way." The day before he had undergone the apothecary's examination at the Medical College, and after taking the oath obtained an open commission empowering him, on the invitation of the magistrates, to be apothecary in the town of Köping.

For the longing for an independent sphere of activity had led Scheele in the autumn of 1775 to leave Upsala and remove to Köping, in order as dispenser to take charge of the apothecary's shop there, which belonged to a young childless widow of the former owner. From this time Scheele's life flowed calmly on in this town, uninterrupted by any remarkable occurrences, if we except a passing cloud caused by a buyer presenting himself with an offer to purchase the apothecary's shop of which Scheele had charge. This gave occasion to numerous proofs of friendship and regard for him. Gahn proposed that he should remove to his house; Bergman offered him a place at his table till some other suitable employment should turn up. Linnæus, Wargentin, Bäck, Schultzenheim, Alströmer, and the brothers Bergius offered him an apothecary's shop with a suitable laboratory and several advantages at Alingsos. Others wished to instal him as *Chemicus regius* in the capital and make him director of a new distillery. On D'Alembert's proposal

[1] Translated from a paper by Prof. A. E. Nordenskjöld of Stockholm. Continued from p. 521.

he had been invited to Berlin and promised a salary of 1,200 rixdollars specie, and attempts were made to induce him to go to England by a promise of £300 a year, which foreign offers Scheele however declined, with the saying which indicates his modest requirements as to his mode of life, "I cannot do more than eat my meat; if I can do that at Köping, I need not seek it elsewhere." He was soon freed from the trouble of choosing, by the townsmen of Köping and the gentry of the neighbourhood declaring that the town would not have any one else than Scheele as apothecary, and offering in case of need to obtain privileges and build a new apothecary's shop for him. The matter was thus settled to Scheele's advantage. He was allowed to retain his place as manager of the apothecary's shop at Köping till his death, which happened on the 21st May, 1786, after some months' illness, probably brought on by constant work in cold laboratories with substances poisonous and injurious to health. Three days before his death he married the widow of the former apothecary, Fru Sonneman.

In the town house at Köping is preserved the inventory taken at the death of the great departed chemist.[1] It gives us indeed an insight into the modest circumstances in which he lived, but it indicates economy and the possesion of some means, and shows that the glory of poverty, with which some biographers have sought to surround Scheele's memory, by no means corresponds with the actual facts. As indicating the scantiness of the literary assistance within Scheele's reach, it deserves to be noted that at his death, after a stay of more than ten years at Köping, he only possessed a collection of books consisting of twelve works on medicine and chemistry, with several other Swedish, German, and French books, valued at 6 spec. (26*s*.)

Scheele was described as a man of moderate height and of a powerful frame. His modest manners and his genuine worth speedily won for him the friendship and affection of all with whom he came in contact. He appears to have prospered most at Köping, whose inhabitants entertained for him great regard, mingled with admiration at the experiments and researches, to which he devoted all the time he could spare. The memory of the distinguished man is still preserved in the town. There they tell you that the stone lion, which forms the sign of the apothecary's shop, had been gilt by Scheele so well as never to require renewal, that Scheele made a vane to the steeple, a sun, with rays pointing in many directions, which protects it from lightning without any lightning conductor; that Scheele tried to make gold, and with that end in view worked much with Spanish green, which brought about his death, &c.[2]

When Scheele died he had not completed his forty-fourth year. A great part, perhaps the greater part, of his short life-path had been constantly occupied with earning a living, and for a complete exhibition of the influence he exerted it would not be enough to go leaf by leaf through the field of chemical research. We must also take note of the development of chemical physiology, of pharmacy, and above all of the whole of the industrial arts of recent origin, for on all these branches of human knowledge his genius has impressed an ineffaceable stamp. Here we can only give a short sketch of his most important discoveries.

Scheele's first work of which we have any knowledge, "Chemical Experiments with Sal Acetosellæ," was given in to the Swedish Academy on the 17th of August, 1768. It was read to the Academy, but not printed. Two years after we find for the first time Scheele's name in the *Transactions* of the Academy, in a paper by Anders Johan Retzius, in which he states that Scheele, a *Pharmacie Studiosus*, of good abilities and eager to learn, had succeeded in producing from tartar, by means of chalk and sulphuric acid, a clear and pure acid. To judge by the title and some remarks of Gahn's, it appears that the first-named work contained a fundamental discovery in organic chemistry, viz. that of oxalic acid. The discovery of tartaric acid formed a further important step forward within the same branch of knowledge, and was besides of epoch-making significance through the new method which Scheele here for the first time employed in producing the acid. The same method is still used in similar operations, and in Scheele's skilful hand formed the means by which he separated and ascertained the properties of a number of other organic acids occurring in animal and vegetable juices, as citric, malic, and lactic acids, all substances before unknown, or of whose true nature the knowledge was very obscure and erroneous. By other experiments and researches, which were always simple and went straight to the mark, Scheele enriched the chemistry of animals and plants with the discoveries of uric acid, gallic acid, and glycerine. It lies beyond the scope of this paper to give an account of the great importance of these discoveries, not only for theoretical chemistry, for medicine, and animal and vegetable physiology, but also in a purely technical point of view. Only as an instance, we give here some notes of the technical history of glycerine.

While engaged in some pharmaceutical work, Scheele found that by heating oils and animal fats with oxide of lead it is possible to extract from them an uncrystallisable substance with a sweet taste, which, like common sugar, when treated with nitric acid yields oxalic acid. On this account he named the new substance oil-sugar—a name afterwards changed to glycerine. As usual Scheele carefully ascertained the chemical properties of the new substance, yet without carrying out the research by investigating the nature of the ingredient of the fatty matter which combines with the oxide of lead. This was not done till about thirty years afterwards, when Scheele's research was resumed by Chevreul, who, starting from Scheele's observations, after twelve years' hard work, cleared up the true nature of the animal fats and showed that they contain, along with glycerine, various fatty acids which with alkalies form soap, and one of which, under the name of *stearine*, has since been extensively used as light-yielding material. It is on this research that the modern soap industry and the manufacture of stearine candles, &c., are grounded. Glycerine, too long neglected as a useless by-product, has obtained a manifold practical application, not least in Sweden, where, as is well known, it now forms the raw material of one of our most important explosives, a main constituent of aseptine, &c.

By these researches in a field of investigation in which Scheele had scarcely any predecessor, he was the true founder of our chemical knowledge regarding the productions of organic nature, for the further development of which hundreds of professorships have been established, and which has long since become of incalculable importance for the intellectual progress and economical advantage of the human race. This field of inquiry he further enriched by the examination of a number of ethers, and above all by his "Research on the Colouring Matter of Berlin Blue." A brief historical sketch may perhaps here also be of interest.

In the beginning of the eighteenth century Diesbach, a German dyer, along with the alchemist Dippel,[1] accidentally discovered the beautiful blue colour which is known under the name of Berlin blue. The discovery, which supplied a

[1] The inventory shows:—Assets, gold and silver, 61 spec.; tin, 10 spec; glass and porcelain, 11 spec.; other movables, 187 spec.; apothecary's shop, 667 spec.; goods in apothecary's shop, 175 spec.; real property, 500 spec.; open accounts, 100 spec.: total 1,711 spec. (about 376*l*.). Against this sum there are indeed debts amounting to 630 spec., but if proper attention be given to the economical state of Sweden at that time, Scheele must have been considered by his contemporaries a man in comfortable circumstances.

[2] A story which probably originated from the manufacture of a large quantity of "Scheele's green."

[1] German alchemist and mystic, died 1734.

long-felt want of a good and cheap blue colouring matter, was at first kept secret, till the process of preparation was published in a paper in the *Philosophical Transactions*, 1724, by Woodward. Afterwards a number of chemists attempted to ascertain the true nature of the colouring matter, but without any further success than that improvements were made in the process of preparation, and some new substances were discovered, into the composition of which the colouring principle entered as a constituent—among which as the most important may be named the yellow prussiate of potash discovered by Macquer in 1752. In 1772 Sage still believed that phosphoric acid entered as a constituent into the composition of prussiate of potash, and in 1786 Westrumb declared the colouring matter to consist of a volatile phosphor-soap. Two short papers by Scheele, together occupying not more that twenty-two pages of the *Transactions* of the Swedish Academy of Sciences for 1782 and 1783, at last brought clearness into this confusion. Scheele showed that the origin of the colouring power was a peculiar volatile acid (blue acid), whose properties he accurately ascertained, and of which he produced many new and important compounds. Scheele, besides, showed that the acid contained carbon and nitrogen, and that when subjected to combustion it gives off carbonic acid, and to dry distillation ammoniacal salts among others. On the other hand, Scheele is thought not to have suspected that the substance which, without any special precautions, he produced in considerable quantity, smelled and tasted, forms one of the most powerful poisons with which we are acquainted. The work thus begun by Scheele was carried on by later chemists (Porret, Gay-Lussac, Berzelius, Faraday, Gmelin, Wöhler, Liebig, &c.), and it is perhaps not too much to say that the accurate knowledge we have thus obtained of the nature of the compounds of cyanogen has exerted an influence on the development of chemistry only inferior in importance to that of the discovery of oxygen and chlorine.

We find the first printed work of Scheele in the *Transactions* of the Swedish Academy of Sciences for 1771. It bears the title, "On Fluor Spar and its Acid." Among the treasures which Pompey brought with him to Rome after his victory over Mithridates are enumerated goblets and cups of a beautifully-coloured fragile mineral, which, from the town at the plundering of which they were first obtained, were named *Vasa myrrhina*. They soon became fashionable, and Pliny and other writers speak of the fabulous sums that were paid and the bloody deeds that were done in order to obtain them. Among all the different objects belonging to Ancient Rome preserved in our museums, there is not, remarkably enough, a single fragment of these vessels so renowned in the history of luxury; but it has been guessed that they were made of a mineral which is now called fluor spar, and is still occasionally used for vases and cups. In mineralogical literature proper this mineral is first mentioned by the Saxon Agricola, who speaks of its use as a flux in the smelting of metals, and warns against mistaking this beautifully-coloured, but brittle and by no means hard mineral for a precious stone. Somewhat more than a century afterwards the art of etching on glass by means of this mineral was discovered at Nürnberg, and about the same time Elsholz, a Berlin physician who employed himself in the examination of phosphorescent substances, discovered that fluor spar became self-luminous when heated. All substances that are self-luminous without sensible combustion attracted at that period immense attention—certainly a survival from the alchemists' dreams about the philosopher's stone, which, among its other perfections, was also to have that of being self-luminous. The mineral, in consequence of its property of being a "light-bearer," now became the object of repeated but rather resultless examinations, until Scheele, by some simple experiments both analytic and synthetic, showed that the mysterious substance consisted of "lime saturated with a peculiar acid." This acid attacks glass and dissolves with ease siliceous substances. Scheele at first employed glass-vessels in producing it, which gave occasion to erroneous statements. The mistakes were immediately acknowledged and corrected when Scheele's attention was drawn to them by the apothecary Meyer of Stettin. Unwarranted objections, for instance by the Frenchman Boulanger, who declared that fluoric acid was nothing else than muriatic acid combined with some earth, and by Monnet, who believed that fluoric acid was only vitriolic acid "volatilised by means of a singular combination with fluor spar," were on the other hand refuted by new experiments in a paper printed in the *Transactions* of the Swedish Academy of Sciences for 1780. Scheele's examination of fluor spar had as its direct result the discovery of the simple substance *fluorine*, which without doubt, through its general occurrence in nature, and its properties differing from those of all other simple substances, is destined to play a very important part in the development of chemistry, although our knowledge of it is yet very incomplete from the impossibility of procuring vessels capable of resisting its corroding action.

(*To be continued.*)

ON THE LONG PERIOD INEQUALITY IN RAINFALL[1]

1. IF it be true that there is a variation in the power of the sun depending on the state of his surface, this variation might naturally be expected to make itself apparent through a corresponding change in the rainfall of the earth, so that when the sun is most powerful there ought to be the greatest rainfall.

2. While the connection indicated above is that which most readily occurs to the mind, yet the difficulty of ascertaining the facts of the case in a manner bearing the smallest approach to completeness, is so great as to be at present insuperable.

There is, *first of all*, an intense reference to locality in rainfall, so that the rainfall at one place may differ greatly from that at another place in its near neighbourhood.

Again, there are, probably, in addition to possible secular inequalities, very great oscillations in the yearly rainfall at any one place, or accidental variations as we may term them, in our ignorance of their cause.

Thirdly, it is in comparatively few places, and those places chosen not with the smallest reference to this particular problem, that we have anything like a trustworthy account of the rainfall throughout a considerable number of years.

Fourthly, we have no information of any importance with respect to the rainfall at sea.

3. Besides the formidable catalogue of difficulties now mentioned, we ought to bear in mind the following considerations. The convection currents of the earth are regulated by two things, one of which is constant, while the other may be variable. The constant element is the velocity of rotation of the earth on its axis, while the element of possible variability is the power of the sun. Hence it follows that if the sun be variable it will cause a variation in the direction as well as in the intensity of the earth's convection-currents on the principle which tells us that the resultant of two forces, one constant and the other variable, must vary both in magnitude and direction.

Now if it be true that we have a long period variation, not merely of the intensity, but also of the distribution of the earth's convection-currents, and if we bear in mind the intensely local reference in rainfall, it would be too much to expect that the rainfall inequality should exhibit the same years of maximum and minimum at all places.

[1] By Balfour Stewart, LL.D., F.R.S., Professor of Natural Philosophy at the Owens College, Manchester. Being a paper read before the Lit. and Phil. Society of Manchester.

It is even conceivable that some places might exhibit a maximum when others showed a minimum, while others again might exhibit a double instead of a single period.

4. It appears to me that if we bear in mind these considerations, it will not answer to add together the rainfalls of a few selected stations as they stand, with the view of determining by this means whether there be a long-period inequality in the rainfall of the *whole earth*. We are not yet in a position to reply experimentally to this question.

It does not, however, follow that nothing can be done. Dr. Meldrum and others appear to have achieved good preliminary work in the direction of indicating the existence of a rainfall inequality depending upon the state of the sun. Dr. Meldrum began by pointing out that in a good many places there is a greater rainfall during years of maximum than during years of minimum sun-spots, and that this phenomenon repeats itself from one solar cycle to another. Again, Governor Rawson has pointed out the existence of certain localities where the rainfall inequality appears to be of a precisely opposite character, while Dr. Hunter has shown the practical importance of the investigation with reference to certain tropical stations. The subject has likewise been discussed by Piazzi Smyth, Stone, and others.

5. The question has arisen whether it might be possible to throw any light on this problem by the method of deducing unknown inequalities proposed by Mr. Dodgson and myself (see *Proceedings* of the Royal Society, May 29, 1879). The essence of this method consists in a way by which we may numerically estimate the indications of an equality. Let us suppose, for instance, that in ignorance of the diurnal range of temperature we try to find whether there be a temperature inequality of twenty-four hours, or whether there be not rather one of twenty-six hours. We should begin by taking a large number of hourly readings of temperature, and we should group these into two series, the one containing twenty-four numbers in each horizontal row, and the other twenty-six. We should thus have twenty-four vertical columns from the one series and twenty-six from the other, and we should take the mean of each vertical column of each series, as well as the mean of the whole. Now it would speedily be found that an inequality was indicated by the twenty-four hourly series, and none by the twenty-six hourly series. For in the first series the mean of that vertical column representing observations at 5 A.M. would be greatly less than the mean of the whole, while the mean of that column representing observations at 2 P.M. would be much higher than the mean of the whole. On the other hand, in the twenty-six hourly series, provided it were sufficiently extended, we should perceive no such differences. Thus, in the twenty-four hourly series the differences of the means of the various vertical columns from the mean of the whole would be much greater than in the twenty-six hourly series, and the mean amount of these differences might be taken to form a numerical criterion of the presence or absence of an inequality.

6. This method applied to the subject in hand might be expected to reveal the presence or absence of inequalities in rainfall, provided we have observations sufficient for the purpose. It is clear that the successful application of this method does not require a previous knowledge of the exact form of the inequality. Whether a maximum rainfall occur at epochs of maximum or at epochs of minimum sun-spot frequency, whether there be only one rainfall maximum corresponding to the solar period, or two, or even three, is a matter of no consequence as far as this method is concerned. All that is necessary is that the rainfall should always be similarly affected by similar states of the sun.

Here, however, we must bear in mind that this method of detecting inequalities by summing up and averaging the departures from the mean caused by the inequality, likewise sums up and averages the accidental fluctuations. Now these accidental fluctuations are particularly large for rainfall, and it is therefore desirable to lessen their disturbing effect as much as possible. This can only be done by confining ourselves to long series of observations in which the accidental fluctuations may be supposed to counteract each other to a great extent, while the long period fluctuations will remain behind.

7. Through the kindness of Mr. Whipple, Director of the Kew Observatory, I have received copies of those catalogues of rainfall which he has himself made use of in a paper which was recently communicated to the Royal Society (January 8, 1880). Of these Paris, Padua, England, and Milan form the most extensive series, that of Paris embracing 161 years, Padua, 154, England (Symons's table), 140, Milan, 115. Mr. Whipple has likewise furnished materials by which the labour of applying the process in hand to these series will be greatly abridged, and he has kindly allowed me to make use of these. I will therefore apply the process to these four stations.

8. Let us begin by grouping the Paris yearly values into series of 8. We thus obtain the following final numbers (in centimetres):—

51·4, 47·5, 45·7, 48·7, 51·1, 49·8, 46·5, 47·2,

the mean being 48·5. From this we obtain the following series of differences :—

$$+2·9 - 1·0 - 2·8 + 0·2 + 2·6 + 1·3 - 2·0 - 1·3.$$

In order to diminish the effect of accidental fluctuations, let us equalise this series of differences by taking the mean of each two. We thus obtain

$$+0·8 + 1·0 - 1·9 - 1·3 + 1·4 + 1·9 - 0·4 - 1·7.$$

If we now add these together, without respect of sign, and divide by their number (8), we obtain 1·3 as the mean departure from the mean of the whole, and bringing this departure into a proportional shape by dividing it by the mean rainfall, we obtain $\frac{1·30}{48·5} = 2·68$ per cent.

9. These explanations will enable the reader at once to perceive the principle of construction of the following table :—

Name of station.	Proportional rainfall inequality as exhibited by series of 8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.
English rainfall, Symons's catalogue	2·63	2·14	1·55	1·79	3·15	1·69	2·57
Paris ...	2·68	3·07	1·99	2·65	3·70	2·57	3·08
Padua ...	1·77	3·62	2·02	1·47	3·31	3·52	3·40
Milan ...	1·12	3·22	3·16	1·78	4·13	3·78	2·49

We ought to give the English, the Paris, and the Padua observations a somewhat higher weight than those of Milan, as the former embrace a longer period. This will be done sufficiently well by giving the first three sets weights of 3 each and the Milan set a weight of 2. If we perform this operation, and then take the mean of these stations, we obtain as under :—

	Proportional rainfall inequality as exhibited by series of 8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.
Mean of the four stations weighted as above	2·15	3·00	2·09	1·94	3·52	2·81	2·92

A maximum corresponding to nine years and a still greater one corresponding to twelve years is thus exhibited, each of these being recorded at three stations out of four.

The proportional numbers indicated are not large, but it must be remembered that it is the mean difference for all the years that is given, and that the maximum and minimum rainfall will represent differences above and below the mean which will each be about double of the numbers recorded above.

10. Regarding the rainfall values as representing the meteorological result of the sun's action, let us now compare these with declination range values, which may be taken to represent the sun's magnetic effect. Prof. Loomis has compiled (*American Journal of Science and Arts*, second series, vol. l. p. 153) what seems to be a very good table, exhibiting a set of yearly values of magnetic declination range, extending with slight breaks from 1777 to 1868.

Let us take this table, and treat it precisely as we have treated the rainfall, except that it does not seem necessary to make any attempt at equalisation, such as that made in Art. 8.

We thus obtain the following result:—

Name of station.	Proportional declination range inequality as exhibited by series of 8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.
Prague, or reduced to Prague	3·37	3·39	10·07	4·66	9·33	4·09	4·98

Here we have unmistakable maxima corresponding to ten and twelve years. The result is thus not unlike that which we have derived from rainfall observations; indeed we could hardly expect a more perfect correspondence between the two, bearing in mind the limited amount of observations which we have for determining inequalities of long periods.

DEEP-SEA DREDGING AND LIFE IN THE DEEP SEA[1]

As Dr. Carpenter explained in his lecture here some short time ago, four-elevenths, or nearly three-fourths of the surface of the earth is covered by sea. The average depth of the ocean is, according to the latest calculations of Mr. Otto Krummell, about 1,877 fathoms, or somewhat over two miles, very nearly the distance from the Royal Institution to the top of Primrose Hill. If we try and project Primrose Hill directly under our feet, keeping the distance the same, we shall form a conception of the mean depth of the sea. The greatest depth known to exist was discovered by the United States ship *Tuscarora* near the Kurile Islands, in the North-east Pacific. It is 4,655 fathoms, or about five miles and a quarter.

The highest mountain existing is of about the same height as the deepest sea is deep. Mount Everest is 4,833 fathoms in height. So insignificant, however, is the total volume of the land raised above sea-level in proportion to the vast cavity occupied by the sea, that were this cavity emptied of its water, the whole of the land now above sea-level could be shovelled into it twenty-two and a half times over before it would be filled up to the present sea-level.

Nevertheless the depth of the oceans, great as it is, is as nothing in comparison with the vastness of their extent of surface. As Mr. Croll has said, the oceans in relation to their superficial area are as shallow as a sheet of water 100 yards in diameter and only an inch in depth.

The sides of the ocean-basins are not at all steep. They are mostly so little inclined that an ordinary locomotive engine could run up them in a straight line with ease. Their inclination is usually not more than three or four degrees or less. Around some oceanic islands the slope is greater. The steepest slope known is, as Capt. Tizard informs me, at Bermuda, where there is an inclination of nearly twenty degrees from the edge of the reef to 2,000 fathoms. There are no such things as mountains and valleys on the deep-sea bottom. Animals cannot slip down against their will into the depths, but must move deliberately into them, and travel a long journey to reach them.

[1] Friday Evening Lecture delivered at the Royal Institution on March 5, by H. N. Moseley, F.R.S., Assistant Registrar of the University of London.

The pressure exerted by the superincumbent water at great depths is so great as to be almost beyond conception. It amounts roughly to a ton on the square inch for every 1,000 fathoms of depth, about 166 times as much as the pressure to which we are subjected at the present moment. At the greatest depths the pressure is about four tons and a half. Vast though this pressure is, it is, however, only about one-eighth of that which Prof. Abel and Capt. Noble have measured, as produced in their experiments on gunpowder. The deep-sea animals, being completely permeated by fluids, are probably no more conscious of pressure acting upon them than we, and, so long as they move slowly from one depth to another, are most likely unaffected by the consequent changes of pressure.

With regard to the temperature of the deep-sea water, the conditions which would affect animals are comparatively simple. Nearly all over the ocean the temperature at 500 fathoms is as low as 40° F., and this is the case even immediately under the equator in the Atlantic and Pacific Oceans. Below 2,000 fathoms the temperature is never more than a few degrees above freezing-point, excepting in the peculiar cases of land-locked seas, such as the Sulu Sea.

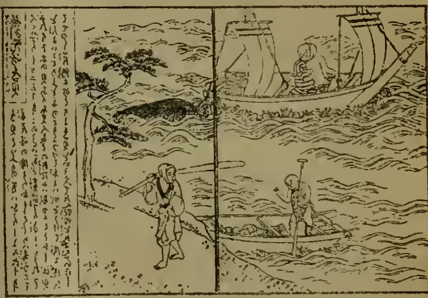


Fig. 1.—Japanese dredge in action.

At comparatively small depths in the sea it is almost certainly entirely dark so far as sunlight is concerned. Prof. Forel found that in the Lake of Geneva, even at a depth of only 30 fathoms, photographic paper was entirely unacted on after protracted exposure. We can hardly believe that the red, green, or yellow rays can penetrate sea-water much further than those to which ordinary photographic paper is sensitive. It may safely be assumed that sunlight is entirely absent at a depth of 200 fathoms, probably at a much less depth. We dredged blind crustacea at a depth of 120 fathoms, and a blind isopod is found in the Lake of Geneva at a depth of about 55 fathoms.

In depths of 500 fathoms almost everywhere, everywhere in over 1,000 fathoms, there must be an entire absence of any currents in the water. Any movement taking place in the water at that depth must be of a molecular nature only, excessively slow and quite imperceptible to animals.

Altogether the deep sea, cold, dark, and still, must b about the slowest place to live in that can be imagined.

I now turn to the consideration of deep-sea dredging.

The dredge is an ancient contrivance of fishermen of a very wide distribution. It is used in Japan, and the accompanying amusing figure (Fig. 1) is taken from a woodcut in a Japanese book on the principal land and marine food products of Japan. In it a fisherman is shown quietly smoking his pipe whilst his dredge tows astern catching bivalves (either a Cardium or a Pecten). For the sake of clearness the artist has represented the dredge as partly raised out of the water. On the margin is the description, which my friend, Mr. F. V. Dickins, has translated for me. The dredge is described as a basket net which is dragged from the stern of a boat scratching up sand and mud and the shell fish. The particular shell fish here being caught are explained to have been formerly considered poisonous, and it is said that they are even now not considered very good, and are never used in gentlemen's kitchens.

A great step in advance was made on board the *Challenger* in the introduction by Sir George Nares of the trawl-net as a substitute for the dredge in deep-sea investigation. Still both the sounding and trawling apparatus used on board the ship were very imperfect in comparison with the apparatus now employed. Mr. Alexander Agassiz, following Sir William Thomson's improvements in methods of sounding, has introduced the use of wire rope for trawling with, instead of the hempen rope which we used. The wire rope has most important advantages. It occupies only one-ninth of the space of the hempen rope on board the ship, being only one inch and a sixteenth in circumference. It is of galvanised steel wire with a hemp core. It is not as big as my little finger, and contrasts favourably with the large trawl ropes of the *Challenger*. The wire rope is heavy in the water, and need not be weighted when in use like the old rope. Moreover it can be let run out and be wound in at such a rate that three or four hauls can be got in one day in depths over which the *Challenger* consumed a whole weary day for one haul.[1] Mr. Agassiz has also improved the trawl-net. Our trawl was an ordinary beam trawl which might fall on its back on the bottom and be towed along in vain. This

Fig. 2.—Mr. A. Agassiz's deep-sea trawl.

one is, as will be seen from Fig. 2,[2] reversible. It has two beams instead of one, as in the old pattern, and these are fixed to the irons midway between the two margins of the mouth of the net, one of which will scrape the bottom on whichever side the trawl may fall. Mr. Agassiz has also used with great success a simple iron bar with twelve or fifteen swabs fastened on to it, and towed in a transverse position. With this machine he brought up on one occasion no less than 124 specimens of two large species of Pentacrinus at one haul.[3]

I pass now to the consideration of life in the deep sea. As Prof. Weismann of Freyburg well said in a lecture on the animal life of Lake Constance,[4] "The sea is the birthplace of all animal and plant life; from it animals and plants have spread themselves on the land and into the freshwaters which permeate it." This birthplace of the various forms of life lay, no doubt, in shallow water on the coasts, and thence has taken place the colonisation of the deep sea on the one hand and of the land on the other.

It is only animals, however, which have made their way into deep water. The absence of sunlight at great depths is entirely prohibitive of the existence there of plants. As far as I observed, we did not dredge any sea-weed in the *Challenger* Expedition from a greater depth than 33 fathoms. Edward Forbes, however, found ordinary sea-weeds in the Ægean Sea down to a depth of 79 fathoms,[5] though they were very scarce at that depth, and may possibly not have grown there, and Dr. Carpenter dredged Corallinaceæ in abundance in 150 fathoms in the Mediterranean.[1] The question of the exact limit of the different species of sea-weeds in depth, and of the absolute limit of plant-life altogether in the sea, is one of great importance, and which has received but little attention. It could easily be worked out by any yachtsman on our coasts.

In considerable depths only one plant is known to exist. It is a lowly-organised parasitic fungus, which infests corals, boring finely-ramified canals in their hard substance. This plant was found by Prof. Martin Duncan[2] in corals dredged from over 1,000 fathoms. Fig. 3

Fig. 3.—*Achlya penetrans*, Duncan.

gives a view of its appearance taken from Prof. Duncan's illustrations; you would hardly recognise it as a plant. It consists simply of a ramified mycelium and small spores. Like some other fungi which live in mines and cellars, it is able to live in the dark, because it nourishes itself upon the tissues of its hosts. It belongs to the same genus as a fungus that attacks the salmon in our rivers and kills them, and is hardly to be distinguished from that plant. It is an extremely ancient form, and infested corals even in Silurian times.[3]

Though plant life is so meagre, animal life is abundant

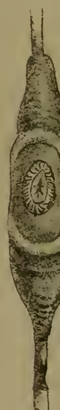


Fig. 4

Fig 5.

Fig. 4.—*Actinia abyssicola* (Moseley). Attached to the stem of an Isis.
Fig. 5.—*Edwardsia coriacea* (Moseley).

in the deep sea. There are hardly any of the groups of invertebrate animals which inhabit our shores which are not represented in deep waters. The only ones which I know of as absent, as far as yet observed, from depths of say 1,000 fathoms and more, are Planarian worms, and certain minute animals such as Rotifers, Tardigrades, and Infusoria. It is quite possible that these minute forms

[1] A. Agassiz: "Dredging Operations of the U.S. Coast-Survey Steamer *Blake*," *Bull. Mus. Comp. Zool.* vol. v. No. 1, p. 7.
[2] *Ibid.*, vol. v. No. 6. [3] *Ibid.*, vol. v No. 14, p. 296.
[4] Aug. Weismann, "Das Thierleben im Bodensee," s. 5. (Lindau: Stettner, 1877.)
[5] Brit. Ass. Report, 1844, p. 165.

[1] *Proc. R. Soc.*, 1872, p. 587. [2] *Proc. R. Soc.*, 1876, p. 238.
[3] *Quart. Jour. Geol. Soc.*, 1876, p. 205.

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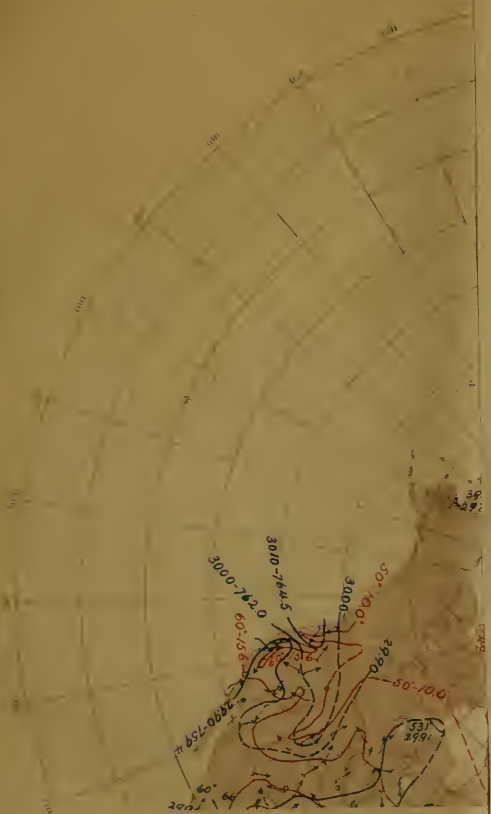
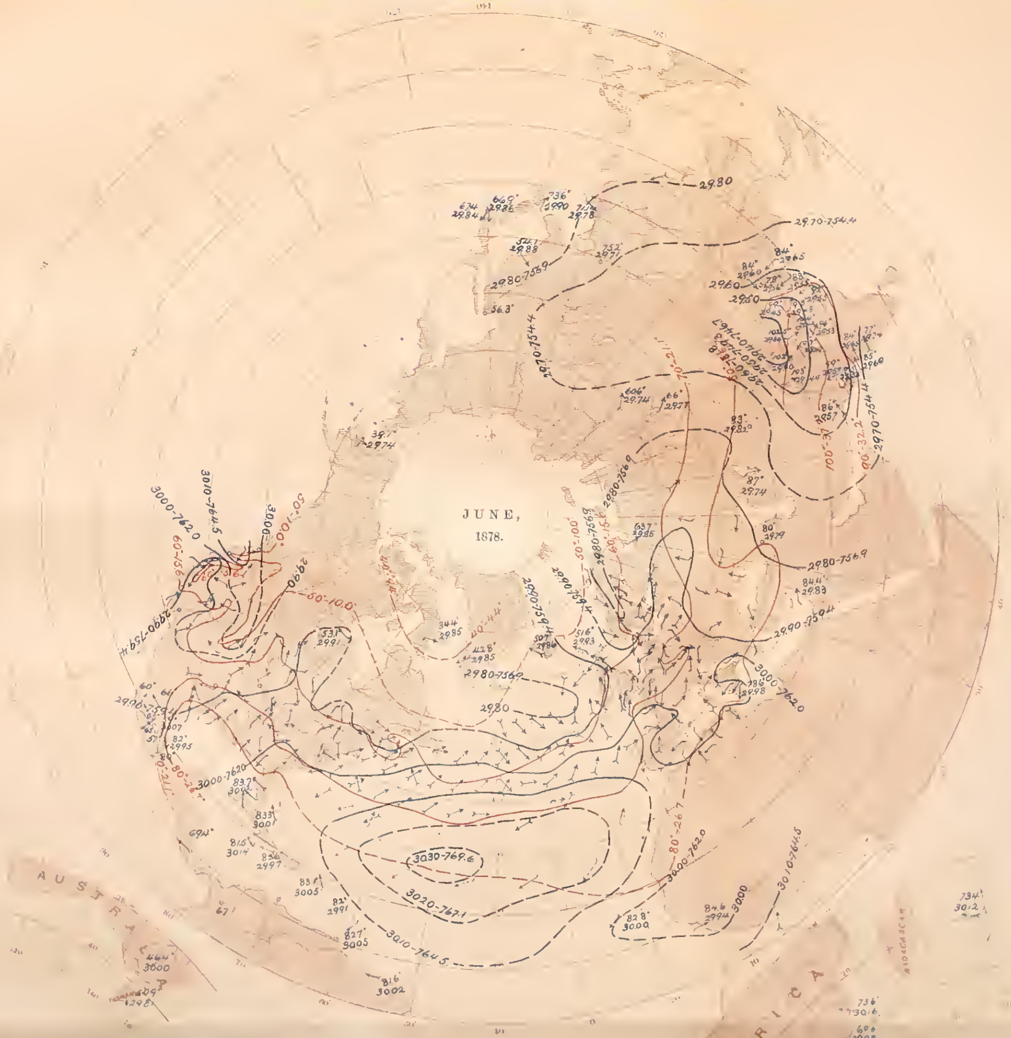


Office of the Chief Signal Officer,

UNITED STATES ARMY.

Charted from Actual Observations taken Simultaneously, Series commencing October, 1877.



PREVAILING WINDS.

Arrows shows the direction of, and fly with, the wind. Force is shown as follows:

Symbols.	Force.	Velocity: Miles per hour.	Velocity: Metres per second.
⟶ (1 barb)	1, 2	0 to 9	0 to 4.0
⟶ (2 barbs)	3, 4	9.1 to 22.5	4.1 to 10.1
⟶ (3 barbs)	5, 6	22.6 to 40.5	10.1 to 18.1
⟶ (4 barbs)	7, 8	40.6 to 67.5	18.1 to 30.2
⟶ (5 barbs)	9, 10	67.6 up.	30.2 & over.

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

Albert J. Myer

BRIG. GEN. (BVT) ASSG'D CHIEF SIGNAL OFFICER, U. S. A.

ISOBARS AND ISOTHERMS.

Isobars in *blue*: detached barometer means in English inches.

Isotherms in *red*: detached temperature means in degrees Fahrenheit.

INTERNATIONAL MONTHLY CHART.

Showing mean pressure, mean temperature, mean force and prevailing direction of winds at 7:35 A. M., Washington mean time, for the month of June, 1878, based on the daily charts of the International Bulletin.

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may exist in great depths, but it is as well to note that we have not as yet been able to detect them, possibly from want of adequate means and of proper search.

Many genera of animals, and even some species have a vast range of depth in the sea. Some of the animals common on our sea-shores are represented in very great depths by very closely allied species. As examples may be cited two sea anemones from deep water. The close resemblance of these to forms common in our aquariums will be recognised at once.

The one, *Actinia abyssicola* (Fig. 4), from 1,350 fathoms, belongs to the same genus as the commonest anemony exposed on the rocks all round our coast at low tide. In the deep sea, in the lack of rocks for it to spread its disc out flat upon, it is obliged, as in the specimen figured, to cling round the dead stem of an Alcyonarian coral, or to clasp some similar support. The other anemony (Fig. 5) belongs to the genus Edwardsia, also found on our coasts, and nearly resembles the English species, though it comes from 600 fathoms. It has a long cylindrical body, and covers its skin with a coating of small shells gathered from the bottom mud.

A curious sea-anemony of the genus Cerianthus, may also serve as an illustration. This anemony uses its thread-cells, which other anemonies and jelly-fishes use, as bathers know, to sting with, to build itself a house. It produces the cells, which are extremely large, in great quantity, felts the threads together, and thus constructs a tube in which it lives, burying the tube in the mud, and expanding itself at the mouth ready to dart down into safety when alarmed. The tube is about 4½ inches in actual length, and is covered with small foraminiferous shells from the bottom, woven into it. A closely-allied species lives in shallow water in the Mediterranean, and I found abundance of a huge species with the tube four times as long expanding its tentacles in a depth of only a foot of water at low tide in the full glare of a tropical sun at the Philippine Islands in water which felt quite hot to my feet. Yet this deep sea form, which differs from the others in little except its size, was dredged from 2,750 fathoms, and inhabits a region absolutely devoid of sunlight, and with a temperature always close on freezing point.

The simple coral, *Bathyactis symmetrica*, of which the accompanying figure (Fig. 6) represents a large specimen, magnified to three times the natural size, ranges through all depths from 30 fathoms to 2,900 fathoms, or three miles and a quarter, almost the greatest depth from which living animals have been obtained. The coral has a world-wide range, occurring in all parts of the Atlantic and Pacific and in the Indian Ocean. It varies very much in size, some specimens being extremely minute, but I have been unable to discover any relation between the size and the different conditions under which the various specimens lived. The size does not depend on depth, temperature, or the quality of the bottom, as far as I can make out.

When I speak of a coral I shall refer only to the skeleton of the animal. The figure above represents the hard skeleton of an animal like a sea-anemony. The soft tissues have been entirely removed.

In the cases of all groups of invertebrate animals, annelids, mollusca, crustacea, we find numerous similar instances of the wide range of modern shore genera, and even species into very great depths. For example, as Mr. Davidson shows, the Brachiopod *Terebratula vitrea* ranges from 5 to 1,456 fathoms, whilst the genus Waldheimia ranges from shore to 2,160 fathoms, and Discina from 50 to 2,425 fathoms. As Mr. P. H. Carpenter has shown, the genus Antedon of our coasts ranges down to 2,900 fathoms. Amongst the Ophiuridæ, as appears from Prof. Lyman's report, the genus Amphiura ranges from 2 to 2,650 fathoms. Prof. Ehlers long ago showed that deep-sea annelids and Gephyreans belong mostly to shallow-water genera. Myriochele occurs in 2,900 fathoms, Priapulus in 2,750 fathoms, Balanoglossus in 2,500 fathoms, and Dr. McIntosh has given me similar instances, and informs me that the common shallow-water annelid, *Lumbriconereis fragilis*, ranges down to 1,780 fathoms. From Mr. Boog Watson's account of the mollusca of the *Challenger* Expedition it appears that the common shore genus Dentalium ranges down to 2,600 fathoms. Amongst crustacea Peneid and Caridid shrimps extend to all depths, whilst the barnacle Scalpellum ranges down to 2,850 fathoms.

Although many forms have this wide range, there are certain well-marked deep-sea forms which are not met with in shallow water unless in Polar regions.

The accompanying figure (Fig. 7) represents a beautiful simple coral, *Odontocyathus coronatus*, from 390 fathoms off St. Thomas, in the West Indies, immediate allies of

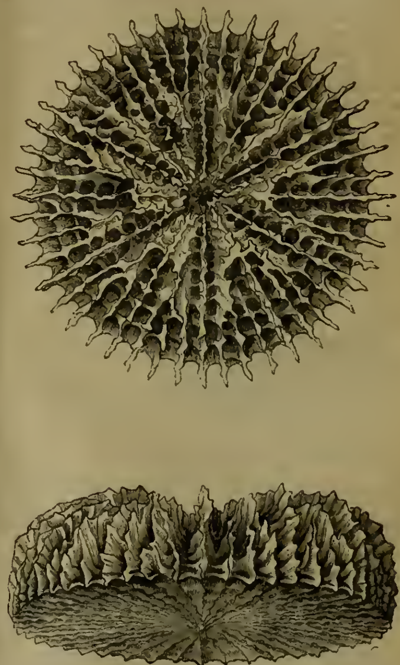


FIG. 6.—*Bathyactis symmetrica*. Three times the natural size. Viewed from above and edgewise.

which have not been found in shallow water. The coral is remarkable for having a wide flat base with tooth-like spokes all round its edge, no doubt a contrivance for keeping it upright as it rests on the mud at the sea bottom. The genus of corals, Stephanotrochus, may also be cited as confined at present, as far as known, to deep water. Four species of the genus were dredged by the *Challenger* in from 410 to 1,000 fathoms. All but one of them, which was obtained off New South Wales, were dredged in the Atlantic. The species here figured (Fig. 8) *Stephanotrochus diadema* was from 1,000 fathoms off the Azores.

There being scarcely any difference in the conditions of life from a depth of 500 fathoms downwards, the deep-sea fauna exhibits no zones of distribution in depth. Its upward limit rises in some parts of the world higher towards the coast line, in others lies lower, according to the varying conditions of light temperature-currents and food. In the higher latitudes it approaches shallow water. In the Straits of Magellan we dredged blind crustacea and other elements of the deep-sea fauna in 120 fathoms; but even in the tropics the deep-sea fauna is met with at comparatively small depths. Off St. Thomas in the Danish West Indies, for example, deep-sea animals are extremely abundant at 450 fathoms.

From the upper limit of range the deep-sea fauna, speaking generally, extends downwards continuously, without break or defined limit of range of species or genera. We had not in the *Challenger* time to make series of dredgings to determine the upper limit of the deep-sea fauna. It may lie in the places cited much nearer to the surface than stated. At Cebu, in the Philippines, far within the tropics, vitreous sponges occur in abundance at 95 fathoms, and the deep-sea fauna may almost be said there to reach that upper limit, although the temperature at that depth is as high as 70° F. Mr. Agassiz,[1] who has so thoroughly explored the deep-sea off the east coast of North America and the West Indies, concludes in his latest report that the range of the deep-sea fauna should be carried as high as 300 or 350 fathoms. He terms the fauna extending from the shore to 150 fathoms the littoral fauna, whilst from the 100-fathom line to the 400-fathom line extend species which are neither littoral nor have the wide geographical distribution belonging to forms found below that depth. We might term the inhabitants of this interval the intermediate fauna. Dr. Günther tells me that he has arrived at similar conclusions from his examination of the deep-sea fish collected by the *Challenger* expedition. Below 350 fathoms no zones of depth are to be made out in their distribution.

The geological bearings of these facts are all-important. We shall never be able to tell from the fossil contents of strata whether they were deposited at 400 or 2,500 fathoms. Even more, since some species and very many genera range at present from the shore to vast depths, many forms now restricted to deep water may formerly have lived in less depths, and most probably did so. Moreover as the present deep-sea fauna varies so much in upward range in different places and climates, so also probably did it vary in geological times. We can therefore not even form conclusions of any value from these grounds as to the depths at which a deposit was formed, from 400 fathoms upwards, until the region of reef-coral and plant-life is reached. We must rely on other evidence.

The question would not be one of much importance if, as Prof. Geikie concludes, all the geological deposits with

FIG. 7.—*Odontocyathus coronatus* (Moseley). Magnified to twice the natural size.

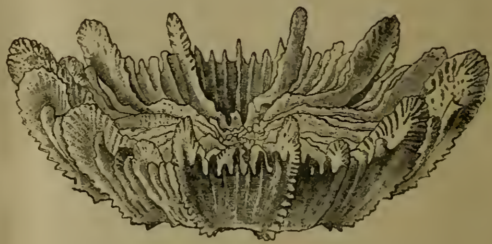


FIG. 8.—*Stephanotrochus diadema* (Moseley). Once and a half the natural size.

which we have to deal are shown, by containing ripple-marks and otherwise, to have been formed in shallow water,[2] but many geologists are, I believe, opposed to his views in this matter.

A most important feature of the deep-sea fauna is that it is world-wide in its distribution. I have already referred to a species of coral, *Bathyactis symmetrica*, which ranges all over the world. Fig. 9 represents another coral, *Cryptohelia pudica*, which is a hydroid allied to the jelly-fishes which float on the sea-surface, and not to sea-anemonies like the other corals I have shown. This is the common skeleton of a highly complex colony. Each of the small swellings on the branches contains a group of animals. In the centre of each group is lodged an animal with a mouth and stomach, and all round were others without mouths. The latter catch the food and give it to the central animal, which digests it and nourishes them and the whole coral tree by means of a complex system of canals. Other animals perform solely the function of rearing the young. The fully-developed larvæ are worm-like, and when ready escape and swim away to found each a new colony. For corals, like us, travel in their youth and see the world, and become stationary like us only in later life. Each group of animals is covered by a protective lid, hence the name of the coral, Cryptohelia. It occurs all over the world in from 350 to 1,500 fathoms.

Some few deep-sea forms appear to have a restricted range. I say appear, because we have dredged some few as yet only from one locality, but so little deep-sea dredging has been done that probably these will be found elsewhere in the future.

No better instance of the world-wide range of deep-sea forms can be cited than the fact that Portuguese fishermen fishing for deep-sea sharks in 450 fathoms off the coast of Portugal bring up the Glass-rope Sponge entangled on their lines, and that Japanese fishermen fishing off Inosima in more than 300 fathoms catch sometimes a shark of the same genus as that caught by the Portuguese, and bring up at the same time an almost identical sponge. The sponge reached England first from Japan.

There is absolutely nothing to restrict the geographical range of animals in the deep sea. Dr. Wallich, the pioneer of deep-sea research, eighteen years ago recognised the deep homothermal sea "As the great highway for animal migration, extending from pole to pole." Below 500 fathoms it is everywhere dark and cold, and there are no ridges that rise on the ocean bottom to within 500 fathoms of the surface, so as to bar the migration of animals in the course of generations from one ocean to another, or all over the bottom of any one of the oceans. The apparently shallow barriers seen in the map of Atlantic and Pacific have over 1,000 fathoms of water upon them.

Were there any variations in the conditions of life such as to restrict certain animals to very great depths, as mountain plants are restricted to certain heights on land, then we might expect to find a peculiar fauna in the deep

[1] *Bull.* Mus. Comp. Zool., vol. v. No. 14, p. 294.
[2] *Proc.* R. Geog. Soc., 1879, p. 426.

depressions, and especially in the deepest hollows on the bottom of the sea, where the water is over 4,000 fathoms deep; but such is not the case as far as we know. The deepest depressions lie in the North Pacific, the deepest of all being one close to the Kurile Islands, the soundings there being 4,655 fathoms.

Mr. Alexander Agassiz has glanced over and helped to sort the whole deep-sea collection made by the *Challenger*, and he believes that the collection made by the successive dredgings of the United States Government in deep water off the eastern coast of the United States and the West Indies contains almost all the types dredged by us all over the world. No better proof of the ubiquity of deep-sea species could be given. We got quite tired on the *Challenger* of dredging up the same monotonous animals wherever we went.

Many animals which occur in deep water in temperate and tropical regions occur in shallow water in high latitudes. Hence it is usually concluded that an Arctic or Antarctic fauna has colonised the deep sea; but probably it is also

FIG. 9.—*Cryptohelia pudica* (M. Edw. & H.). Twice the natural size.

the case that deep-sea forms have moved up into shallow water in polar regions, because there the temperature is low and the water is dark during most of the year, both from the absence of sun or the obliquity of its rays, and because of the covering of the water by ice and snow. Probably colonisation has taken place in both directions. Some of the identical animal forms occurring at New Zealand and Great Britain may have moved up from deep water at both places.

The higher we rise into shallow water above the limit of the deep-sea fauna, the more restricted becomes the geographical range of the species occurring. I may cite an instance. Off the Aru Islands in the Malay Archipelago we dredged in 129 fathoms at the same haul a number of corals and other animals, nearly all of which we did not find elsewhere, and which I believe Mr. Agassiz has not found off the American coast.

(*To be continued.*)

NOTES

WE are sure our readers of all shades of politics must regret that Sir John Lubbock has lost his seat in Parliament. We have nothing to do with the immediate causes of his defeat, but for the sake of science and enlightened legislation we trust he may find some other constituency liberal enough in the best sense of the term, to choose him as its representative. Meantime his loss is to some extent made up for by the election of Prof. Maskelyne, though we trust the latter's duties as a legislator will not lead to the neglect of what we consider his much higher function of original research.

WE have some further details concerning the new agricultural college about to be opened near Salisbury. Mr. John Wrightson, for many years Professor at Cirencester, and well known for his contributions to scientific agriculture, is converting his house and extensive farm near Downton into an institution which shall combine lands worked by himself with a teaching staff mainly composed of experienced professors once at the Royal Agricultural College. There is plenty of room, not for one new college only, but for half a dozen; and the present scheme commends itself to us in many ways. We feel sure that it will work in friendly rivalry with Cirencester, avoiding its mistakes while profiting by its experience. We would suggest that some shorter title than the "South Wiltshire and Hampshire Agricultura College" should be found for the new institution.

WE understand that Prof. Boyd Dawkins, F.R.S., of Owens College, Manchester, has accepted an invitation to give a course of lectures at the Lowell Institute, Boston, Mass., in October and November of this year.

THE eighteenth meeting of the delegates of the French Sociétés Savantes took place at the Sorbonne on March 31. M. Regnier, President of the Archeological Section, was the president at the inaugural sitting. He was assisted by M. Milne-Edwards, President of the Science Section, and M. Delisle, President of the Historical Section. In his speech the President spoke in some detail of the heliographical reproduction of old manuscripts published recently in England. The Section of Science was divided as usual into three commissions. M. Allegret, Professor of the Faculty of Lyons, was appointed President of the Commission for Mathematics; M. Filhol, Professor to the Faculté des Sciences of Toulouse, President of the Commission for Physico-Chemical Science; and M. Cotteau President of the Commission of Natural Sciences. The General Sitting of Sciences were presided over by M. Milne-Edwards, assisted by M. Faye and M. Wurtz. The distribution of prizes took place on Saturday, April 3, under the presidency of M. Ferry, the Minister of Public Instruction. Prince Oscar of Sweden, Prof. Nordenskjöld, and Capt. Palander were present, and greatly cheered by undergraduates and spectators. Except the allusion to the high rewards, the speech of M. Ferry was almost entirely confined to educational topics According to the proposals of the Commission of Sciences gold medals have been awarded to Dr. Crevaux for his explorations in Tropical America, M. Crova, Professor to the Faculté des Sciences de Montpelier, and M. Violle, Professor to the Faculté of Lyons, for their works in Physics; M. Pierre, as Director of the Botanical Garden of Saigon (Cochin-China), and MM. Chantre and Falsan for their studies of the old glaciers of the Rhone.

THE Italian Minister of Agriculture and Commerce has decided to present to Parliament a project for executing a great geological map of the kingdom. The expense is calculated at 6,000,000 francs.

SHOCKS of earthquake were felt at Tenez, on the Algerian coast, on March 2, at 8.30 p.m., and at Orleansville and Tenez on the 25th, at 5.20 a.m.

THE *Gardeners' Chronicle* regrets to hear of the decease from cholera of Adolf Biermann, the Curator of the Royal Botanic Garden, Calcutta.

ON the 1st inst. the Geological Society of France celebrated the fiftieth anniversary of its foundation.

THE annual meeting of the Paris Physical Society took place on April 2 in the large hall of the Société d'Encouragement. It was very well attended, the hall having been lit by ten Werdermann lights, which worked with great regularity and gave a very pure illumination. Very few new experiments were made. We must notice, however, a new use of M. Trouve's polyscope. M. Trouve placed his electrical polyscope in the stomach of a fish swimming in an aquarium, and without its seeming to suffer any inconvenience, it radiated a light equal to one common candle.

IN various works on botany M. Alph. de Candolle has remarked (*Arch. des Sciences*, March), there are enigmatical and even unintelligible descriptions, which it would have been better not to publish. And this is the case not only with incompetent writers, but with those of the first rank. He gives a list of *species dubiæ*, &c., from vols. xiv. to xvii. of the *Prodromus* (published 1856–1873), referred to their authors (deceased), care having been taken to attribute each enigma to its true origin. Those volumes of the *Prodromus* contain 11,056 species classed and described, and the enigmatical amount to 562, or about 5 per cent. It is noted that there are pretty large proportions of enigmas (1) in certain authors who have written much, as Blume (66), Miquel (59), Roxburgh (20), Kunth (19), Sprengel (17); (2) in authors who have published only one or two volumes, or even simple memoirs, such as Blanco (32), Opiz (28), Loureiro (15), Don (14), Noronha (11), Griffith (11), Hamilton (11) . . . Martens and Galeotti (4). (The extent of the writings must be taken into account.) Three great naturalists who have written much, viz., Linnæus, Lamarck, and Brown, stand together about the middle of the list, with the numbers 7, 9, and 8 severally. M. de Candolle refers further to a document by Endlicher, in which that naturalist gives a list of enigmatical genera, amounting to 109 out of the 6,895 genera known in 1840, or about $1\frac{1}{2}$ per cent. Analysis here shows that the incapable or mediocre authors have given most enigmas. Père Vellozo (29) is most prominent in this respect, and a regret is expressed that he, with some other culpable *pères* (Blanco, Loureiro, &c.), did not confine themselves to writing homilies. The troublesome result of certain publications has now rendered botanists more prudent.

THE Belgian Academy of Sciences has announced the following subjects of prize competition for 1881 :—In mathematical and physical sciences : 1. Extend, as much as possible, the theories of points and straight lines of Steiner, Kirkman, Cayley, Salmon, Hesse, Bauer, to properties which are, for superior plain curves, for surfaces and for twisted curves, the analogues of the theorems of Pascal and Brianchon. 2. Extend to eight points of a curve of the third order the anharmonic property of four points of a conic. 3. New researches on the spectrum of oxides, chlorides, and bromides of barium, calcium, and strontium, whose absolute purity has first been proved by chemical analysis. In natural sciences : 1. New researches on the germination of seeds, especially on the assimilation of nutritive deposits by the embryo. 2. New researches on development of Trematoda, from the histogenic and organogenic point of view. 3. New stratigraphical, lithological, and palæontological researches fitted to determine the arrangement or order of succession of layers of the formation named Ardennais by Dumont, and at present considered as Cambrian. The value of the medals awarded will be 600 francs for each question. Memoirs (which may be in French, Flemish, or Latin) are to be sent in, with mottoes as usual, before August 1, 1881. (A prize question on torsion is reserved for the programme of 1882.)

FROM the following extract from the *Planter's Journal*, quoted in the *Barbados Globe* of March 8, it will be seen that science has reached that remote colony :—"Those who are interested in the agricultural prosperity of Barbados will have observed with pleasure the increased attention that has of late been paid here to the application of the methods and improvements of scientific agriculture to the raising and reaping of our staple crop. The planter is more and more fully realising the fact that, if he is to hold his own in the face of the competition that is springing up all around him in the field where his supremacy was once unquestioned, he must persistently and patiently invoke the aid of the processes and the discoveries which science offers to those who seek her. Hence it is that we have now, under the provisions of the Education Act, 1878, an Island Professor of Chemistry and Agricultural Science; that there is besides a private analytical chemist resident amongst us; and that the Barbados Agricultural Society has appointed a Chemical Committee, which has for some months been steadily engaged in doing good, though unostentatious, work in obtaining analyses of manures and similar matters. The result of these movements is seen in the encouraging fact that the prudent planter, in purchasing his foreign fertilisers, is more careful in inquiring into their quality, and, as a necessary consequence, the agents for the better class of manures are willing to meet his requirements by placing before him satisfactory analyses of the articles which they offer for sale. There prevails therefore in the manure market a better condition of things both for the buyer and for the honest vendor—the former receiving more value for his money, and the latter running less risk of being undersold by the fraudulent maker of 'sophisticated' manures."

IN consequence of the general election it has been considered advisable to fix the date for the Conference on the Progress of Public Health—which has been held annually by the Society of Arts since 1876—somewhat later than was originally intended, or than has been the case in former years. It will therefore be held in the beginning of June. A programme of subjects for discussion has been drawn up by the Executive Committee, and will be submitted to the Conference. The following are the subjects included :—1. The development of Local Government administration, especially by the constitution of County Boards. 2. The extension of the powers of the local authorities of urban and rural sanitary districts. Amendments in the Public Health Act. 3. Sanitary inspection and classification of dwellings. 4. Amendments in the Rivers Pollution Prevention Act. 5. The advisability of strengthening the administrative organisation of the Local Government Board. Local Government Board Administration Areas. 6. Further suggestions by sanitary authorities. The programme will also be issued to sanitary authorities throughout the kingdom. It is not proposed to make any attempt to procure papers which may be read and discussed; but the Committee state that they will be glad to receive any communications containing fresh information or giving accounts of progress made since the last Conference. Such communications, if approved by the Committee, will be printed and circulated at the Conference, but it is probable that time will not admit of any discussion being taken upon them.

THE Scientific Committee of the Royal Horticultural Society, having appointed a committee to collect evidence and report the effect of the past severe winters and cold summer on trees, shrubs, and plants, will be glad of the co-operation of all horticulturists interested in the subject, whether members of the Society or not. Forms are in preparation for filling up, and may be had on application to the Secretary, South Kensington.

WE regret to hear that the University of St. Andrew's is in such difficulties that it has been resolved to reduce the salaries of the professors to a considerable extent for some years, unless her old alumni and other friends come to the rescue. A large part of the income of the University is derived from the farms which form part of its endowment, and the recent depreciation of this kind of property has seriously affected the moderate income of the University, which we hope will be able to weather the storm.

THE University of Buda-Pesth, which was founded in 1635, intends to celebrate, on May 13, the hundredth year since its revival and development by Maria Theresa. There will be a thanksgiving service in the morning and a grand academical and civic procession through the streets. An oration will be delivered and an ode recited, and there will be a banquet, to be followed by a grand ball. In honour of the occasion medals will be struck, honorary degrees will be conferred on distinguished men, and a work by the Hungarian Minister of Justice, Pauler, describing the work of the University during the last 100 years, will be published.

IN consequence of the unavoidable absence of Dr. C. W. Siemens, his paper at the Society of Telegraph Engineers, on "The Application of the Dynamoelectric Current to the Fusion of Defractory Materials in considerable Quantities," which was to have been read on the 14th inst., is postponed until the 28th inst. The papers to be read will be seen from our Diary.

BAUMGARTNER, the inventor of a navigable balloon, having three cars attached, each with ten or twelve wings, set in motion by a crank, has attempted an ascent at Leipzic. On the rope being cut the balloon rose very slowly, skimming the house-tops, whereupon the two assistants jumped out of the centre car in alarm. The balloon shot up to a great height, then burst and fell. Baumgartner was not seriously hurt, and is resolved on a second experiment.

THE ship *Border Chief*, which arrived at Melbourne from London on February 14, reports seeing an iceberg of very large proportions in lat. 47° S. and long. 52° E. This ice island was considered to be about 250 feet high and about five miles in length. Another vessel, it is stated, struck an iceberg on March 26, in lat. 46° N., long. 48° W., and sank next day. A Cardiff steamer on her homeward voyage from New York encountered an immense mass of drift-ice, which it took forty-eight hours to get clear of; in steaming through it she received several injuries. No fewer than 100 icebergs are stated to have been seen on the passage.

THE season is extremely rainy in Algeria, and an almost unexampled occurrence has taken place; inundations have destroyed some houses at Nemours, and the traffic on the railway from Arzew to Saïda has been obstructed by the fall of rocks undermined by the recent rains. A magnificent crop is anticipated, and travelling in the Sahara will be exceptionally easy this summer.

WE have on our table the following works:—"The Field Naturalist's Handbook," Rev. J. G. Wood and Theodore Wood (Cassell); "Water Analysis," E. Frankland (van Voorst); "Botany for Children," Rev. G. Henslow (Stanford); "Ethnology," J. H. Painter (Baillière); "Guide to the Electric Testing of Telegraph Cables," V. Hoskier (Spon); "The Influence of Colloid upon Crystalline Form and Cohesion," Dr. W. M. Ord (Stanford); "Introduction to the Science of Language," 2 vols., A. H. Sayce (Kegan Paul); "Indian Notes," F. K. Hogg, M.D. (Churchill); Publications of the Cincinnati Observatory; "Micrometrical Measurements of Double Stars;" "The Constitution of the Earth," R. Ward (G. Bell and Sons); "The Disestablishment of the Sun," John Bland (Sprague and Co.); "Abbildungen von Vogel-skeleten," Dr. A. B. Meyer (Dresden); "A Criticism of Dr. Croll's Molecular Theory of Glacier Motion," J. J. Harris Teall (Simpkins); "Secret of a Good Memory," J. Mortimer Granville (Bogue); Journal of the Royal Society of New South Wales, and Annual Report of the Department of Mines of New South Wales (Trübner); "Notes of Observation of Injurious Insects;" "Astronomie Populaire," Camille Flammarion; "Practical Chemistry," W. A. Tilden (Longmans); "The Sidereal Messenger of Galileo Galilei," E. S. Carlos (Rivington); "British Marine Polyzoa," 2 vols., Thomas Hincks (van Voorst); "United States Geological Survey," vol. xii. 1879; "Testing Instructions," vol. ii., Schwendler (Trübner); "Physiology of Religion," part I, Henry Lee (Trübner); "Transactions of the Cremation Society of England" (Smith, Elder); "International Dictionary for Naturalists and Sportsmen," E. Simpson Baikie (Trübner); "The Geological Record for 1877," edited by W. Whitaker (Taylor and Francis); "Henry's Contribution to the Electro-Magnetic Telegraph," W. B. Taylor (Washington); "Die Beobachtung der Sterne, Sonst und Jetzt," J. Norman Lockyer (Vieweg und Sohn); "Japanese Metric and English Weights and Measures," Edward Kinch (Tokio); "Annuaire de l'Académie Royale des Sciences;" "Elements of Modern Chemistry," Adolphe Wurtz (Swan, Sonnenschein, and Allen); "Geography," Keith-Johnston (Stanford); "Philosophie Scientifique," H. Girard (Trübner); "Australian Orchids," part 5, R. D. Fitzgerald (Trübner).

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. G. Kirby; a Prince Albert's Curassow (*Crax alberti*) from Columbia, presented by Mr. H. B. Whitmarsh; a West African Love Bird (*Agapornis pullaria*) from West Africa, presented by Mr. J. W. Gillespie; a Long-eared Owl (*Asio otus*), captured in the Red Sea, presented by Dr. Wm. Anderson; a Greater Black-backed Gull (*Larus marinus*), European, presented by Mr. E. Thornhill; a Slow-worm (*Anguis fragilis*), British, presented by Mr. Leslie Jeyes; two Dingo Dogs (*Canis dingo*), two Red Kangaroos (*Macropus rufus*), two Vulpine Phalangers (*Phalangista vulpina*, var.), two Mauge's Dasyures (*Dasyurus maugæi*), a Short-headed Phalanger (*Belideus breviceps*), two Emus (*Dromæus novæ-hollandiæ*) from Australia, two Common Wombats (*Phascolomys wombat*), from Tasmania, a Weeper Capuchin (*Cebus capucinus*) from Brazil, a Horned Tragopan (*Ceriornis satyra*) from the South-east Himalayas, deposited; a Feline Douroucouli (*Nyctipithecus vociferans*) from South Brazil, a Rock Cavy (*Cerodon rupestris*), a White-spotted Rail (*Rallus maculatus*), an Orinoco Goose (*Chenalopex jubata*), a Brazilian Teal (*Querquedula brasiliensis*) from Brazil, purchased.

GEOGRAPHICAL NOTES

As might have been expected, Prof. Nordenskjöld and his companions have met with an enthusiastic reception in Paris, both from Government, from the scientific societies, and from the general public. Delegates from the Government received him on his arrival, the unusual honour of a Commandership of the Legion of Honour has been conferred upon him, while Capt. Palander has been made an officer. He was present at the public meeting of the Sociétés Savantes, when he received a warm reception, while the Geographical Society received him publicly in the Cirque of the Champs Elysées. On Sunday a banquet at the Hôtel Continental was given him, with Prince Oscar of Sweden as president, and on Monday another banquet by the Geographical Society as a body, while the municipality of Paris presented him with a special gold medal. We wonder if any member of the municipality of London could tell who Nordenskjöld is, or what he has done, that all Europe, except England, should make so much fuss about him. Such a reception as he has had in Paris in its nationality and publicity contrasts markedly with the treatment he received here. No doubt he arrived at an unfortunate time, but surely, if the transition state of the Government excused inaction on its part, the Geographical Society could have organised a meeting, even although a prince was not at hand to take the chair. Possibly after all our insular want of sympathy with foreign enterprise, however great, may account for the absence of that enthusiasm which greeted our own abortive expedition of three years ago. The English edition of Prof. Nordenskjöld's narrative will be published by Macmillan and Co.; it will appear simultaneously in English, Swedish, German, and French.

M. J. PALMARTS has published at Brussels a pamphlet entitled "Projet d'Exploration au Pole Nord," in which, after a preliminary disquisition of a general nature, he expounds his plan for the construction of a submarine apparatus to attain the object in view. The *Times* Naples correspondent states that the *Cristoforo Colombo* is now in course of preparation for an exploring voyage in the North Seas.

THE current number of the Geographical Society's *Proceedings* contains Mr. J. Thomson's report of his journey from the head of Lake Nyassa to the south end of Lake Tanganyika, followed by Maj.-Gen. Sir M. A. S. Biddulph's paper on Pishin, and the routes between India and Candahar, which furnishes a vast amount of new topographical information. In order to make this more readily intelligible, it is illustrated by some excellent wood-engravings from, we believe, the author's own sketches, and a good map of part of southern Afghanistan, constructed from surveys made during the late expedition, on which the unexplored country to the east is usefully indicated. A proposal is made by Admiral Ryder to found medals for the encouragement of surveying by naval officers, which the council of the Society, after careful consideration, think had better be placed in other hands. Among the remaining matter is Dr. Holub's address on the subject of the Marutse-Mabunda empire, but the publication of the map to illustrate his former paper appears to be unavoidably postponed.

IT is stated that a new Belgian expedition is to leave this month for the purpose of establishing commercial stations along the Congo.

M. SLATIN, an Austrian traveller, is about to visit Dara, in Darfur, and proposes to explore the country to the south of Hofrat-el-Nahas and Kalaka. MM. de Müller-Capitany and de Lucken have recently left Cairo for Massowah, whence they intend to visit the region bordering on Northern Abyssinia. After spending a year there they will direct their course to Fazokl, by way of Valkait and Gallabat, and they will then endeavour to penetrate southwards into the Galla country.

MM. POPELIN AND CARTER, with the second Belgian Expedition, have arrived at Karema, M. Cambier's station on Lake Tanganyika, but it is said that only one elephant has survived the journey. Under the auspices of the King of the Belgians an establishment is to be formed in Eastern Africa for the capture and training of elephants. A further Belgian expedition is to be despatched to Karema under Capt. Ræmaekers and his brother, who will take with them three artisans and also a small steamer for use on Lake Tanganyika.

THE French Committee of the International African Association have despatched M. Bloyet to Zanzibar to undertake the formation of their station in Usagara.

COL. GORDON-PASHA has recently informed the Church Missionary Society that the Egyptian military station on the Uganda frontier had been moved back, and that consequently the country between Egypt and Mtesa's kingdom is in an unsettled and insecure state, being overrun by Kaba Rega's men. The road to the Victoria Nyanza by way of the Nile is therefore not now practicable. The two members of the Nyanza Expedition, the Rev. C. I. Wilson and Mr. Felkin, with three Waganda chiefs, are expected to arrive in England during the present month, as they had reached Suakim on March 16. Mr. Wilson will thus be the first Englishman, since Speke and Grant, who has traversed Africa from Zanzibar to Uganda, and thence down the Nile.

HERR CARL LAMP gives some striking illustrations in *Globus* of the hatred that exists between the Mayos of Yucatan and the Mexican Creoles. He shows how important the exploration of the country would be, but the explorer must take his life in his hand. The same number (13) of *Globus* contains some interesting details of Mr. C. M. Doughty's journeys in North Arabia.

THE leading contribution to the new number of the *Annales de l'Extrême Orient* is Count Meyners d'Estrey's paper on Sumatra, being a communication recently made by him to the Société Académique Indo-Chinoise.

THE new part of *Le Globe* contains a suggestive paper on the *rôle* of missionaries, looked at from a geographical standpoint.

ON the 16th inst. Prof. Vambéry is to read a paper at the Society of Arts on "Russia's Influence over the Inhabitants of Central Asia during the last ten years." Prof. Vambéry's intimate knowledge of Central Asia lends great value to anything he may say, though it is well known his opinions are rather violently anti-Russian. He is coming to London expressly to read the paper, and is expected here on the 13th. Sir Douglas Forsyth is announced to preside at the meeting.

ACCORDING to an evening contemporary the Moscow correspondent of the *Kölnische Zeitung* writes that a war between Russia and China may result in the occupation of Tchikislar, and that the fanatical Mahommedan population of Tchikislar is the surest ally for Russia! At first sight this was rather confusing, but the further statement that Russia "has a pretender for Tchikislar *in petto*—an elder son of Yakoob Khan," inclines us to the belief that the writer may not impossibly be confounding Kashgar with Tchikislar!

THE HISTORY OF MUSICAL PITCH[1]

"PITCH" is itself merely a sensation due to, and hence measured by, the number of double or complete vibrations, backwards and forwards, made in one second of time by a particle of air while the sound is heard. It is convenient to call the pitch of a musical sound the number of vibrations to which it is due. "Musical pitch" is the pitch of the "tuning note," or that by which all other notes on an instrument with fixed tones is regulated according to some system of tuning or "temperament." Of these, two are of prominent importance in the history of pitch, the "Mean-tone" and the "Equal," the first being also frequently called "unequal." In mean-tone temperament, completed by Salinas in 1577, all harpsichords and pianos were originally tuned in England till 1844, and all organs till 1854. It may still be heard on Green's organs at St. George's Chapel, Windsor, Kew Parish Church, and St. Katharine's, Regent's Park, and on a few country organs. It consists in flattening the Fifths of the scale sufficiently to make the major Thirds perfect, so as to sound without beats. As long as the player did not employ more than two flats or three sharps this answered very well indeed. But on introducing a third flat or fourth sharp he had to play them by substitution, and hideous noises, called "the wolf," were produced, and hence players have agreed to accept the much less perfect equal temperament, in which the Fifths are scarcely perceptibly flattened, and the major Thirds are made very much too sharp (producing the unpleasant "grittiness" of the harmonium), because at any rate all the keys are alike and the wolves are reduced to cubs.

It is convenient to consider A as the tuning note in all cases, but pianos and organs are usually tuned to C. The following relations give an easy sum in the rule of three for passing from A to C, and conversely. In equal temperament A 444, that is, the note A making 444 double vibrations in a second, corresponds to C 528, and conversely. In mean-tone temperament A 418 corresponds to C 500, and conversely, whereas for a perfect minor Third between A and C, A 440 corresponds to C 528, and conversely.

Man's memory of pitch is generally weak and short, though there are a few exceptions. Even in running down an octave unaccompanied singers will often flatten pitch. Hence some means of handing down pitch is necessary. The only carriers of pitch which need be noticed are the organ-pipe and the tuning-fork, which dates from 1711, so that for all older pitches the organ-pipe is the sole, as it still is the principal, authority. Both pipe and fork alter with temperature. The pipe alters, roughly speaking, by one vibration in every thousand for each degree Fahrenheit, sharpening by heat and flattening by cold. This is an extremely important change, and all pitches of organs must be reduced to one standard temperature, for which 59° F. =

[1] Re-arranged and abridged by the Author from a paper on the same subject read before the Society of Arts on March 3, 1880, by Alexander J. Ellis, F.R.S., F.S.A. For a detailed authentication of the facts herein mentioned reference must be made to the *Journal* of the Society of Arts for March 5 and April 2, 1880.

15° C. = 12° R. is here selected and used. The tuning-fork alters only by 1 vib. in 21,000 for each degree Fahrenheit, flattening by heat and sharpening by cold (the exact contrary to an organ-pipe), but this minute change may generally be disregarded. It is best, however, to reduce forks also to the same standard temperature. The tuning-fork, if carefully treated, will probably retain its pitch exactly for any number of years, since we know by examination that some forks have not varied one-tenth of a vibration from 1837 to 1880. Even very bad rusting does not flatten a fork by more than 4 vib. in 1,000.

Suppose then that we had a series of forks, tuned in unison with the different A's of different organs and other instruments, how are we to appreciate the difference between them, independently of the ear, which, even when well trained, is found to be most unsatisfactory in the judgments it forms as to the magnitude of an interval? The only satisfactory method is to measure them, that is, to determine the number of vibrations in each fork. For this purpose there are elaborate contrivances, but only one is easy of application, and, as has been ascertained by experiment, the results I have obtained by it do not differ by so much as one-tenth of a vibration from those yielded by the beautiful machines of Prof. McLeod and Prof. Alfred Mayer, who kindly tested my determinations by them. The "tuning-fork tonometer" was invented by J. H. Scheibler (1777-1837), silk manufacturer of Crefeld. Its principle is this: Two tuning-forks of nearly the same pitch, when sounded together, break up their continuous tones into a succession of loudnesses and weaknesses, called beats. The number of such beats that take place in ten seconds can be easily counted when it lies between ten and fifty, and most easily when it is forty. The number of beats in one second is exactly equal to the difference of the pitches of the two forks. Then again each fork can be made to produce its own octave by being held over a proper resonance jar, and this octave will beat with another fork nearly of its own pitch. Then from any selected low fork, say about A 220, a series of sharper forks, each beating (roughly) four times in a second with the preceding, is constructed, until one is reached which beats with the octave of the lower fork. Then all the forks are allowed several weeks to cool and settle, and the beats are afterwards counted with perfect accuracy, a very long, tedious, and extremely difficult operation. The sum of all the beats between the lowest fork and its octave is the pitch of the lowest fork, whence that of all the intermediate forks is immediately known. This done, the determination of the pitch of any fork or pipe, whose note lies within the octave counted, is very easy. The forks I used belonged to Scheibler himself, and were kindly lent me by Herr Amels, but I had to do the counting myself, and Professors McLeod and Mayer kindly enabled me to verify the results. It was by means of these forks and others tuned from them that I was able to measure the pitches of other forks and of pipes, and thus obtain the materials for this history.

First a large number of forks were obtained, most kindly lent or copied for me by numerous helpers; then I determined the pitch of a large number of organs, or obtained forks tuned to them at known temperatures. Organ-builders helped me with ancient pipes they had preserved from old organs. Pipes, of which the dimensions were given in old books, were reconstructed full size or to a scale, and their pitches measured. Then the records of other investigators of pitch were searched, and their procedure ascertained. The chief of these were the measures made by Scheibler; by Näke with Scheibler's forks; by Delezenne with a sonometer tuned to a fork of Marloye's, the accuracy of which I tested; by Lissajous, probably with the siren and bellows of constant pressure; by Cagnard de la Tour with the siren; and the older determinations of Dr. Robert Smith (master of Trinity College, Cambridge), Fischer (of Berlin), Euler, and Marpurg made with a weighted string. From these, together with my own, I collected more than 320 pitches, nearly half of which were for the first time measured by myself, reaching from A.D. 1361 to the present day, and on these the following history is based.

Early musical pitch was of two kinds, known as the *Church pitch* (*Chor-Ton*, *Ton de Chapelle*) and the *Chamber Pitch* (*Cammer-Ton*, *Ton de Chambre*), the former adapted to the ecclesiastical tones, the latter to the freer secular music performed in the private apartments or "chamber" of the prince, for his own pleasure, as the band used both in church and chamber consisted generally of his paid servants. Chamber pitch was also generally used for private, secular, and convivial music of all kinds. The confusion in most books between these two pitches is exceedingly great, and the confusion has been increased by Prætorius, 1619, who insists upon calling the higher pitch the chamber pitch, whether it was used in church or chamber, and who introduces a new pitch, which he considers suitable to church (*chormässig*).

That the general reader should be able from the first to form some practical notion of differences of pitch, it may be mentioned that "mean pitch," as it will be called, or Handel's and Prætorius's suitable pitch, is still used in the three churches I have described as using mean-tone temperament, and with equal temperament at All Hallows the Great and Less, Upper Thames Street, at the German Chapel Royal, St. James's Palace, and in many country organs, as Wimbledon, St. George's Chapel at Great Yarmouth, St. Nicholas at Newcastle-on-Tyne. The "French pitch," about a quarter of a tone higher, may be heard at Fulham parish church, in many country churches, as Arundel, Barking, St. Mary's, Shrewsbury, and will be probably heard at the Covent Garden Opera this season. An ancient "medium pitch," about the tenth of a tone sharper than the French, now adopted as a church organ pitch by all the principal organ-builders, unless some other pitch is specially ordered, may be heard on a genuine old organ at Hampton Court Palace, and on the present modern alterations of the old organs at Westminster Abbey, St. Paul's Cathedral, the Temple Church, Whitehall and St. James's Chapels Royal, and many other organs. It is practically what the Society of Arts pitch was intended to be. The modern high "orchestral pitch" used at present in England, which is also the *highest* pitch used by Broadwood, Erard, Steinway, Brinsmead, and other pianoforte makers, may be heard on the organs at the Albert Hall and Alexandra Palace, and at the Crystal Palace; also at St. Michael's Church, Cornhill. Exeter Hall organ is a little flatter, and about the pitch used in France just before the introduction of the Diapason Normal. To get the true sensation of these pitches, however, the organs should be heard at nearly 60° F., as they rise and fall rapidly with the temperature. But the interval between the highest and lowest of these pitches is only five-eighths of a tone, and merely represents the rise in pitch since the Congress of Vienna.

The great organ at Halberstadt (twenty-nine miles south-west of Magdeburg, in Prussian Saxony) was perhaps the first organ with three manuals and a pedal. It was finished February 23, 1361, by Nicholas Faber, and restored in 1495 by Gregory Kleng. It existed, unused, in the days of Prætorius, 1619, who figured its keyboards, described it, and gave the measurements of its largest pipe, B *natural*, four octaves below the B just above the bass staff, which was probably unaltered in length by Kleng, so that it gives a pitch 500 years old, the earliest I have been able to obtain. I had a pipe constructed to a scale of one-sixteenth, sounding four octaves higher, and by measuring its pitch at 59° F. under three inches' pressure of wind, I obtained A 506 (to the nearest whole number of vibrations to which I here limit myself). This is a minor Third above mean pitch, and five-quarters of a tone above our highest orchestral pitch. This estimate agrees with Prætorius's. Now this high pitch and a corresponding very low pitch are thus justified by Schlick of Heidelberg, 1511, who says: "The organ is to be suited to the choir and properly tuned for singing, for where this is not considered, persons are often forced to sing too high or too low, and the organist has to play the chromatics, which is, however, not convenient for every one. But what is the proper length of the pipes for this purpose, and convenient to the choir to sing to, cannot be exactly defined, because people sing higher or lower in one place than in another, according as they have small or great voices. However, if the longest pipe, the F below the Gamma ut [that is, F just below the bass staff], has its body down to the [beginning of the] foot, sixteen times the annexed line [which was 4⅝ Rhenish inches long, so that the pipe was 6⅙ Rhenish feet in length], I think it will be a suitable length for the choir. But if you build an organ a fifth larger, then you must make C in the pedal [that is, C on the second leger line below the bass staff] of this length." And then he goes on to explain how these dimensions best suit the ecclesiastical tones, going through each in succession, and gives the preference to the first pitch with the 6⅙ Rhenish foot pipe on F. Now, making models of the proper dimensions, I found the first pitch was A 377, which is a whole tone flatter than mean pitch, and more than a minor Third flatter than our highest orchestral pitch; and the second pitch was A 504, that is, the same as the Halberstadt organ (for one or two vibrations are an insensible difference in organ pitch for the tuning A). We have then the same man, at the same time and for the same purpose—the ease of playing and singing ecclesiastical tones—recommending two pitches a whole Fourth apart. The lower of these pitches was greatly developed in France. Delezenne found it as A 374 in a dilapidated organ near Lille, at L'Hospice Comtesse. I found it in a model of Dom Bédos's dimensions, 1766, and he is still the great authority on organ-building. Mr. Hopkins, of the Temple Church, found it probably in Strasburg on organs built for the French, about 1714, by the great German organ-builder, A. Silbermann. The Rev. Sir F. A. Gore-Ouseley says that most untouched organs in France are of this pitch. A great deal of this depth is to be attributed to the lengths of the foot to which builders worked. The old French foot was 6 per cent., the Rhenish foot 3 per cent. longer than the English; hence the pipes of a French, Rhenish, and English foot long differed so that the French was half and the Rhenish a quarter of a tone flatter than the English. Hence, when to raise the French pitch the French one-foot was made to sound B instead of C (as at Versailles, 1789, giving A 396), the pitch practically coincided with the English one-foot pipe put upon C (as at Trinity College, Cambridge, 1759). This seems to have been also the lowest Roman pitch very nearly (uncertain whether A 395 or A 404). Such was the low church pitch which was principally worked out in France, the English example being solitary so far as my researches extend.

The high church pitch was chiefly worked out in Germany, but seems also to have found favour in England before the Protectorate, and was also partially developed in France. In Germany we had Halberstadt and Schlick, already cited, and even at the present day we find A 484 at Lübeck Cathedral, A 481 at St. Catharine's, Hamburg, A 489 (formerly, now 494) at St. James's (St. Jacobikirche), in the same town. In England we had a pitch of A 474, recommended by Tomkins, 1668, and realised in Father Smith's old Durham organ, 1683, and his St. James's Chapel Royal Organ, 1708, and in Jordan's, St. George's, Botolph Lane, 1748, and probably in many other early English organs. Unfortunately the Puritans smashed all our English organs in 1644–46, so that with us organ tradition is rudely broken. Prætorius, however, mentions a pitch much used in churches in North Germany, which he persists, however, in calling chamber pitch. On examining the compass of the voice which he has written in this pitch, I find that it could not have been flatter than A 567, that is a Fourth sharper than mean pitch, so that it was related to mean pitch as Schlick's high to Schlick's low pitch. On comparing the highest notes which Orlando Gibbons (1583–1625) wrote for the different voices in his church music, with those assigned by Prætorius, 1619, it would seem that he used nearly this very high pitch, and Prætorius himself says that "the English pitch on instruments is a very little (*ein gar geringes*) lower." In France Mersenne's church pitch does not go higher than A 504, which agrees with Schlick and Halberstadt, that is it was a minor Third above mean pitch. And even in Prætorius's time organs were often at this pitch, or a tone flatter than his sharpest. In the Franciscan convent at Vienna we have the lowest form of this old high church pitch in its smaller organ, untouched since 1640, and giving A 458, practically our English highest concert pitch.

Early chamber pitch, like early church pitch, by which it was primarily determined, was also both high and low. As the same band played in church and chamber the differences were always some definite interval of the scale, so that they amounted to a transposition often very troublesome. The mean-tone scale may be considered to have been always in use at this period, as the numerous others which were invented were generally slight alterations of it. This scale differed from the modern equal scale in having a narrower whole tone and having two kinds of semitones, the large from B to C and E to F, the small from F to F *sharp*, B *flat* to B, that is for chromatic intervals. Expressed in vibrations, the great semitone was 7 per cent. of the vibrations of the lower note, the small semitone 4½ per cent., while the equal semitone is 6 per cent. and the just 6⅔ per cent. The mean tone is 12 per cent., the equal tone 12¼ per cent. All this rendered the mean tone scale unsuited for transposition or for shifting of pipes in re-arranging an organ; yet both constantly occurred in former times. The higher chamber-pitch was generally a great semitone to a mean tone, or mean minor Third, or even a Fourth flatter than its corresponding higher church pitch. And these chamber pitches came to be used in churches in place of the highest church pitches. There seems little doubt that the high church pitches, except the very highest, were similar depressions of the very highest. In France, however, Mersenne, 1636, gives us a chamber pitch, A 563, which was a tone *higher* than his own high church pitch A 504, and corresponded to Prætorius's highest pitch already mentioned. These depressed church pitches were, however, still too high for most chamber music, and they were still further flattened. The most curious instances are in Hamburg, where the St. James's organ, 1688, built after the ecclesiastical tones of Roman Catholicism had become a tradition, was yet so high as A 489, and had on it one stop (as late as 1761, when it was removed), which was a whole minor Third *flatter* than the rest of the organ, that is, in the chamber pitch of the time and place. And Mattheson the composer (1681–1764), an early friend of Handel, had St. Michael's Church organ, to the building of which, in 1762, he contributed upwards of 3,000*l*., tuned to A 408—most certainly the true chamber pitch of the time. It is curious that this pitch, a small semitone flatter than mean pitch, was as nearly as possible that used by Taskin, A 409, who was court-tuner to Louis XVI. in France, 1783, very nearly of the same time, and that this corresponds well with the pitch A 407 found by Sauveur in 1704. This became a low chamber pitch, and conflicted with that derived from the low-pitched organs.

Mean pitch, as I have termed it, seems to be the result of this conflict. This pitch was formally introduced by Prætorius as the most suitable pitch he could find for Protestant church music, and it was fixed by a drawing of the dimensions of his pipe, 1619, whence I had one constructed which gave C 507, corresponding to mean tone A 424, and this was also the precise pitch to which the London Philharmonic Society played from its foundation, 1813, to 1828. The mean pitch varied slightly within the limits A 415 (found in G. Silbermann's organ at the Roman Catholic Church, Dresden, 1722, as determined by forks chained to it by King Frederick August der Gerechte, which remained till 1824, one of which I have myself measured—this organ gave A 418 in 1878), and A 428, used by Renatus Harris, 1696. The mean of this is A 422½, which is the pitch of Handel's own fork, a pitch which I also found at Verona, and at Padua about 1780, and Delezenne found at Lille about 1754. This is also the pitch of Green's organs at St. Katharine's, London, and Kew Parish Church, both A 423, and St. George's Chapel, Windsor, A 428. The fork of Stein, maker of pianos to Mozart, was A 421½. Seville Cathedral and all Spanish church organs are about A 420 even now, which is also the pitch of G. Silbermann's Freiberg Cathedral organ. In recent times, 1860, this was the pitch of the Russian Court church band. The fork of the Opéra Comique in Paris, 1820, was A 423, and in 1823 was A 428. The fork of the Dresden Opera under Carl Maria von Weber (1813-21) was at A 423. In short throughout Europe this pitch prevailed, as shown by above sixty pitches which I have collected. The resonance of the air in the Cremona violins, about 1700, shows two maxima, the principal about C 270, and the other not so well marked, about C 252½, corresponding to A 451 and A 422. The latter is mean pitch; the former, a great semitone higher, was the corresponding chamber pitch. It was during this period that the founders of modern music wrote, and hence adapted their vocal music to mean pitch, which must be considered as the classical musical pitch, to which our present orchestral pitch stands in the relation of a chamber pitch a great semitone higher. The establishment of this fact is perhaps the most important practical conclusion of my investigations. A curious metrical relation also leads to a useful classification of old organs having the mean-tone temperament. Mean pitch corresponded to organs with a B-pipe one English foot long, and I call these B foot organs, A 419 to A 428. The old sharp English pitch of Father Smith at Durham had the one foot pipe on A, and I call these A foot organs, being a tone sharper than the other, A 468 to A 475. An intermediate medium pitch, also used by Father Smith at Hampton Court, into which his sharp pitch was frequently altered by shifting the pipes, had the one-foot pipe on B flat, A 438 to A 444. The lowest organs, of which that in Dr. R. Smith's time at Trinity College, Cambridge, is the only example I know for certain in England, had the one-foot pipe on C, and was a C foot organ, A 395 to A 404, which was equivalent to a French B foot organ, pitch A 396. The variation of pitch here indicated depends mainly on the difference of the "scale" or ratio of the diameter to the length of a pipe used by different builders. Of course the introduction of equal temperament has slightly altered these relations.

The unfortunate break-up of mean pitch in modern times seems to have been entirely accidental, and certainly bears no trace of systematic plan or execution. It has been both aimless and vacillating—often merely capricious. I find no mention of any opposition to mean pitch till the French Conservatoire in 1812 used A 440, apparently as an experiment, for it found no adhesion. This pitch, afterwards proposed by Scheibler, and adopted by a congress of physicists at Strassburg in 1834, was really a resuscitation of the English B *flat* foot organ pitch. The great change was initiated by the presentation by the Emperor of Russia and an Austrian Archduke of sharper brass instruments to two household regiments in Vienna in 1816, and this subsequently entailed a rise at the two Vienna operas, which had to use these bands occasionally. The sharpening spread slowly and grudgingly through most of Germany. At Dresden it rose from the flutist Fürstenau getting a new flute from Vienna, but had not quite reached A 440 in 1862. At the celebrated Gewandhaus concerts at Leipzig the sharpening went on more rapidly to A 449 in 1859, and in France, after a very chequered career, the pitch of the Grand Opera, which was A 427 in 1811, and A 434 to 440 in 1829, where it remained to about 1854, became A 448 to 449 in 1858, when the great increase of pitch and the diversity of standards used in different towns induced the French Government to issue a commission, which resulted in establishing the French Diapason Normal A 435 in 1859. This pitch, being a quarter of a tone above mean pitch and about the same below the high orchestral pitch then reigning, enabled music of both kinds to be sung with tolerable ease. And this is of great importance, for we cannot afford to discard either classical or modern music, and to sing either to the pitch of the other is to do injustice to both composer and singer. The sudden change was, however, troublesome and expensive, although France, like England, had passed through that pitch without any complaint a few years before.

In England the increase of pitch abroad apparently induced Sir George Smart to alter the Philharmonic pitch about 1828, after consultation with singers, and he raised his fork to A 433, keeping, however, mean-tone temperament. This is practically the French normal, and the mean-tone C of Sir G. Smart actually coincides with the equally-tempered C of the French. This fork was long in use, and copies of "Smart's C" were greatly in vogue down to 1846 and later, stamped "Philharmonic," although the Philharmonic Society never issued a fork. But under the *bâton* of Sir Michael Costa the pitch rose rapidly, and the mean pitch from 1846 to 1854 was A 452½. The Society of Arts in 1859, in imitation of the French Commission, called together a large committee of musicians and men of science, who decided on C 528, to which they supposed would correspond A 440 (which would be just intonation), instead of A 444 (in equal temperament). Mr. Griesbach was commissioned to make the standard, but his C 528 turned out to be C 534·5, giving A 449·4, but incorrectly tuned as A 445·7 by a short monochord. Hence, in the market, the Society of Arts pitch is one of those very sharp pitches which it was intended to moderate. In 1874 the Philharmonic Concerts reached their maximum of A 454·7, and Steinway's pianos—which in England are at this pitch, in common with Broadwood's, Erard's, Brinsmead's &c.—at New York have gone up to A 457. Hence we have most undesignedly reached a chamber pitch, a great semitone above the classical music, and most unmusicianly play classical compositions written for mean pitch at this disfiguring sharpness. Covent Garden Opera has, however, resolved to adopt the French compromise system this season. Abroad in Germany, after a very general adoption of the French Normal, orchestral pitch again rose, and Vienna, which had reached A 456 before 1859, was at A 447 in 1878. The rest of Germany seems to be lower, Dresden intending to be A 440, but really slightly flatter. Bologna was A 443 in 1869, and the rest of Italy is probably not greatly different. There is, however, but one standard of pitch now in the world, the Diapason Normal at the Conservatoire at Paris, actually A 435·4, and even Belgium, which has a military standard of A 451 (the same as the British Army Regulation), had decided by a Commission to adopt French pitch, which only the expense of providing new instruments to the army at present prevents.

The above rapid survey of the history of musical pitch may be condensed into the following table, in which all such pitches as I have here mentioned, together with a few others, are included. The column T gives the number of *tenths* of an equal semitone by which any pitch exceeds the initial zero pitch, so that by subtraction of their *tenths* the interval between any two pitches in the table may be instantly ascertained. The column marked A gives the nearest whole number of vibrations of A in numerical order from the lowest to the highest, embracing an interval of a whole Fifth. As it takes an increase of two or three vibrations at these pitches to rise by the tenth of a semitone, the same tenths will be found to correspond to different numbers of vibrations, all being given to the nearest whole number only.

CONDENSED HISTORY OF MUSICAL PITCH

T.	A.	
		1. Church Pitch Lowest.
0	370	Zero pitch, not observed.
2	374	L'Hospice Comtesse, Lille.
3	377	Schlick, low, 1511; Bédos, 1766; French C foot organs; A. Silbermann at Strassburg, 1714.
		2. Church Pitch Low.
10	392	Euler's clavichords, St. Petersburg, 1739.
11	395	Trinity College organ, 1759; English C foot organs; Roman pitch pipes, 1720.
12	396	Versailles Chapel, 1789; French B foot organs.
		3. Chamber Pitch Low.
15	404	Roman pitch, 1730, from a fork.
16	407	Sauveur, Paris, 1713.
17	408	Mattheson, Hamburg, 1762.
„	409	Pascal Taskin, Paris, Court Clavecins, 1783.
		4. Mean Pitch for Two Centuries, English B foot Organs.
20	415	Chained fork of the Roman Catholic Church organ, built by G. Silbermann, 1722.
21	418	Same organ in 1878. Euler's organs, 1781.
22	420	G. Silbermann's Freiberg organ, 1714; Torje Bosch's Seville Cathedral organ, 1785; and all church organs in Spain.
23	422	Stein's fork for Mozart's pianos, 1780; Lower resonance of Cremona violins, 1700; Old fork at Lille, about 1754; Verona and Padua, 1780; Russian Court church band, 1860.
„	423	Handel's fork, 1751; Green's St. Katharine's, 1778, and Kew, 1790; Dresden Opera under Weber, 1815-21; Paris Comic Opera, 1820.
24	424	Prætorius's "suitable" church pitch, 1619; Original Philharmonic Concerts, 1813-1828.
25	427	Paris Grand Opera, 1811.
„	428	Renatus Harris's organs, 1696; Green's St. George's, Windsor Castle, 1788; Paris Comic Opera, 1823.
		5. The Compromise Pitch.
27	433	Sir George Smart's fork, 1828.
„	434	Paris Grand Opera, 1829.
28	435	French Diapason Normal, 1859.
		*6. Modern Orchestral and *Ancient Medium Pitch.*
30	440	Paris Conservatoire, 1812; Paris Opera, 1829; Scheibler's Stuttgart pitch, 1834; Dresden, 1862.
31	442	*Father Smith's (= Bernard Schmidt's) low pitch at Hampton Court Palace, 1690; English B flat foot organs.
„	443	Bologna, Liceo Musicale, 1869.
32	445	Madrid, Opera, 1858; Naples, S. Carlo, 1857.
„	446	Broadwood's medium, 1849-80; Paris, Grand Opera, 1856; Griesbach's A 445·7, 1860, for Society of Arts, meant for A 444.
33	447	Vienna Opera, 1878.
34	449	Paris Grand Opera, 1858; Leipzig, Gewandhaus Concerts, 1859; Griesbach's C 534·5, 1860, for Society of Arts, meant for C 528.
35	451	Lille Opera, 1848 and 1854; British and Belgian Military Instruments Standard, 1879; Higher resonance of Cremona violins about 1700.
„	453	Mean of the Philharmonic Concerts under Sir M. Costa, 1846-54.
36	455	Highest Philharmonic, 1874; Broadwood's, Erard's, Brinsmead's, and (English) Steinway's concert pianos, 1880.
„	456	Vienna celebrated high pitch before 1859.
37	457	(American) Steinway's pianos.
		7. Church Pitch High.
37	458	Vienna, large Franciscan organ, 1640.

T.	A.	
43	474	Tomkins's standard, 1668; Father Smith's high pitch at old Durham and old St. James's Chapel Royal organs, 1683 and 1708; the Jordans, at St. George's, Botolph Lane, 1748; English A foot organs.
45	481	St. Catherine's, Hamburg, 1543.
46	484	Old smaller organ in Cathedral, Lübeck.
48	489	St. James's (S. Jacobi), Hamburg, original pitch, 1688.
		8. *Church Pitch Highest.*
50	494	St. James's (S. Jacobi), Hamburg, present pitch, 1879.
51	496	Rendsburg organ, 1668.
53	504	Schlick's high pitch, 1511; Mersenne's *ton de chapelle*, 1636.
54	506	Halberstadt organ, 1361.
		9. *Church Pitch Extreme and Chamber Pitch Highest.*
73	563	Mersenne, *ton de chambre*, 1636.
74	567	Usual church pitch in North Germany in 1619, called chamber pitch by Prætorius. Probable pitch of church music of Orlando Gibbons (1583-1625).

ALEXANDER J. ELLIS

THE ATOMIC WEIGHT OF ANTIMONY[1]

IN a previous paper on this subject,[2] we gave our reasons for the opinion, since fully confirmed, that the bromide of antimony is the most suitable compound of this element, as yet known, for determining its atomic weight; and the results of fifteen analyses of five different preparations of the bromide were published, which gave for the atomic weight in question the mean value 120·00 with an extreme variation between 119·4 and 120·4 for all the fifteen analyses, and between 119·6 and 120·3 for the six determinations in which we placed most confidence. The antimonious bromide used in these determinations was purified first by fractional distillation, and secondly by crystallization from a solution in sulphide of carbon. In the crystallised product thus obtained, the bromine was determined gravimetrically as bromide of silver in the usual way. Although it seemed at the time that the results were as accordant as the analytical process would yield under the unfavourable conditions, which the presence of a large amount of tartaric acid in the solution of the bromide of antimony necessarily involved; yet it was obvious that the agreement was far from that which was desirable in the determination of an atomic weight, and our chief confidence in the accuracy of the mean value—independently of its remarkable agreement with previous results—was based on the fact that the known sources of error tended to balance each other. Hence our conclusions were stated with great caution, and the hope was expressed that after a more thorough investigation of the subject we might be able "to return to the problem with such definite knowledge of the relations involved as will enable us to obtain at once more sharp and decisive results than are now possible." Unfortunately this investigation has been delayed by causes beyond our control.

In our previous paper we described a simple apparatus which we devised for subliming iodide of antimony; and in a note to the paper we stated that we were applying the same process to the preparation of the bromide of antimony, and that it promised excellent results. Our expectations in this respect have been fully realised, and the product leaves nothing to be desired either as regards the beauty or the constancy of the preparation. The fine acicular crystals are perfectly colourless, and have a most brilliant silky lustre. With ordinary precautions they can be kept indefinitely without change, and it is easy therefore to determine the weight of the material analysed to the tenth of a milligramme.

We have carefully studied the causes of error involved in the analytical process of determining bromine in an aqueous solution of bromide of antimony and tartaric acid by the usual gravimetric method. These causes we propose to discuss in a future more extended paper. In this preliminary notice we have only space to state that we have satisfied ourselves that the small differences between the results previously obtained arose wholly from the analytical process, and not from any want of constancy in the material analysed; and further that these sources of error are to a very great extent under control. Moreover, we have found that the volumetric determination of bromine by silver was not materially affected, if at all, by the same causes. We have thus been led to devise a mode of testing the atomic weight of antimony, which, while it has all the advantages of the gravimetric method previously employed, is free from its sources of error.

If the atomic weight of antimony were 122·00, it would require 1·7900 grammes of pure silver to precipitate the bromine from a solution of 2·0000 grammes of antimony bromide, while if the atomic weight of antimony were 120·00 it would require 1·8000 grammes of silver. Now it is easy to estimate volumetrically $\frac{1}{10}$ of this difference with great certainty. We therefore prepared with great care a button of *pure* metallic silver, which we annealed and rolled out to a thin ribbon. We then weighed out from two to four grammes of bromide of antimony, prepared by sublimation as described above, and dissolved this salt in an aqueous solution of tartaric acid, which we then transferred to a litre flask and diluted to about 500 cubic centimetres. We next very accurately weighed out a quantity of silver slightly less than that which calculation showed was required for complete precipitation. This silver was dissolved in nitric acid, and the solution having been evaporated to dryness over a water bath, the silver salt was washed into the flask containing the bromide of antimony. As soon as the supernatant liquid had cleared, the small additional amount of a normal silver solution required to produce complete precipitation was run in from a burette, and measured with the usual precautions. We used no extraneous indicator, because it was important not to introduce any possibly new disturbing element into the experiment, and in the titration of bromine with silver the normal and familiar phenomena, which mark the close of the process, furnish a very sharp indication. The details of one of the determinations were as follows:—

The weight of the bromide of anatomy used amounted to 2·5032 grammes. To precipitate the bromine from the solution of this material 2·2404 grammes of silver would be required if Sb = 122·00 and 2·2529 if Sb = 120·00. We weighed out, with as much accuracy as if we were adjusting a weight, the smaller of these two quantities of metallic silver, and after dissolving the pure metal in pure nitric acid, evaporating the solution to dryness and redissolving in water, we added at once the whole of this silver solution to the litre flask containing the solution of bromide of antimony, in the manner described above. It was then found that $12\frac{4}{10}$ cubic centimetres of a normal silver solution (one gramme of silver to the litre) were required to complete the precipitation. It will be seen that the weights of the bromide of antimony and silver used could be thus determined with the most absolute precision, and we have the greatest confidence in these values to the $\frac{1}{10}$ of a milligramme. Moreover, it will be noticed that the volumetric method is only used to estimate the difference in the atomic weight which has been in question, and that if the method were only accurate to the $\frac{1}{10}$ of the quantity to be measured it would give us the value of the atomic weight within $\frac{2}{10}$ of a unit; while if, as we had reason to believe, the process was accurate within 1 per cent, it would fix the atomic weight within $\frac{2}{100}$ of a unit.

By the method just described, the following results were obtained. The letters *a* and *b* indicate different preparations.

Wt. of Sb Br$_3$ taken.	Total wt. of Ag used.	Per cent. of Br Ag=108 Br=80.	Corresponding value of Sb.
a 1. 2·5032	2·2528	66·6643	120·01
a 2. 2·0567	1·8509	66·6620	120·02
a 3. 2·6512	2·3860	66·6644	120·01
b 4. 3·3053	2·9749	66·6696	119·98
b 5. 2·7495	2·4745	66·6653	120·01
	Mean value	66·6651	120·01

Mean value of fifteen gravimetric determinations previously published	66·6665
Theory Sb. 120 requires	66·6666
,, Sb. 122 ,, ...	66·2983

In order still further to control the work, we collected the bromide of silver formed in the last two determinations, washing the precipitate with the precautions which experience had shown to be necessary, and determining its weight, first, after drying at 150° C., and, secondly, after heating to incipient fusion. In

[1] Contributions from the Chemical Laboratory of Harvard College. Preliminary notice of Additional Experiments. By Josiah P. Cooke, Erving Professor of Chemistry and Mineralogy.

[2] *Proc.* Amer. Acad. Arts and Sciences, vol. xii. page 1.

b 6 there was a loss of $\frac{1}{10}$ of a milligramme; in *b* 7 a loss of $\frac{2}{10}$ of a milligramme only at the second weighing. This is an absolute proof that there could be no sensible occlusion of any tartaric acid or any tartrate by these precipitates, and, as stated in our original paper, the same test was frequently applied, although not always in our previous determinations. It is also evident that these last experiments give us two essentially distinct determinations of the atomic weight, although the materials employed were identical with those of *b* 4 and *b* 5.

Wt. of Sb Br_3 taken.	Wt. of AgBr determined.	Per cent. of bromine Ag=108 Br=80.	Corresponding value of Sb.
b 6. 3·3053	5·1782	66·665	120·01
b 7. 2·7495	4·3076	66 667	120·00
Mean value	... ...	66·666	120·00

Lastly, it is obvious that these gravimetric determinations, taken in connection with the corresponding volumetric results, give us the most conclusive evidence of the purity, both of the metallic silver used, and also of the bromine in the bromide of antimony, which is the basis of this atomic weight investigation. By comparing *b* 6 and *b* 7 with *b* 4 and *b* 5 respectively, we obtain the following data:—

1. 2·9749 gram. of silver gave 5·1782 gram. bromide of silver.
2. 2·4745 ,, ,, 4·3076 ,, ,,

Hence it follows that, as shown by these experiments, the proportions of the silver to the bromine were respectively:—

1. 108·00 Silver to 79·99 Bromine.
2. 108·00 ,, 80·01 ,,

Mean value 108·00 ,, 80·00 ,,

This is the ratio of the atomic weight of silver to that of bromine, and corresponds to the second decimal place with the determinations of Stas as well as with those of Dumas.

In conclusion it gives us pleasure to express our obligations to Mr. G. De N. Hough and Mr. G. M. Hyams, two students of this laboratory, who have greatly aided us in the experimental work of this investigation.

SOCIETIES AND ACADEMIES

London

Royal Society, March 11.—"Report on the Fossil Flora of Alum Bay," by Baron Ettingshausen. The materials upon which the report is based were stated to be in the British Museum, Museum of Practical Geology, Woodwardian Museum, and in Mr. J. S. Gardner's collections. The fossil flora of Alum Bay contains, according to the author, about 116 genera and 274 species belonging to 63 families. Of these genera 3 are said to be Thallophyta, 2 Filices, 5 Gymnospermæ, 6 Monocotyledons, 28 Apetalæ, 15 Gamopetalæ, 54 Dialypetalæ, and 2 indeterminable. A number of genera are enumerated which the author supposes to be common to Alum Bay and Sheppey, and hence he infers, as Heer did, that there is a close connection between the two floras. The small number of ferns and palms in comparison with the much greater number at Bournemouth and of palms at Sheppy is remarkable. Many of the dicotyledons are stated to show a genetic connection with miocene species, and a great number of the latter are seen to have originated as far back as the eocene. On the other hand some of the miocene genera were not completely differentiated into genera in the eocene period. Two examples are given: Castanea, which although perfectly developed in the miocene, is said to be only represented in the eocene by a castanea-like oak, uniting characters now distinctive of the two genera, and a Pomaderris-like Rhamnus, also seeming to unite two genera which were quite distinct from each other in the miocene.

More than fifty of the species from Alum Bay are common to Sotzka and Hæring, while a lesser number are common to Sézanne, the Lignitic of America, and to other floras. The paper includes a list of species.

In the discussion Dr. Carruthers could not quite agree with determinations which brought together plants from all parts of the globe. Mr. Mitchell questioned the utility of giving specific names to plant remains that are neither described nor figured, especially when no nearer approximation to their position can be made than is indicated by the terms Carpolithes and Phyllites. Mr. Gardner explained the position of the leaf-bed at Alum Bay, stating it to be a small vertical clay basin, similar to those found in a horizontal position near Bournemouth; and hence he did not consider it remarkable that the flora from Alum Bay should appear restricted (as indicated by the paucity of palms and ferns) by comparison with the Bournemouth flora, which has been obtained from a series of basins extending for several miles.

Chemical Society, March 30.—Anniversary meeting.—Mr. Warren De la Rue, president, in the chair. The president, in his annual address, contrasted the condition of the Society during the past year with its position in 1869. The number of Fellows has increased from 522 to 1,034, the income from 1,100*l.* to 2,700*l.*; papers read from 31 to 75. A rapid glance was then taken of the recent progress of chemistry, especial reference being made to the decomposition of the elements chlorine, bromine, &c., by Meyer; the photographs of the whole of the spectrum recently made by Capt. Abney; the artificial production of the diamond by Hannay; the synthesis of vegetable colouring matters and alkaloids; the discovery of a new element, scandium, &c. The officers for the ensuing year were then balloted for; the following were elected:—President—H. E. Roscoe. Vice-presidents—F. A. Abel, C.B., B. C. Brodie, Warren De la Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, A. W. Williamson, J. Dewar, J. H. Gilbert, N. S. Maskelyne, V. Harcourt, R. Angus Smith, J. Young. Secretaries—W. H. Perkin, H. E. Armstrong. Foreign Secretary—Hugo Müller. Treasurer—W. J. Russell. Other members of council—M. Carteighe, C. Graham, C. W. Heaton, H. McLeod, E. J. Mills, J. M. Thomson, W. C. Roberts, W. A. Tilden, W. Thorp, T. E. Thorpe, J. L. Thudichum, R. Warington.

Anthropological Institute, March 23.—Edward B. Tylor, F.R.S., president, in the chair.—A paper by Mr. V. Ball, M.A., F.G.S., on Nicobarese ideographs was read. As the Andamanese may be said to have not progressed in civilisation beyond that stage which was represented by the people of the early stone periods in Europe, so the Nicobarese, who are much less savage and degraded than their neighbours of the Andamans, may justly be compared with the inhabitants of the "bronze period." The example of Nicobarese picture-writing described by the author was obtained in the year 1873 on the island of Kondul, where it was hanging in the house of a man who was said to have died a short time previously; it is now in the Museum of Science and Art at Dublin. The material of which it is made is either the glume of a bamboo or the spathe of a palm which has been flattened out and framed with split bamboos. It is about three feet long by eighteen inches broad. The objects are painted with vermilion, their outlines being surrounded with punctures which allow the light to pass through. Suspended from the frame are some cocoanuts and fragments of hog's flesh. The figures of the sun, moon, and stars occupy prominent positions. Attention was directed to M. Maclay's description of a Papuan ideograph which symbolised the various guests present at a feast given in celebration of the launch of two large canoes (*vide* NATURE, vol. xxi. p. 227).—Mr. Alfred Tylor read a paper on a new method of expressing the law of specific changes and typical differences of species and genera in the organic world, and especially the cause of the particular form of man. The lower animals have no abstract ideas, and therefore all they can know must be derived from objects. Their reproduction of specific form and decoration seems to prove that they possess a mental power of appreciating the niceties of form and colour in a very high degree The forms and decorations of organised beings seem to be regulated by laws which the author provisionally called *emphasis* and *symmetry*. Emphasis was defined as the marking out by form or decoration of the important parts or organs. The law of emphasis, as applied to human work, was illustrated by the structure of a Greek temple, in which all the parts have their functions expressed or emphasised by ornament. It is a remarkable fact, and one that can scarcely be accidental, that just as animals fall naturally into two great classes, the *vertebrata* and *invertebrata*, so the emphasised functional decorations group themselves into two classes, and these two classes are identical with the vertebrata and the invertebrata. In the vertebrata the emphasised ornamentation is what we may call axial, being the outward expression of the central axis or vertebral column with its appendages; and in the invertebrata the decoration tends to follow the outline of the animal, and so develops borders. It has always excited wonder that the child—a separate individual—should inherit and reproduce the characters of its parents and indeed of its ancestors, but if we remember that the great law of all living matter is that the child is *not* a separate individual, but a part of the living body of the parent, up to a certain date, when it assumes a separate existence, then we can comprehend how living beings inherit ancestral characters, for they are parts of one continuous series in which not a single break has existed or can ever take place. Just as the wave-form over a pebble in a stream remains constant, though the particles of water which compose it are ever changing, so the wave-form of life, which is heredity, remains constant, though the bodies which exhibit it are continually changing. Mr. Tylor's paper was illustrated by a large number of diagrams.

Royal Microscopical Society, March 10.—Dr. Beale, F.R.S., president, in the chair. Fifteen gentlemen were nominated or elected Fellows.—Mr. Beck exhibited an improved form of microscope with swinging sub-stage; Mr. Mayall a new traverse lens, by Mr. Tolles; Mr. Dunning a new form of turn-table; Dr. H. Gibbes a $\frac{1}{12}$-homogeneous immersion objective for use with the binocular; and Mr. Crisp Klönne and Müller's demonstration microscope and a specimen of micrometric ruling by Prof. Rogers, of Harvard, U.S.—Mr. James Smith described his method of illumination for high powers.—The following papers were read:—On a sponge parasitic within *Carpenteria raphidodendron*, by Prof. Martin Duncan, F.R.S.—On a petrographical microscope, by M. Nachets.—On double and treble staining of animal tissues, by Dr. H. Gibbes.—On *Podophyra quadripartita*, by Mr. Badcock.

Institution of Civil Engineers, March 23.—Mr. W. H. Barlow, F.R.S., president, in the chair.—The paper read was on explosive agents applied to industrial purposes, by Prof. Abel, C.B., F.R.S.

Edinburgh

Royal Society, March 15.—Lord Moncrieff, president, in the chair.—By request of the Council, Lieut. Conder, of the Royal Engineers, gave an interesting and detailed lecture on the topography of Jerusalem.—Dr. James Geikie presented a communication on the geology of the Farö Islands, which he had visited last summer in company with Mr. Amund Hellend, of Christiania. In the absence of the author, the paper was read by Prof. Geikie. It was divided into two portions, the first treating of the more purely geological characteristics of the islands, which consist mainly of miocene volcanic formations intermingled with coal and clay deposits and attaining a thickness of from 10,000 to 12,000 feet; and the second part bearing particularly upon the evidences of glacier action. There were all the indications of prolonged glaciation, striæ, moraines, boulder-clay, &c.; but there was no evidence that this action was the result of a great ice-drift from the north. Everything indeed proved the glaciation to have been purely local.—Prof. Tait communicated a note on the colouring of maps. This he reduced to the problem of so lettering by the fewest possible symbols a number of points in a plane which have been joined two and two by non-intersecting lines so as to form three-sided areas, that no two connected points shall have the same name.

Paris

Academy of Sciences, March 29.—M. Ed. Becquerel in the chair.—The following papers were read:—Application of the theory of sines of superior orders to the integration of differential linear equations, by M. Villarceau.—On the determination of high temperatures, by MM. Sainte-Claire Deville and Troost. They describe an improved form of apparatus they used in 1863 (primarily for determining the expansion of porcelain) now simplified by use of a Sprengel *trompe*, by means of which may be removed and measured, whenever desirable, the thermometric matter (nitrogen) contained in the porcelain reservoir, and the temperature be calculated.—On the hypergeometric series of two variables, and on simultaneous differential linear equations with partial derivatives, by M. Appell.—On a class of functions of several variables drawn from inversion of integrals of solutions of differential linear equations, the coefficients of which are rational functions, by M. Fuchs.—On the manner in which frictions come into action in a fluid which departs from the state of rest, and on their effect in preventing the existence of a function of velocities, by M. Boussinesq.—Memoir on integrations relative to the equilibrium of elasticity, by M. Mathieu.—Researches on diffusion, by M. Joulin. This first portion relates to condensation of various gases by porous bodies (charcoal, dry or saturated with liquid), the pressure being varied from a few centimetres to 4 atm., and the temperature from 0° to 100°. The absorbent was put in a glass tube which communicated (through tubes with cocks) with a manometric reservoir and a mercury pump. *Inter alia*, the saturation of dry charcoal with oxygen, nitrogen, or hydrogen is instantaneous, but with carbonic acid slow. Saturation with gaseous mixtures is slower than that with each of the constituent gases. Charcoal soaked with alcohol condenses much less than if soaked with water, and is saturated with gas much more slowly.—On a new property of vanadates, by M. Hautefeuille. Vanadates fused in contact with air rapidly take up a constant quantity of oxygen (bi-vanadate of lithia absorbs in a few minutes more than eight times its volume of this gas at a dark red, and liberates this gas at about 600° during crystallisation). Vanadates liberate *in vacuo*, in passing from the vitreous to the crystalline state, quantities of oxygen variable with the proportions of acid and base, and the nature of the base. This has a bearing on determination of equivalents.—On some properties of mixtures of cyanide of methyl with ordinary alcohol and with methylic alcohol, by MM. Vincent and Delachanal. The topics treated are the boiling points and densities of the mixtures, and a rational method of separating cyanide of methyl from ordinary alcohol.—Experiments showing that the anæsthesia due to certain lesions of the cerebro-rachidian centre may be replaced by hyperæsthesia under the influence of another lesion of that centre, by M. Brown-Sequard. Among other conclusions, the theory that the conductors of sensitive impressions of the limbs intercross in the spinal cord must be rejected; and one lateral half of the base of the brain may suffice for the transmission of sensitive impressions from both sides of the body.—Reflex effects of ligature of one pneumogastric on the heart after section of the opposite pneumogastric, by M. François-Franck. In this a retardation or arrest of the heart occurs, almost as notable as if the cut nerve had been intact; this effect is shown to be reflex. He studied the phenomenon in relation to time, with what he calls a *nevrotome à signal electrique*.—Contribution to the study of the transmission of tuberculosis, by M. Toussaint. From experiments on pigs he infers that where tuberculosis occurs in those animals it is analogous to galloping consumption in man. The bovine species, on the other hand, which have tuberculosis much more often, have most often the chronic variety. Hence young pigs from tubercular parents soon die, and in adults which become tubercular the quick progress of the affection prevents reproduction. The facts also prove that tuberculosis is transmitted with the greatest facility (1) by ingestion of tubercular matters, (2) by heredity or lactation, (3) by inoculation with tubercular matter or blood, (4) by simple cohabitation.—On a mode of treatment of certain infantile cases of deafness or deaf-mutism, by M. Boucheron. The cases referred to are those arising from naso-pharyngeal catarrh, causing the mucus of the Eustachian tube to swell and stop the passage, the stirrup bone, ere long, being, through pressure of external air on the tympanum, made to press strongly on the liquid of the labyrinth, injuring the acoustic nerve. M. Boucheron chloroformises the child and practises catheterism, insufflation of air, and pharyngeal cauterisation with a brush dipped in iodine solution.

CONTENTS

THURSDAY, APRIL 15, 1880

DOES CHLOROPHYLL DECOMPOSE CARBONIC ACID?

THE recent memoirs of Pringsheim, noticed in NATURE, vol. xxi. p. 85, by Mr. Vines ("Untersuchungen über das Chlorophyll," July and November, 1879) suggest very serious doubts as to the correctness of an inference which has crept, without the explicit consent of botanical physiologists, into the position of a fundamental doctrine of biological science. The recent excellent article in NATURE on "Vegetation under Electric Light," together with the discussion which took place at the Royal Society when Mr. Siemens's paper describing his experiments on plants under the influence of the electric light was read, tend still further to make it desirable to examine critically the claims which the inference alluded to has on our adhesion.

The inference in question is this, that the substance known as chlorophyll has the property of decomposing carbonic acid so as to fix the carbon and liberate a portion of the oxygen of that acid when in the presence of sun light. Accordingly it has been said that "Chlorophyll is the hand wherewith the organic world lays hold of the carbon of the inorganic world."

Vegetable physiologists are, however, careful not to commit themselves to such an assertion with regard to chlorophyll itself. The chlorophyll-grains or corpuscles are particles of protoplasm impregnated with chlorophyll much in the same way as the blood corpuscles and other tissues of animals are impregnated with hæmoglobin. It is one thing to attribute the decomposition of carbonic acid to "cells containing chlorophyll," or even to "chlorophyll corpuscles," and another thing to pass from such a wide statement to the definite ascription of the CO_2-decomposing property to the green-coloured substance chlorophyll.

It is perfectly true that by the method of concomitant variation we are led to a conclusion favourable to the *importance* of chlorophyll in this function. It is only by plants (or animals) containing chlorophyll and only in those parts of plants containing it that CO_2 is decomposed and oxygen liberated. Further, it appears that wherever chlorophyll is present *in a living organism* (even an animal) exposed to sunlight, the decomposition of CO_2 takes place. But whilst we are thus justified in *connecting* chlorophyll with the decomposition in question, any conclusion as to its sole efficiency, and accordingly any notion of a specific chemical activity on its part, is forbidden by two important facts: firstly, that living protoplasm is always present in intimate association with the chlorophyll when the decomposition of CO_2 is effected (forming the bulk of the chlorophyll-corpuscle); and secondly, that chlorophyll extracted from the chlorophyll-corpuscle and put to the test *in the absence of protoplasm* has hitherto not been shown to possess the power of effecting the specific decomposition sometimes attributed to it.

Very usually blood-red and leaf-green are placed side by side as complementary, not only in colour, but in function, the one active in oxidation and the special property of the animal, the other active in deoxidation and the special property of the plant. The pleasing agreement in difference which these two bodies apparently present has, no doubt, a real basis in fact, but the actual analogies between them have very possibly tempted the speculative biologist a little too far.[1] Both present remarkable and characteristic absorption spectra, both contain iron, both are diffused in the living albuminoid substance of organisms, the one of plants, the other of animals. Nevertheless a most important fact is true of hæmoglobin, which we have not ground for asserting with regard to chlorophyll, namely, that it can be extracted from the albuminoid substance with which it is associated, and then, when in a pure crystalline state, can be made to exhibit its peculiar property of combining with oxygen and again liberating that oxygen, just as it does in the living tissues.

On the other hand, the peculiar property which has been inferred for chlorophyll, namely, that of seizing the group CO from CO_2 and liberating O under the influence of sunlight, ceases altogether (as far as we know) when the chlorophyll is detached from the living protoplasm of an organism, and no effect of any kind upon CO_2 can be produced by its agency when thus isolated.

In reference to this objection to the assumed function of chlorophyll, it may be urged that the chlorophyll, when extracted from the chlorophyll-grain, is chemically altered by the solvent (alcohol or ether) used. To this it appears there is a complete answer. By chlorophyll we mean clearly enough the *green* substance present in the chlorophyll corpuscles. This substance is green in virtue of a specific absorption of light, which happens to be of such a nature as to cause definite well-marked bands of absorption in the spectrum of light which has passed through it. The solution obtained by appropriate treatment of green leaves gives precisely the same absorption-bands as does the green substance in the plant (the whole series being moved a very little to the blue end according to the known law that absorption-bands travel in that direction when a less dense solvent is substituted for a more dense one). Hence the *green* substance, to which we have to limit the term chlorophyll, may be inferred to exist unchanged in the solution.

The persistence of a complex banded absorption spectrum is, according to a large range of observations on the phenomena of absorption, a distinct proof of the persistence of chemical and molecular constitution. Those who are not prepared to admit this must, whilst thus disposing of a part of the evidence against the specific activity of chlorophyll, abandon the only evidence we have in favour of the specific activity of hæmoglobin, for it is upon the identity of the absorption-spectra of hæmoglobin, both in the organism and in the crystalline form, that we have to depend for the inference that the substance which we extract is the same substance as that which circulates in the blood and colours the muscles.

It cannot, however, be stated that a negative has been directly proved with regard to the supposed CO_2-decomposing property of chlorophyll. It is possible that chlorophyll, when extracted by solvents from the chlorophyll-corpuscles, may yet be shown to possess that property. The solvents themselves may, so long as they are present, exert an inhibitory effect. Whilst ether and alcohol may do so it

[1] As an example see Letourneau, "Biology:" Library of Contemporary Science, 1878, p. 97.

is possible that vegetable fats may be more propitious, or that some other solvents may be found more closely resembling the natural solvent of the chlorophyll-corpuscle than those at present known.

Apart, however, from the absence of sufficient evidence to warrant the assumption that chlorophyll has a specific chemical action on carbonic acid in the presence of sunlight, there have to be considered (1) facts connected with the part played by the sunlight which render it improbable that chlorophyll is thus concerned, and (2) facts which point to another use for chlorophyll, and one which involves that concomitance of chlorophyll with CO_2 decomposition which has been most strongly urged in favour of its supposed special property; (3) facts which suggest that such chemical activity as that sometimes attributed to chlorophyll is the special property of protoplasm, or rather of the higher members of that ever-ascending and descending series of albuminoid bodies occurring in organisms, of which series the theoretical apex is entitled to the name "protoplasm" (so far as the term can receive a chemical limitation).

1. If chlorophyll were the active agent in CO_2 decomposition under the influence of sunlight, we should expect the rays absorbed by chlorophyll to be those most efficient in promoting such decomposition. Such, it has been shown by Sachs and others, is *not* the case. Light which has traversed a solution of chlorophyll is still efficient in exciting the plant-cell (whatever part of the cell may be called into play) to the decomposition of CO_2 and liberation of O. It is true that the activity of light thus treated is diminished, but that is explained by the fact that the rays of the whole visible spectrum are some more, some less, capable of exciting the decomposition, and that the total amount of light transmitted is much diminished. The maximum evolution of oxygen by green plants is *not* in the red rays where chlorophyll most absorbs, nor in the indigo and violet which it also largely absorbs, but in the yellow, the orange, and the green, which it allows to pass entirely, except for three very narrow and feeble absorption bands.

2. The action of light on the chemical motion of protoplasm (and we know of no changes in protoplasm which can be considered as other than chemical) is known to be a very important one. *Supposing* that chlorophyll is not directly related to the action of light in exciting the decomposition of carbonic acid by the true living substance of green plants, there are yet other activities of the protoplasm of the plant-cell to which it may be related. Engelmann has recently shown that luminous rays (independently of the obscure heat-rays) cause sudden contraction of protoplasmic organisms devoid of chlorophyll or other pigment, whilst the expansion of Æthalium on the surface of tan in the dark, and its contraction beneath the tan during sunlight, is a well-known phenomenon capable of experimental demonstration. The action of solar rays other than those highly endowed with the property of exciting thermal vibrations upon the living tissues of both animals and plants appears to be more general than has been usually admitted,[1] and due to a direct influence upon the protoplasm of living cells. This being the case, it is not surprising that, supposing the active agent in the decomposition of carbonic acid in green plants to be the protoplasm itself, that activity should be excited by the same part of the spectrum which excites the human retina. At the same time it would not be surprising that other specific chemical activities should be promoted in protoplasm by the incidence of luminous rays, and it may well be that chlorophyll has a relation to these activities rather than to the decomposition of carbonic acid.

It is here that the important suggestion of Prof. Pringsheim (*see* NATURE, vol. xx. p. 86), based on very simple but careful observations, comes in. The *respiration* of the plant-cell is promoted according to these observations by the action of light. Intense sunlight in the presence of oxygen gas causes the chlorophyll of a plant-cell (as watched with the microscope), to oxidise and disappear. Similarly it causes decomposition and disruption of the protoplasmic portion of the cell. Ultra-red rays have not this effect, and extreme red rays have it but feebly, whilst the more refrangible rays, even to an extreme distance in the blue, exhibit it powerfully. Here then is a chemical action taking place in the plant-cell under the influence of light, and in this case the rays which are active appear to be more nearly coincident with those absorbed by chlorophyll than in the case of CO_2 decomposition. It does not appear that the oxidising process is non-existent in the absence of light, but merely that it is far more active in the presence of light. Accordingly Prof. Pringsheim suggests that the true function of chlorophyll is, by its general absorbent action on light, to protect the protoplasm of the cell from this excessive oxidation, and especially to protect the protoplasm of the chlorophyll corpuscles. Oxidation being thus entirely or nearly entirely arrested in the chlorophyll corpuscles, whilst proceeding in a lessened degree in the general protoplasm of the cell, the protoplasm of the chlorophyll corpuscles is at liberty *under the influence of those rays of light which are allowed to pass by the chlorophyll* (the very reverse of former suppositions on the subject) to decompose carbonic acid and synthesise the elements of starch (or of hypochlorin). And we know, as stated above, that the rays of light allowed to pass by chlorophyll are those which are the most efficient in the excitation of this activity.

Prof. Pringsheim's hypothesis thus reconciles in a most ingenious manner the concomitance of chlorophyll and CO_2-decomposition with the inactivity of that body as isolated and the apparent irrationality of its absorption-phenomena.

3. That so special an activity as the decomposition of carbonic acid and synthesis of the elements of starch is due to protoplasm itself and not to a body which, like chlorophyll, appears to be of a *comparatively* simple chemical nature, is probable on *à priori* grounds.

Throughout the organic world—so far as our knowledge goes, and it may be admitted that it does not go very far—the more complex chemical processes connected with nutrition on the one hand, and secretion on the other appear to be carried on directly under the influence of the living substance of cells. We know of no formed-products similar to chlorophyll which stand between the gland-

[1] The cases of "sun-burn" produced by the glare of the electric light without any accompanying sensation of heat, related both by Prof. Tyndal and Mr. Norman Lockyer, are in point. Further also the remarkable influence of exposure to sunlight on the phosphorescence of Beroë, as recorded by Prof. Allman, *Proc. Roy. Soc.* Edinburgh, 1862.

protoplasm of animals and the material which they break down into secretions, such as the components of bile, or such as the hydrochloric and sulphuric acid of other glands. But still more important are the examples of elaboration and synthesis presented by some of the lowest organisms. Without chlorophyll, or, as far as we have any ground for conclusion, any such intermediary, the protoplasm of the Bacteria acts upon ammonium acetate so as to build up carbon, nitrogen, hydrogen, and oxygen into an albuminoid compound like itself. Such action appears to be the specialty of protoplasm, for even when a share of the work is attributed in the green plant to the green pigment chlorophyll, yet we have to come back to protoplasm to finish the job and do the really difficult feat of combining carbo-hydrates and ammonia. By dismissing chlorophyll from the operation altogether we do not add materially to the capricious many-sidedness of protoplasm. Here it can take carbon from carbonic acid and nitrogen from ammonia, there it can do with nothing less than an acetate, there again it must have a tartrate at least, and in a fourth example it perishes without albumens.

If the green pigment has been misrepresented in the foregoing indictment, and if it really is something more than a screen for protoplasm, its character must be re-established by direct demonstration of its capabilities. The facts, as at present in evidence, look very much indeed as though chlorophyll had been assigned a position of unmerited dignity.[1] E. RAY LANKESTER

HANDBOOK OF BOTANY

Handbuch der Botanik. Bearbeitet und herausgegeben von Dr. N. J. C. Müller, Professor in Münden. Erster Band, Erster Theil. Anatomie und Physiologie der Gewächse. (Heidelberg, 1880: Carl Winter's Universitätsbuchhandlung.)

THE volume before us is the first of a work which is to treat of all the departments of the science of botany. In his preface Prof. Müller explains that he has been led to undertake this very serious task by the conviction that unity of design is the first essential in an educational work such as this is to be, and that this unity cannot be attained unless all the parts of it come from the same hand. Possibly his estimate of the value of this unity may be correct, but it must not be forgotten that the division of a labour such as this secures one very important advantage, namely, the complete treatment of each of the separate parts, and this may after all be quite as important as the unity of design.

These considerations naturally recall to memory the handbook which was planned on so magnificent a scale by Hofmeister. That work is still unfinished, and long periods of time intervened between the publication of volumes of it by the different authors, so that, as it is, the work necessarily exhibits but little unity of design, and must therefore, from Prof. Müller's point of view, possess comparatively little educational merit. As a matter of fact, however, the deficient unity is hardly noticed, for the parts are so complete in themselves that they can stand alone, and are of permanent value as books of reference.

We will now proceed to form an estimate of the success which has attended Prof. Müller in the execution of the first part of his plan. In this volume he treats more especially of the physiology of plants, giving also some account of their coarser anatomy, and he does so with so much detail that he fills more than six hundred pages. It will perhaps be well to defer any remarks upon the latter subject until it has been treated, as Prof. Müller promises, in a more complete manner in subsequent volumes.

With regard to physiology, then, it must be admitted that Prof. Müller's work is an elaborate one, and that it gives evidence of much labour and thought; but yet the result cannot be regarded as other than unsatisfactory. It contains a great deal of information, some of it of a very recondite description, but it is not arranged in a clear and logical manner so that the student can readily grasp the facts and appreciate their mutual relations. There is a want of proportion or perspective about it, and the result is that the fundamental facts do not stand out clearly from those of secondary importance. The mode of stating the facts is not always all that could be desired. On p. 1, for instance, protoplasm is spoken of as being *fluid* (*flüssig*), a mode of describing its consistence which is generally considered to be inaccurate. But the most serious defect in the book is the want of definite statements of the conditions under which the more important vital phenomena take place. There is a sort of vagueness about Prof. Müller's account of these which will prove distressing to any student who reads his book. For example, let us take the discussion of the mode of growth in surface of the cell-wall. On p. 100 there is a very brief statement of the theory of growth by intussusception; on p. 146 there is an account of Nægeli's theory of the structure of the cell-wall; but when we turn to p. 170, where the account of the actual growth of the cell-wall is given, no reference is made to either of these theories, which are generally regarded as being of the first importance in explaining the process of growth. Then as to the turgid condition of the growing cell: this is certainly mentioned on p. 170 and on p. 193, but no hint is given of the means by which this condition is produced and maintained, or of its significance in the process of growth. It is evident that a student would have considerable difficulty in obtaining anything like a clear idea of the mode of growth in surface of a cell-wall from Prof. Müller's account of it.

Again, there is no clear distinction made, in Prof. Müller's account of the circulation of liquids in the plant, between the slow movement of solutions of nutritious substances and the rapid movement of water in connection with the process of transpiration; and the paths along which the liquids travel in these two movements are by no means clearly traced. The recent important researches of Sachs and of von Höhnel on this subject appear to have been overlooked.

Further, in discussing the decomposition of carbonic acid by chlorophyll under the influence of sunlight, Prof. Müller makes no clear statement as to which of the

[1] Mr. Vines suggests that if Pringsheim's view be correct, then it might be possible by aid of an artificial chlorophyll screen to excite the protoplasm of fungi or even of animals to the decomposition of carbonic acid. This seems to me unlikely on account of the definitely characteristic chemical activities acquired by protoplasm in different organisms. *But it certainly would be worth while trying the experiment with an etiolated green plant and an artificial chlorophyll screen.* The experiment would be decisive.

rays of the solar spectrum are the more active in the process.

It would be easy to multiply criticisms of this kind, but enough has been already said to show that the book is unsuitable for the use of students, at least of those who are not already tolerably advanced. The first essential of a good handbook for students is that it should give a clear and, as far as possible, complete account of the actual attainments of the science of which it treats. This Prof. Müller's book certainly does not do. Many points of importance are either omitted or treated far too superficially, whereas others of less importance are discussed at great length in a highly theoretical manner, which, be it said, is often ingenious and interesting. The book cannot, therefore, be regarded as a successful handbook; its merits are rather those of a treatise upon those parts of the physiology of plants which are susceptible of a physical and mathematical treatment.

It only remains to add that the general appearance of the book, the paper, type, and figures are good, and to express the regret that there is not an alphabetical index at the end which might serve as a guide through the somewhat intricate mazes of the contents.

OUR BOOK SHELF

On the Urari, the Deadly Arrow-poison of the Macusis. By Richard Schomburgk, Ph.D. 4to. Pp. 18. (Adelaide: E. Spiller.)

IN this pamphlet the author describes the researches made by himself and by his brother, Sir Robert Schomburgk, into the modes of preparation of urari. Although an arrow-poison is prepared by a number of Indian tribes in Guiana, and between the Amazon River and the Orinoco, yet that prepared by the Macusi Indians is much stronger, and other tribes come very long distances in order to obtain it. This greater strength is thought by the author to depend upon the use by the Macusi Indians of the *Strychnos toxifera*. The bark of this plant contains all the properties of the urari, and the Macusi Indians add to it a number of other substances. With great difficulty the author prevailed upon an old urari-maker to show him the process of preparing the poison. The ingredients were—bark of *Strychnos toxifera*, 2 lbs.; from Yakki (*Strychnos schomburgkii*), ¼ lb.; Arimaru (*Strychnos cogens*), ¼ lb.; Wakarimo, ¼ lb.; the root of Tarireng, ½ oz.; the root of Tararemu, ½ oz.; the fleshy root of Muramu (*Cissus spec.*); four small pieces of wood of a tree of the species of Xanthoxyleæ, called Manuca. (Manuca is the strong bitter wood of a tree of the Xanthoxyleæ. The bark and the root are used as an effective remedy against syphilitic sickness on the Rio Negro, Amazon, and Rio Branco.)

These ingredients were crushed singly in a mortar, and the bark of *Strychnos tox.* was thrown first into a pot containing about seven quarts of water. As soon as the water began to boil he added at intervals a handful of the other ingredients except the muramu. The whole was then kept boiling very slowly, the foam being carefully skimmed away, for twenty-four hours, the mixture being kept at an equal heat. At the expiration of that time the extract had been reduced by boiling to about a quart, became thick, and assumed the colour of strong coffee. It was then strained through a large funnel made of palm-leaves and filled with fresh silk-grass. The filtrate was exposed in a flat vessel to the sun for about three hours, and he then added the slimy juice expressed from the muramu root, which had been previously soaked for a short time in the boiling poison. The urari immediately underwent a remarkable alteration, curdling to a jelly-like substance. The poison was then poured into very flat earthen vessels, in order to still further concentrate it by exposure to the sun. When it reached the consistency of thick treacle it was poured into small calabashes, where it ultimately changed into a hard substance. During the preparation a number of superstitious precautions are taken, in order, as they imagine, to prevent the poison losing its efficacy. No certain remedy is known for the effects of the poison; those employed by the Indians are the juice of sugar-cane either alone or mixed with an infusion of the leaves of the tree *Eperua falcata*. Salt and urine are sometimes also employed as remedies.

The author mentions the researches on the physiological action of urari by Waterton and Virchow, but seems unaware of, or at least does not allude to, the observations of Bernard, or the more recent works of German observers. This pamphlet is, however, interesting as containing the author's own original observations upon the mode of preparation of the urari, made, as they were, under great difficulties.

Notes of Observations on Injurious Insects. Report, 1879. (London: W. Swan Sonnenschein and Allen, 1880.)

THIS report, for the production of which we are mainly indebted to the exertions of Miss E. A. Ormerod, the Rev. T. A. Preston, and Mr. E. A. Fitch, is, this year, one of unusual interest, inasmuch as it reviews the destructive work of the insect world to our garden and field crops during a summer unequalled for its want of sunshine and continued heavy rains. Moreover, owing to the energy displayed by the editor in inducing gardeners, foresters, &c., to record what observations they may have made, we have, as the result, a very full and very varied report. Notwithstanding that the temperature was below and the rainfall above the average, "the returns show insect attack fully up to the usual amount, and insect presence often exceeding it. The unusual cold of the winter and the depth to which the frost penetrated the ground do not appear to have acted prejudicially on larvæ subjected to them, either at the time or in subsequent development, and the only cases in which the weather appears notably to have had effect in ridding us of insect attack is where the persistent rainfall or the tremendous downpour of summer storms have fairly swept the insects from the plants, or in some cases of leaf-feeders, where the plant-growth has (conjecturally) been driven on past the power of the larvæ."

Referring to the power of the frost "during the past winter" (the report is dated December 19 last), it is stated that at Dalkeith it penetrated the earth to a depth of fifteen inches, while in Perthshire it went down to from twenty to twenty-four inches. Miss Ormerod alludes to the prevalent idea that "cold kills the grubs," and gives her experience of an examination of all larvæ and pupæ found fully exposed to its influence, whether unsheltered, under bark, or in frozen ground. In every case, even where the ground was frozen so hard that it required a hammer to break it, and the larvæ and pupæ were perfectly rigid, on thawing they showed no sign of injury, "and in the case of the larvæ of the cabbage weevil (which was the only instance in which any immediate action was to be expected) they continued the operation of making their earth cases for pupation (as is usual with this grub on disturbance from the gall) as if nothing had happened."

The extreme severity of the winter was also favourable, in other respects, to insect-preservation, large numbers being secured from the attacks of birds by being buried under the snow or in the frost-bound ground.

The report, which embodies notes from observers all over the United Kingdom, is one of very great value not only to the entomologist, but also to the practical cultivator, whether of field or garden crops. The persistent energy with which Miss Ormerod and her coadjutors have advanced these inquiries, the result of which is the full and elaborate report before us, is worthy of all praise. It is satisfactory to learn that for the coming year a large number of fresh observers have promised their help, and with the hope that this notice may induce some of our readers to communicate their own experiences to Miss Ormerod at Dunster Lodge, Spring Grove, Isleworth, we may perhaps mention the following as a guide to the kind of information required :—

1. Any notes as to the extent of insect injury, and estimated pecuniary loss from such.

2. Remedies found of practical use in checking such ravages.

3. Any notes of coincident circumstances such as of weather influences, or surroundings, or state of the soil which may increase or diminish insect attack.

It is pointed out that even the shortest notes are valuable when collated with others, and the importance of noting down the observations as they occur is also impressed upon observers.

JOHN R. JACKSON

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.*]

The Density of Chlorine

IN NATURE, vol. xxi. p. 350, my friend, Mr. F. D. Brown, argues that the low density of chlorine at high temperatures may be explained on the assumption that it undergoes decomposition in the sense of the equation $Cl_2 = 2Cl$, thereby renewing a suggestion made by Lieben in a communication to the French Academy shortly after the publication of V. and C. Meyer's first paper.

A few days ago it might have been said that, however probable such an explanation might appear to be on general grounds, there was nothing in the Meyers' observations to justify it rather than the alternative hypothesis that the chlorine underwent decomposition into other as yet unknown substances. On the contrary, taking into account Meyer's observations on iodine, which by reason of their greater number may be regarded as furnishing more conclusive testimony than the more limited series with chlorine, there was apparently distinct evidence in favour of the latter view. The dissociation of iodine, according to Meyer, takes place within a range of about 400° C., between 600° and 1,000°, and a further increase of nearly 600° is practically without effect; whereas had the change been of the character indicated by Mr. Brown, a further diminution in density ought to have been observed.

A recent communication to the French Academy by Crafts and Meier, however, materially advances the discussion. These observers maintain that Meyer's estimates of temperature (made by the calorimetric method with a platinum block) are excessive, and that, in fact, the highest temperature realisable with the Perrot gas-furnace (determined by an air thermometric method), is 1,390° instead of about 1,570°. They have also obtained a considerably lower value for the density of iodine at the highest temperature of the furnace, the quotient of the theoretical density ($I_2 = 8·786$) by the observed density being ·60 for their highest observation, and ·65 for Meyer's. Their results are as follows:—

Temperature. °				Density.		
445	...	...	...	8·70	8·78	8·75
830–880	...	...	...	8·04	8·11	
1,020–1,050	...	...	...	7·02	7·18	6·83
1,275	...	...	...	6·07	5·57	
1,390	...	...	...	5·23	5·33	

Should it ultimately be proved that the molecules of the halogens are thus dissociable, our present views regarding phenomena such as the nascent state and the influence of light in inducing hydrogen and chlorine to enter into reaction will meet with much support the appeal as to their elementary nature will then be entirely thrown on the spectroscope for decision.

London Institution, April 10 HENRY G. ARMSTRONG

The Omori Shell Mounds

I HAVE received the enclosed letter from Prof. Morse, with a request that I should forward it to you. I hope that it may be published, for the article in NATURE to which it refers seemed to me to do very scant justice to Prof. Morse's work. I refer more especially to the evidence adduced by him on cannibalism by the ancient inhabitants of Japan—on their platycnemic tibiæ—on their degree of skill in ceramic art—and beyond all other points, on the changes in the molluscan fauna of the islands since the period in question.

It is a remarkable fact, which incidentally appears in Prof. Morse's memoir, that several Japanese gentlemen have already formed large collections of the shells of the Archipelago, and have zealously aided him in the investigation of the prehistoric mounds. This is a most encouraging omen of the future progress of science in Japan. CHARLES DARWIN

Down, Beckenham, Kent, April 9

IN NATURE, vol. xxi. p. 350, is a review of my memoir on "The Omori Shell Mounds" by Fredk. V. Dickins. I do not now heed the spirit in which it is written, nor would I deem it worthy of notice did it not occur in the pages of your widely-read magazine. One expects in a reviewer some knowledge of the subject he reviews. Mr. Dickins, by a series of mistakes, betrays his ignorance of the whole matter. The extraordinary blunder he makes regarding the Ainos has already been promptly corrected by a Japanese gentleman residing in London. It is charitable to assume that Mr. Dickins has lived in Japan, otherwise he would not, in common with so many of his countrymen, commit the wilful blunder of calling the principal city of the empire by its wrong name. On the other hand, it is impossible he could have seen the Omori deposits, otherwise he would not make another blunder by expressing his belief that they have been completely swept away, when in truth but a small portion of them have been removed. He says: "These mounds consist for the most part of shells, little, if at all, distinguishable from what are still found in abundance along the shores of the Gulf of Yedo." Had he taken the trouble to read the memoir he attempted to review he would have seen that all the species occurring in the mounds vary in size, proportion of parts, and relative abundance of individuals from similar species living along the shores to-day. That some species extremely abundant in the mounds are scarcely met within the vicinity, while one species has never been found within 400 miles of Omori; indeed, it belongs to a different zoological province!

His complaint at the large number of plates given to the illustration of pottery, tablets, &c., shows how incapable he is of appreciating that part of the work which has received the highest commendation from archæologists, namely, the presenting as far as possible an exhaustive illustration of every form of vessel and variety of ornamentation. He laments the absence of a plate giving figures of the bones and shells, especially the latter, that are stated to belong to extinct species. Had he looked at the last plate (a copper plate, by the way, and not a lithographic one, as he calls it) he would have seen every species, with one exception, figured, when similar forms from the neighbouring shores could be got for comparison.

I did not feel justified in comparing shell-mound forms with similar forms from Niigata, Kobe, or Nagasaki, and the reason will be obvious to any one having the slightest familiarity with the variations that species show in widely separated localities.

As to figuring fragments of bones, I did all that my limited knowledge of mammalian osteology would permit in identifying the common mammals, and in giving a list of them as other writers have done in similar investigations. Possibly Mr. Dickins may here find a fruitful yield for investigation, in which he may establish the recent nature of the deposits. I cheerfully proffer it to him with a large accumulation of fragments of bones in Tokio waiting to be put together!

His comparison of the Omori pottery with Banko will greatly amuse any one at all familiar with Banko, or its associate forms, Hansuki, Otagukuan, Miki, Bashodo, Tokonabe, or their imitators either ancient or modern.

His review being thus occupied with a series of misstatements, he naturally finds no room to discuss my evidences of cannibalism or platycnemic tibiæ.

Finally, his ungenerous complaint of my well-merited compliment to the Japanese printers and binders who made the pamphlet illustrated a lamentable but too common trait of the ordinary Briton in Japan, namely, that which manifests itself in a childish delight at the failures of the Japanese and in sneers at their successes. EDWARD S. MORSE

Salem, Mass., U.S., March 25

Wallace's "Australasia"

MR. EVERETT appears surprised that he should have to make any corrections in my brief account, in the above-named work, of Borneo and the Philippines, countries in which he has resided and travelled for many years. My surprise is that he has not been able to make far larger and more important corrections. Residents abroad soon acquire a mass of local information, and naturally think that what has been long familiar to themselves must be well known in England, forgetting that books on such subjects are written at long intervals, and when written rarely contain all the information up to date. I am exceedingly thankful for any additional facts or corrections for a new edition of the book, but I do not acknowledge to "errors" in the omission of facts which were not to be found in any books in English libraries at the time I wrote. I will make a few observations on the chief points in Mr. Everett's letter.

1. As to the accuracy of the maps I am not responsible, as Mr. Everett might well have supposed in a series of works issued in Mr. Stanford's name. The fact that Palawan and Mindanao are now as completely Spanish possessions as Luzon, is, I think, quite new to British readers.

2. I certainly omitted the mention of *Tupaia* among the Philippine mammals by an oversight. In giving a general sketch of the peculiarities of Philippine zoology I should, however, again omit Palawan from consideration, as that island is zoologically more nearly connected with Borneo. In the absence of all other information about Palawan, I took my account chiefly from Crawfurd's "Descriptive Dictionary." He mentions the frizzled hair of the natives, and deer among the wild animals; and as deer abound both in Borneo and the Philippines, their *absence* in Palawan requires proof rather than their presence.

3. The detailed range of the rhinoceros and wild cattle in Borneo has not yet, that I am aware, been given by any writer. My general statements, though imperfect, do not seem very far from the truth.

4. As to what Mr. Everett styles my "extraordinary statement" about the "Idaan" and "Milanow" tribes, I founded it on Mr. Spencer St. John's book. He says (vol. i. p. 396) of the Idaan—"They were a dark, sharp-featured race, intelligent-looking, and appeared in features very much like the Land Dyaks of Sarawak." While of the Milanows he says (i. p. 46) "some are clothed like Mahomedans, others like Dyaks, *to which race they undoubtedly belong*." As the Milanows live at the mouths of rivers, while the Idaan live inland, I cannot see the "extraordinary" character of the statement that they "correspond" to the division of Land and Sea Dyaks usually made in the Sarawak territory. This does not imply that there are no differences of language, customs, &c., but rather that there are such differences; but if there are radical *physical* differences they were evidently not known to Mr. St. John, whose long residence in Borneo and great opportunities for acquiring information entitle him to be considered an authority.

It will be seen that Mr. Everett's new matter is very scanty, and I should not have thought it worth while to do anything more than make use of it, were not his letter written in a somewhat critical spirit, which I think he would not have adopted had he known the great difficulty of obtaining accurate information on the innumerable subjects that have to be treated in a book of so wide a scope as "Australasia," and dealing with countries which have been as yet imperfectly described. Like some other critics, too, he forgets that general statements for popular information, which must be comprised within a few lines, cannot always be made strictly accurate without becoming vague, and thus ceasing to convey any definite ideas.

ALFRED R. WALLACE

The Comet 1861 I.

IN the course of some work on comets lately communicated to the Royal Society of Edinburgh, in which I show reasons for believing that a planet more distant from the sun than Neptune is at present in the position R.A. 11h. 40m., N.P.D. 85°, or thereabouts, I was led to the conclusion that the comet 1861 I., visible to the naked eye, should have been in perihelion three times before the last appearance. The period of the comet has been calculated to be 415·4 years. It ought therefore to have been visible in the years 1445, 1031, 615. Comets were observed in 1444, 1032, 617. It will be interesting to many readers of NATURE to know that these are identical. They were all observed in July or August, and were all seen to pass close to β Leonis. The following accounts of them have been given:—

A.D. 617 (?).—"In July a comet with a tail 3° or 4° long was seen near β Leonis."—(Ma-tuoan-lin.)

A.D. 1032.—"On July 15 an extraordinary star appeared in the north east. It approached β Leonis."—("Compendium Historiarum," 730.)

A.D. 1444.—"On August 6 a comet 10° long was seen to the east of β Leonis; it became longer day by day till August 15, when it entered the sidereal division of α Virginis."—(Biot.)

The longitude of β Leonis is 169°, its latitude 13° N. If the earth were to remain fixed in its position for July 15 it would see the comet 1861 I. pass through the point whose longitude is 169° 30′, latitude 13° N. If the earth were in the position of August 6 the comet would pass through a point whose longitude is 177° and latitude 13°, or to the east of β Leonis, and moving towards α Virginis. Thus these four apparitions are the same comet; and the meteor-shower of April 20, hitherto considered to depend on the comet 1861 I., cannot be considered to agree in period. GEORGE FORBES

Anderson's College, Glasgow, April 2

A Feat of Memory

THE following feat of memory seems to be worthy of record in your pages. It is new to the writer, though by no means uncommon over here.

Like the country itself, many institutions in the United States run to size in a way apt to astonish the dwellers in our "tight little island." So it is with hotels. Thus at some of them many hundreds of persons are simultaneously dining in one room. At the entrance, the hats, &c., of the guests are deposited with a person in attendance to receive them. He does not check or arrange them in any particular order, and he invariably restores them, each to the right owner, as they emerge from the dining-room. The difficulty of the feat naturally depends on the number of hats in charge at the same time. The most remarkable case which has come under the notice of the writer is at the Fifth Avenue Hotel, New York. There the attendant, who is on duty several hours a day, has sometimes as many as five hundred hats in his possession at one time. A majority of them belong to people whom he has never seen before, and there is a constant flux of persons in and out. Yet even a momentary hesitation in selecting the right hat rarely occurs. The performer at the above hotel says that he forms a mental picture of the owner's face inside his hat, and that on looking at any hat the wearer's face is instantly brought before his mind's eye. It would be interesting to test how far this power is possessed by an average unpractised person when put in the right way of doing it. While many of our ordinary recollections are not visual, at least not consciously so, it appears probable that most cases of extraordinary memory consist in an unusual power of making and retaining visualised impressions. Mr. Galton's interesting paper in NATURE (vol. xxi. p. 252) on "Visualised Numerals" goes a long way to show this to be so in mental arithmetic. Systems of artificial memory tend towards the same point; for they may be roughly described as mainly resting on the systematic manufacture of artificial visualisations; and the hat feat just narrated falls within the same category.

In working the rich mine which Mr. Galton's genius has discovered, I hope he will explore the vein of chess without the chess-board. As efforts of memory, such performances are as surprising as the numerical feats of Colburn and Bidder. And they notably differ from them in that the highest development is reached, not by young boys, but by men of mature years, who, as players over the board, have reached the front rank. The writer (in last year's *Chess Player's Chronicle*) attempted to give a rough estimate of the number of moves and positions possible at chess. They are of course practically illimitable; and with this fact in mind it is easy to form an idea of the difficulty of playing *twelve* games blindfold against very strong antagonists. This task, however, is often performed by Messrs. Zukertort and Blackburne, beyond question in England, and probably in the world, the greatest adepts in this branch of chess-play. It would be highly instructive to learn by what process, in so far as it is a conscious and describable one, these feats are achieved. If Mr. Galton takes the matter up, no doubt he will, with his usual skill, throw a flood of light upon the subject.

EDWYN ANTHONY

Riggs's Hotel, Washington, March 29

Meteor

A LARGE and brilliant meteor was seen here at 8.25 p.m. on the 7th inst. It appeared a little below Zeta Tauri, and travelled very slowly southwards in a line nearly parallel to the horizon, traversing a space of about 50°.

The meteor rapidly increased in brilliancy, and is described as many times brighter than Venus, until near the end of its course, when it diminished in size. No trail was seen, although the meteor appeared to smoke.

SYD. EVERSHED

Wonersh, Guildford, April 12

Carnivorous Wasps

A SUMMER or two ago I observed a number of dead flies, blue-bottles, humble-bees, and hive-bees on a certain part of one path in my garden; though the dead insects were removed every day, yet a fresh collection was seen every morning, the cause of death remaining unknown for several days. One morning I was earlier than usual in the garden, and I saw a number of wasps attacking flies and bees in their flight, biting and twisting their wings, and ultimately killing their victims on the ground.

The garden was at the time full of flowers, and the wasps appeared to be waiting in ambush for the flies and bees as they came over a low wall into the garden. Sometimes the wasps would bite the wings entirely off their victims, and they soon after appeared to be sucking the juices of the flies from the joint between the head and thorax.

WORTHINGTON G. SMITH

"Who are the Irish?"

WILL you permit a few words of reply to your notice of "Who are the Irish?"

Grateful to your critic for pointing out some hastily-written sentences, I am surprised he failed to see the real object of the little book. This was to show in a popular rather than a scientific way the folly of that *race hatred*, arising from the assumption that Irish are Celts and English are Saxons.

It was not necessary to cite French authorities on the Celtic question there, though they appear in the forthcoming pamphlet on "Who are the Scotch?" As for my supposed absurd remarks about Basques and Dark Irish, I only quoted the opinions of the learned Prof. Huxley. My simple and honest desire was to promote peace and goodwill between two peoples, more closely related than the factious and contentious care to believe.

JAMES BONWICK, AUTHOR OF "WHO ARE THE IRISH"

Acton, E., March 24

A LEAF FROM THE HISTORY OF SWEDISH NATURAL SCIENCE[1]

III.

IN a yet higher degree than fluor spar, phosphorus attracted attention through its property of being self-luminous in darkness in consequence of a slow combustion. This substance was accidentally discovered, as I have already mentioned, at the close of the sixteenth century, at Hamburg in the course of experiments made by the ruined alchemist, Brand, with a view to produce the philosopher's stone by the dry distillation of urine which had been evaporated to dryness. The raw material was not abundant, the process of manufacture uncertain, and phosphorus, which is now sold at about 7*s.* 6*d.* per kilogram, was worth many times its weight in gold. Soon after the physician Bernard Albinus discovered that the same substance could also be produced from the ashes of certain plants, but its general occurrence in nature (in the bones of animals and in the mineral kingdom) was first pointed out by Scheele and Gahn, who, during Scheele's stay in Stockholm (1768-70), are believed to have simultaneously made this important discovery.[1] It forms the proper starting point of our knowledge of this substance, of such extraordinary importance in the economy of nature, so indispensable in scientific agriculture, in medicine, and in numberless branches of modern industry.

In attempting to discover the cause of cold-shortness in iron, Bergman and the German Meyer believed that they had discovered almost simultaneously that it was caused by the iron being alloyed with a brittle and easily fusible metal, for which Meyer proposed the name *hydrosiderum*. Soon after, however, Meyer himself and Klaproth showed that a metal completely similar was produced by fusing together iron and phosphoric acid—the latter distinguished chemist expressly declaring that the *analytical* proof of this was difficult to carry out. The year after, however, Scheele succeeded in producing phosphorus in a very ingenious way from cold-short iron. We are thus under a great obligation to him for a very important contribution to scientific metallurgy.

As I have already stated, Brandt proved, about 1730, that the regulus of arsenic ought to be considered as a peculiar semi-metal, whose proper "kalk" was arsenious acid. If we except Macquer's discovery of arseniate of potash, our knowledge of this important and dangerous substance made little progress during the following decades, until Scheele in 1775 published in the *Transactions* of the Swedish Academy of Sciences his remarkable, and in this field epoch-making work "On Arsenic and its Acid." Scheele introduced to our knowledge arsenic acid and a number of its salts, and besides discovered that it gave with zinc a gas previously unknown, which contained "combustible air" and arsenic. This gas (arseniuretted hydrogen) is exceedingly poisonous, and experiments with it forty years after its discovery cost the German chemist Gehlen his life. It appears to be this gas which is given off in rooms where the paper-hangings contain arsenic. This work of Scheele's came to be of great theoretic importance by his sharp glance immediately noting that the white arsenic and the new arsenic acid were different degrees of oxidation, or as it was then expressed, different "stadia of dephlogistication" of the same metal. Long before Davy's discovery of potassium and sodium, Berzelius' of calcium and silicium, and Wöhler's of aluminium, Scheele appear to have had a clear insight into the relationship of the earths to metallic oxides.[2]

[1] Translated from a paper by Prof. A. E. Nordenskjöld of Stockholm. Continued from p. 541.

[1] The first account of this discovery is found in a note of two lines in Scheele's paper on fluor spar to this effect: "That the earth in bone and horn is lime saturated with *acidum phosphori* is newly discovered." (*Trans. Acad. Sc* 1771). The discovery was ascribed by Bergman in his edition of Scheffer's Chemistry, at one place to Scheele, and at another to Gahn. The facts of the case are cleared up in Wilcke's biography of Scheele. He had in the spring of 1770 mentioned to Gahn that he had found in burned hartshorn lime combined with a substance unknown to him, on which Gahn examined the "animal earth by means of the blow-pipe, and found it be composed of lime combined with phosphoric acid." Scheele at first doubted Gahn's statement, until in the summer of the same year at Upsala he for the first time made phosphorus from burned bones.

[2] All metallic "kalks," indeed all earths are distinct acids, whose difference depends on different proportions of phlogiston. In a letter to Hjelm Scheele says:—"The discovery of ferric acid is reserved for chemists, not earlier than the coming century, when we labour in the Elysian fields." Ferric acid was discovered in 1840 by Fremy.

Of still greater importance than the discovery of arseniuretted hydrogen was Scheele's discovery of sulphuretted hydrogen. Long before, indeed, it had been observed that when sulphides were decomposed an ill-smelling gas was given off which blackened silver (Boyle, 1663), was combustible, poisonous, and capable of being absorbed by water, to which it communicated its taste and smell (Rouelle and Meyer, 1754-1774), but no further examination of the nature of the gas had been carried out, and it was generally considered to be impure hydrogen. In 1777 Scheele isolated this gas, also a previously quite unknown fluid compound of sulphur and hydrogen, and gave a correct statement of their composition. The formerly neglected ill-smelling gas now became the subject of comprehensive researches by Bergman, Kirwan, Berthollet, &c. Its chemistry was completely cleared up, and it became an *indispensable* assistant in every laboratory and nearly every chemical manufactory.

At various Saxon and Bohemian mines there are found along with tin ore two kinds of minerals, whose weight early attracted the attention of the miners, and which, seeing no metal could be smelted from them, were considered as "wild" ores of tin. We find them described in detail for the first time in the Mineralogies of Wallerius and Cronstedt, and Cronstedt expressly states that they do contain tin as a proper constituent. One of these minerals, which was afterwards called *scheelite*, but at first by Swedish mineralogists *tungsten*, was found about 1770 in small nodules in the Bispberg mines in Dalecarlia, and was in consequence examined by Scheele. He immediately discovered that this mineral, which had been previously examined without success by so many chemists, was a compound of lime with a new metallic acid.

Bergman supposed that the chemist had here not only to do with a new acid, but also with the acid of a new metal, a supposition which was immediately confirmed by the Spanish chemists, the brothers Don Fausto[1] and Don Juan José d'Elhuyar. This metal is now called by different names—wolfram by Swedes and Germans, scheele and tungstène by the English and French. The last name is derived from tungsten, that given by the miners at Bispberg to the mineral from which the acid was first produced—a derivation perhaps difficult enough for a philologist to clear up in case it comes in question to determine the root of the Frenchman's *acid tungstique*.

The paper "On the Constituents of Tungsten" was published in 1781. In 1778 and 1779 Scheele inserted in the *Transactions* of the Academy "Researches on the Blacklead Molybdæna" and "Researches on the Blacklead Plumbago," of which one paper enriched science with a new simple substance, *molybdenum*, and the other taught us the true chemical nature of a mineral long used and unsuccessfully examined by many chemists. Both these researches have been of immense importance for the metallurgy of iron, the former through the splendid reaction (discovered by L. Svanberg and H. Struve in 1848) which phosphoric acid gives with molybdic acid, and which forms an indispensable means for every metallurgist for discovering the least trace of phosphorus in iron, the latter by the discovery that graphite enters as a constituent into various sorts of iron. Some lines on this point in Scheele's paper suggested the investigations of Bergman, Rinman, Monge, Berthollet, Guyton de Morveau, and others on the chemical difference between pig iron, bar iron, and steel, which alone rendered possible the development of the iron industry to the advanced position which it occupies in this era of steam-engines and railways.

Scheele further enriched our knowledge of the mineral acids by his discovery of nitrous acid and his examination of the products of the decomposition of nitric acid. It is said that an observation connected with this subject first led to his intimate acquaintance with Bergman, and his last scientific communication relates to this subject, inasmuch as shortly before his death he informed Wilcke by letter that nitric acid under the action of sunlight gives off combustible gas.

Want of space compels me to pass over many less considerable, but nevertheless often very important communications by Scheele. I have yet, however, to give account of his two greatest and most important labours.

The first of them was published in the *Transactions* of the Swedish Academy of Sciences for 1774, under the modest title, "On Brunsten, or Magnesia, and its Properties." Brunsten (black oxide of manganese) and various allied species of minerals are first mentioned in the fourteenth century by Albertus Magnus under the name of "magnesia," but they had long before that time been employed in the arts. Afterwards we find those minerals often referred to by mineralogists and chemists, and many unsuccessful attempts were made to ascertain their composition.

Soon after his coming to Upsala Scheele undertook, at the suggestion of Bergman, to try his strength on this difficult substance. Scheele showed at first that brunsten contained a peculiar base combined with a substance which had a strong affinity for combustible bodies. The properties of the new base were carefully investigated, also its relations to a large number of reagents. From these researches Scheele drew the conclusion that we had here to do with a metallic oxide—a view which was soon after confirmed by Gahn through direct reduction with charcoal. Chemistry was thus enriched with a new metal, *manganese*, which has long been very extensively used in the arts, among other applications in the manufacture of Bessemer iron. Scheele observed further that a solution of black oxide of manganese in muriatic or nitric acid when sulphuric acid was added gave a scanty white precipitate. It is distinctive of Scheele's chemical researches that he never neglected to investigate the cause of even the most inconsiderable occurrences in the course of the work, and many of his most important discoveries originated just from the attention he bestowed upon circumstances which would probably have escaped the notice of other chemists. The inconsiderable white precipitate led to the knowledge of a new earth, *baryta*, which soon after was found by Gahn in a mineral of very common occurrence, heavy spar. The salts of baryta are now indispensable in every laboratory as the means of discovering and separating sulphuric acid, and extensive branches of industry are grounded on the multitudinous applications which have long ago been found for this earth.

When black oxide of manganese was treated with muriatic acid Scheele observed that the dark brown solution, obtained by cold dissolving, when heated gives off a strongly-smelling gas, which from its colour was afterwards named *chlorine*. This was the third simple substance to whose discovery the examination of black oxide of manganese gave occasion. It is scarcely possible completely to sketch the enormous influence which the discovery of chlorine exerted on the development of inorganic, but perhaps still more of organic chemistry; and on all the branches of human knowledge and human industry which in any way are related to chemical science. As a single instance it may be observed that at that time there was no other method known of bleaching cotton cloth than by exposing it for a length of time to the action of sunlight. Every cotton-spinning or weaving manufactory therefore required extensive meadows for bleaching its wares. But land is dear in England, and on this account the branch of industry in question was about to migrate from that country, where in the middle

[1] Don Fausto afterwards became Minister of State in Spain. The two brothers studied chemistry for a time under Bergman at Upsala, and visited Scheele at Köping. These two distinguished Spaniards' account of this visit is the only information we now possess regarding Scheele's laboratory and home life at Köping.

of the eighteenth century it had begun to develop itself on an enormously great scale, to lands where ground could be obtained at a cheaper rate. In his first research on chlorine Scheele observed its bleaching property, which was carefully investigated by him, only however for theoretical, not for practical purposes. But ten years afterwards the discovery was practically applied by the French chemist Berthollet, who showed that manufacturers possessed in chlorine an invaluable means of giving cloth the desired whiteness by a simple chemical treatment within the manufactory itself. Now for the first time was it possible for the cotton industry to attain the enormous development, the immense social and political importance which the nineteenth century has witnessed. Chloroform and chloral, &c., are obtained by the action of chlorine on organic substances; by the action of chlorine on lime and potash are obtained chlorides and chlorates—all substances of incalculable importance for theoretical and practical chemistry, for medicine and the arts. Thus in the history of the natural sciences one discovery is linked with another, and the new truth which to-day seems devoid of importance to-morrow becomes a lever for advancing the happiness and well-being of the million.

The second of the works in question is separately printed, first in German, with the title, "Carl Wilhelm Scheele's, d. königl. Schwed. Acad. d. wissenschaft. Mitgliedes, chemische Abhandlung von der Luft und dem Feuer. Nebst einem Vorbericht von Torbern Bergman, Chem. und Pharm. Prof. und Ritter, verschied. Societ. Mitglied, Upsala und Leipzig," 1777.[1] In the introduction, dated 13th July, 1777, Bergman says that the work in question had been ready nearly two years, though various circumstances had delayed its printing, and in a letter to Bergman, preserved in the Library at Upsala, Scheele complains bitterly of the publisher Svederus' procrastination. Various of the most important observations recorded in this work had been already made during the examination of the black oxide of manganese (1771-1774). From all this it follows that Scheele's discovery of oxygen, of nitrogen,[2] and of the composition of atmospheric air took place simultaneously with Priestley's, and that both these investigators reached the same goal by widely separated paths. Lavoisier too is often, but incorrectly, named as the discoverer of oxygen. On the other hand, it was *his* genius that laid Priestley's and Scheele's discovery as the foundation for the new and still existing fabric of knowledge. While Scheele and Priestley,[3] who made the fundamental discovery on which the new theory was founded, remained at the old stand-point, this discovery was estimated by Lavoisier at its true value, and it thus became a veritable turning-point in the history of science. But the numerous ingenious experiments by which Scheele proved the propositions advanced by him at the very beginning of his treatise on "Fire and Air," *that the air is composed of two different gases*, still to this day are the corner-stones in the new fabric of science, and most of them are still repeated in every series of lectures on the subjects in question.

Death broke off Scheele's scientific path the same year that the work was printed in which Lavoisier distinctly rejected the phlogiston theory, and three years before the first edition of his "Traité Élémentaire de Chimie, présenté dans un Ordre Nouveau, et d'après les Découvertes Modernes" appeared. If a prolonged activity had been granted him, if he had made acquaintance not only with isolated propositions from the new theory, but with the fully-developed and completed system, would he have adopted the new theory, and with it as a starting-point gone forward to new and splendid victories in the field of research, or would he, like Priestley, have obstinately stood by the old views? To this question no positive answer can of course be given. But the whole direction of Scheele's activity as a man of science tells in favour of the former alternative, and even much in his peculiar theories which, if we except his attempt to include heat among chemical substances, have many points of contact with current ideas. One thing in any case is certain. He has done enough to earn a place in the first rank of the men of science of all times and of all lands, and his name shall always form one of the grandest memories of his native country.

[1] Most of Scheele's works were first printed in the *Transactions* of the Swedish Academy of Sciences, but were immediately after translated into foreign languages. After his death his collected works were published in Latin under the title "Opuscula Physica et Chemica." Lipsiæ, 1788-89. His short papers, in which important discoveries are often stated and *proved* in a few lines, are complete masterpieces, not only in respect of their contents, but also of their form and mode of exposition. "Ses mémoires sont sans modèle comme sans imitateurs!" (Dumas' "Philosophie Chémique," p. 96.)

[2] The Scotch physician Daniel Rutherford has also great credit in connection with the discovery of nitrogen. He showed in 1772 that a species of gas, which could not maintain combustion, remained after the carbonic acid was withdrawn by means of a solution of caustic potash from the air expired by animals. Rutherford however did not carry out any further investigation of the nature of this gas.

[3] Priestley says in his last work, "Mr. Scheele's discovery was certainly independent of mine, though I believe not made quite so early."

THE UNITED STATES WEATHER MAPS, APRIL TO JULY, 1878

THIS week we have the pleasure of presenting our readers, by the courtesy of General Myer, with the International Weather Map for July 1878, showing for that month the mean pressure, temperature, force, and prevailing direction of the wind. This is the fourth consecutive number of the series, which began with April of that year, and may be regarded as completing the record of the great outstanding features of those changes which characterised the weather of the northern hemisphere in its transition from the spring to the summer of 1878.[1] We shall here chiefly consider the departures from the averages deduced from the curves and figures of the Weather Maps, seeing that these well represent the great seasonal movements of the atmosphere, together with those meteorological conditions which rule the changes of weather occurring in the different regions of the globe on which the welfare and prosperity of nations so intimately depend.

The map for April showed very large deviations from the average atmospheric pressure in all quarters of the globe. Pressure was under the average over North America, Greenland, the Atlantic to south of Iceland, the north of Africa, over Europe south of a line drawn from the north of Scotland to the Sea of Azov; over the valley of the Obi and southwards to lat. 40°; over New Zealand and Australia, and northward to the Philippines; and probably also over a large part of the Indian Ocean, including Mauritius and the eastern part of South Africa. Elsewhere pressure was in excess of the average, but most markedly over the north and east of Europe, and the whole of Asia had a pressure above the normal, except the narrow patch already referred to in the extreme west of Siberia and Turkistan.

Of these disturbances in the distribution of the earth's atmosphere, by far the most remarkable was the depression in the heart of the Atlantic, midway between Spain and New York, which amounted nearly to half an inch. Round and in upon this area of low pressure the wind blew in the usual way, bringing warmth to the region lying to eastward and cold weather to regions lying to westward. On proceeding westward pressure rose, till on the coast of the United States it was only about the sixth of an inch below the normal; but proceeding further in a north-westerly direction through the region of the Lakes, the depression gradually again deepened, till near Lake Winnipeg it fell to full a quarter of an inch below the average. The result to the States was an unusual prevalence of southerly winds, a large rainfall for this spring month, and a temperature everywhere high for the season, rising in the N.W. States to 10°·6 above the average.

[1] These Weather Maps have appeared in NATURE as follows:—April, No. 535, May, No. 538, and June, No. 543.

Reverting to the great depression in the Atlantic, we see that it became gradually less and less on proceeding eastward, till at Gibraltar it had risen nearly to the average pressure of April; but from this point through the Mediterranean a secondary depression was formed, which was deepest over the region lying between, and inclusive of, the Adriatic and Black Seas. Over this region temperature was only the average, whereas to northward temperature rose above the average, the highest excess, 5°·6, occurring in the south of Norway, which was just within the anti-cyclone area of high pressure. To the eastward of the area of low pressure in Western Siberia the temperature rose to 4°·4 above the average, but along the slopes of the Ural Mountains to westward it was only the average, or even slightly below it.

In May pressure in the United States rose to about the normal in the north-western prairies, but eastward it was lower. The lowest depression, 0·070 inch, was about Lake Superior, to west of which, winds being in consequence north-westerly, temperature fell to from 3°·0 to 5°·2 below the normal, whilst in the Gulf States, winds being southerly, temperatures ranged from 0°·5 to 2°·5 above the average.

The great barometric depression in mid-Atlantic, which was so pronounced a characteristic of the meteorology of April, moved northwards in May to a position immediately to west of Ireland, and was still fully a third of an inch below the average. Between these barometric depressions in the United States and the Atlantic an area of high pressure wedged its way southwards from Greenland, and another high pressure area forced its way northwards from mid-Atlantic about lat. 30°, these two areas being each about a tenth of an inch above the normal. The influence of this distribution of the pressure was a temperature from 1°·0 to 3°·0 above the normal over the British Isles and Western Europe, a lowering of the temperature 2°·5 below the normal in Iceland, and as regards the New England States, a lowering of the high temperature which had prevailed in April to the average in May.

The low pressure overspread the whole of Europe and the northern slopes of Asia, as far to eastward at least as the Yenisei, except the northern shores of the Mediterranean and a long narrow patch extending from the Black Sea to Riga. A secondary depression was formed in the basin of the Obi and its tributaries, its centre being 0·125 inch below the normal. On the east side of this depression, along the Irtish and Yenisei, temperature rose from 4°·5 to 6°·6 above the average of May, whereas to westward, as at Moscow, it fell to 3°·0 below the mean. Thus these barometric depressions in Western Siberia during April and May were fraught with important consequences to the agricultural interests of a large portion of the Russian Empire, extending from the Vistula to the Yenisei.

The three barometric depressions, viz., those in the United States, in the Atlantic west of Ireland, and in Siberia, were merely centres of increased depression within a wide general depression encircling more than half the globe. From the shores of California eastward through the United States, the North Atlantic, the north of Europe and Asia to the basin of the Yenisei, there stretched a continuous broad region of low pressure; and it may be added that so far as observations show, another line might be drawn marking out also a continuous low pressure area extending from the Yenisei, through Turkistan, Syria, Egypt, Zanzibar, and Natal, to the Cape. At the same time pressure was above the average over India and Eastern Siberia; but the greatest rise of pressure had taken place in Australasia, so that whilst in April pressure was 0·298 inch below the normal in the south-east of New Zealand, in May it was 0·122 inch above it at Wellington, the increase from the one month to the other being thus 0·420 inch.

Some important changes in the great movements of the atmosphere were brought about in June. Pressure increased over the North-Western States and Western prairies, but the greatest depression below the average was now found over the Gulf and Atlantic States, with the inevitable result of a weakening of the southerly winds of June, an increase of north-westerly, and a lowering of the temperature everywhere, except in the Gulf States, the greatest depression of the temperature being 5°·6 at Washington. The area of high pressure in the Atlantic increased a tenth of an inch and moved westward about 15° of longitude, and at the same time extended in area; the high pressure noted in Greenland in May now covered a wider extent and moved eastward, the greatest excess above the mean being 0·170 inch in the east of Iceland. The high pressure that lay between the Black Sea and Riga now extended westward to Switzerland and eastward to the upper reaches of the Yenisei. The temperature changes accompanying these great atmospheric movements were a slight lowering of the temperature below the average over the whole of Central Europe, the south-west of Norway, and the east of Scotland, and the raising of the temperature of the whole of the Russian Empire above the average, the excess in the valley of the Kama being 6°·5, and from the Sea of Azov to the head of the Caspian 6°·8. Pressure at the same time fell to some extent under the average along the Mediterranean and north of Africa round to Cape Verd Islands, a change intimately connected with the lowering of the temperature which set in to the northward over Central Europe.

Pressure continued low over Southern and South-Eastern Africa and in Mauritius, though relatively not so low as in the previous months; and it had again fallen greatly in Victoria, Tasmania, and New Zealand. The deficiency in the latter islands amounted to 0·429 inch, being a relative fall in the mean pressure as compared with May of 0·561 inch.

In India pressure in the west still continued above the average, the excess at Kurrachee being 0·050 inch; but in the east it had gone below the normal at Visagapatam, stood near the average at Port Blair, and at little below it at Manila. As regards this part of the globe, the meteorological position in June was this; except a narrow patch of higher pressure extending from the mouth of the Indus southward over the west of India, and thence south-eastward through Singapore and Batavia to Adelaide, South Australia, pressure would appear to have been under the average from Cape Verd Islands, round by the Mediterranean, Black, Caspian, and Aral Seas, Tashkent, Shanghai, New Zealand, Australia and the Cape.

In July pressure was under the normal in the United States and Greenland, with two centres of greater depression, one in the north of Greenland and the other about the Rocky Mountains south of lat. 40°. The influence of this arrangement of pressure, as regards the United States, was an increased prevalence and strength of southerly winds to east of the Rocky Mountains, accompanied with a temperature from one to three degrees above the average of July, and a rainfall considerably above the average; whereas on the Pacific coast N.W. winds were in excess, and the temperature in Oregon was 2°·7, and at San Diego 1°·0 below the mean.

From the north coast of South America, and thence stretching to north-east as far as the north of Iceland and Christiansund in Norway, lay a broad extensive region of very high pressure, embracing within its northern limits the whole of the British Isles, the north of France, Belgium, Holland, and a thin strip of the south-west of Norway, the centre being in mid-Atlantic about lat. 35° and long. 35°. In the British Islands temperature was above the average, the greatest excess being 2°·8 in the north of England.

Another extensive area of pressure, above the July average, overspread India and extended towards the north-east, round by Barnaul, Irkutsk, Nerchinsk, Pekin, Shanghai, and Port Blair, whereas over the East India Islands, New Zealand, Tasmania, Australia, Mauritius, and the east of Africa, so far as observations supply information, pressure was under the average, and very largely so over the whole of the southern portions of this wide-spread region.

Between the high pressure of the North Atlantic and the relatively high pressure of Southern Asia, there was interposed an extensive tract of low pressure, stretching from Portugal to the Yenisei, and from Egypt to the North Cape, having its centre 0·244 inch below the average near Moscow. To the east of the Ural Mountains temperature rose to 4°·3 above the average; but on the west side of this depression temperature was 5°·0 at Warsaw and 8°·5 at Kem, west of the White Sea, below the average of July.

A striking feature of the distribution of the earth's atmosphere in July 1878, is the enormous breadths over which pressure was below the average, and the comparatively restricted regions over which it stood above the average. An explanation of this seeming anomaly is furnished however by the figures on the map for July, which presents for the first time a monthly mean for the centre of the Pacific Ocean. This mean is from the Sandwich Islands, and shows an excess there above the normal for July, amounting to the large figure of 0·300 inch.

Thus then the meteorology of the globe for July 1878, stands out as a singular phenomenon, characterised by these broad features, viz.:—(1) a greatly reduced pressure over a large portion of the Southern Hemisphere as compared with what usually obtains there in the winter month of July; (2) a much greater diminution of the pressure than usually takes place in the summer month of July over the land of the Northern Hemisphere, over North America, over Central and Eastern Europe, Western and Central Siberia; and (3) a much larger increase of pressure than usually occurs in the Northern Hemisphere over the great oceans in July, the area of unusually high pressure being extended, as regards the Atlantic to the north-east as far as Christiansund, and as regards the Pacific to westward over Central and Southern Asia, as far as the Arabian Sea. It may be worth remarking that this increased pressure over the oceans and diminished pressure over the land of the Northern Hemisphere is in accordance with what might be expected to result from an increased solar radiation; whilst on the other hand the increased pressure over Southern and Central Asia, and diminished pressure in the Southern Hemisphere, is not in direct accordance with this supposition. The point here referred to will however receive an illustration from subsequent numbers of the Weather Maps, by which it is probable that different results as regards the states of the atmosphere will appear, with the varying states of the sun from year to year.

The future maps of this international series will be eagerly scanned in connection with many of the larger questions of atmospheric physics, as well as those directly practical questions of climate with which we have been almost exclusively concerned in this article. It is plain that we need not hope to succeed in dealing with most of the larger problems proposed by meteorology without the help of the data laid before us in so full and convenient a form by the International Weather Maps of General Myer. It is only thus that we can trace to their proximate causes such climatal phenomena as the recurring droughts of India and the cold, sunless summer of the British Islands in 1879, and show their true relations to the great movements of the atmosphere. For this great work the highest praise must be conceded to General Myer, whose genius struck out this cosmopolitan scheme of observation, and whose powers of organisation and determination of will bore down all obstacles which stood in the way of its realisation; and he has the heartiest wishes of all for its more complete extension over British North America, South America, Africa, and among the islands of the Pacific.

WILLIAM SHARPEY M.D., F.R.S.

DR. SHARPEY, whose death we regret to announce took place on Sunday, was born April 1, 1802. He entered on the study of medicine at the University of Edinburgh in 1818. In the autumn of 1822 he came to London, where he spent three months in dissecting, and then proceeded to Paris, and occupied the following winter in the study of clinical medicine and surgery in the hospitals. In 1823 he graduated in Edinburgh, and subsequently was for a short time engaged in the practice of his profession in his native town, Arbroath. Soon afterwards he appears to have changed the plan of his life, and for the purpose of educating himself for the scientific career which he had resolved to adopt, he proceeded to the Continent. After spending several months, which were devoted to general culture, at Rome, Naples, and Florence, he resumed the study of anatomy at Pavia, under Panizza. The following years were spent partly in Edinburgh, partly in Paris, Vienna, Heidelberg, and Berlin. At Berlin he became the pupil and friend of Rudolphi, and by laborious anatomical studies laid the foundation of his future success and eminence. In 1831 he began to lecture in Edinburgh on anatomy, having his friend Prof. Allen Thomson as his associate; and in 1836 was invited by the Council of the University of London, now University College, to accept the Chair of Anatomy and Physiology, which he occupied until 1874.

It was about this time that he was most actively engaged in physiological investigation. His scientific writings, which were not numerous, have the characteristic excellences of accuracy of observation and soundness of judgment. One of his earliest contributions was on ciliary motion, and appeared in 1830. Others formed the subjects of articles in the "Cyclopædia of Anatomy and Physiology," while a still greater number were embodied in the successive editions of the "Elements of Anatomy." Notwithstanding the rapid progress of anatomical and physiological science during the past thirty years, none of Dr. Sharpey's observations have lost their value.

He was appointed Secretary of the Royal Society in 1854, shortly after important changes had taken place in its administration, in the bringing about of which he, with others whose names are not less distinguished, had taken part. The beneficial effect of these changes in extending the Society's influence for the advancement of natural science was due in great measure to the sagacity and energy with which he administered such of its affairs as fell within the scope of his duties—duties for which he was singularly fitted by the extent and variety of his learning, by the wisdom of his counsels, by the wide range of his scientific interests, by the candour and justice which guided him in appreciating other men's work, and by his ready sympathy with every true and honest worker.

Great as Dr. Sharpey's services to science were in his public capacities as Secretary of the Royal Society, as a Member of the Senate of the University, and of the Royal Commission on Science, and in other ways, these were perhaps not the most important. For years he was the greatest teacher of anatomy and physiology in this country, occupying a position side by side with Johannes Müller in Germany. Just as the influence of Johannes Müller's life and teaching is still powerful in that of his pupils, so we may confidently anticipate that Sharpey's work will follow him. Of the fellow-workers in his own field who are at this moment mourning his loss there is perhaps not one who does not directly or indirectly owe him that which has made him what he is; nor should we be far wrong if we were to add that those who are best endowed owe him most.

While the very sounds of our friend's voice are freshly impressed on our ears, it is too soon to do more than attempt to trace the more marked features of his character. The qualities which chiefly distinguished him intellectually were the variety of his knowledge, the accuracy of his memory, which he retained to the last without appreciable impairment, and his sound discrimination in all matters of doubt or controversy. To his friends he was endeared by his habitual consideration for the welfare and interests of others, his unwillingness to think ill even of those of whose conduct he disapproved, and his transparent truthfulness. When it is remembered how large was the circle of his acquaintance and the number of those who, during the thirty-eight years of his professorial life, came under his personal influence, we may well moderate our grief at parting with him by reflecting on the good that must have accrued from the life and labours of one in whom so vigorous an understanding was united with so genial and sympathetic a nature.

SIGNOR PERINI'S PLANETARIUM

IN NATURE, vol. xxi. p. 111, we described the ingenious planetarium recently invented by Signor Perini, and which has cost him seven years' constant labour. To-day we are able to present an illustration of this invention, which may give those of our readers who have not seen the original, some idea of its construction. The visitors are supposed to be standing underneath the dome, from which

are suspended the sun and planets. Of course it has been necessary for purposes of illustration to greatly exaggerate the proportionate sizes of the planets, but our readers will see that for purposes of instruction Signor Perini's invention must be of the greatest possible utility. For details we must refer the readers to our previous article on the planetarium, which we believe is still standing and may be seen at 77, Newman Street, Oxford Street.

Office of the Chief Si

UNITED STATES AR

Charted from Actual Observations taken Simultane

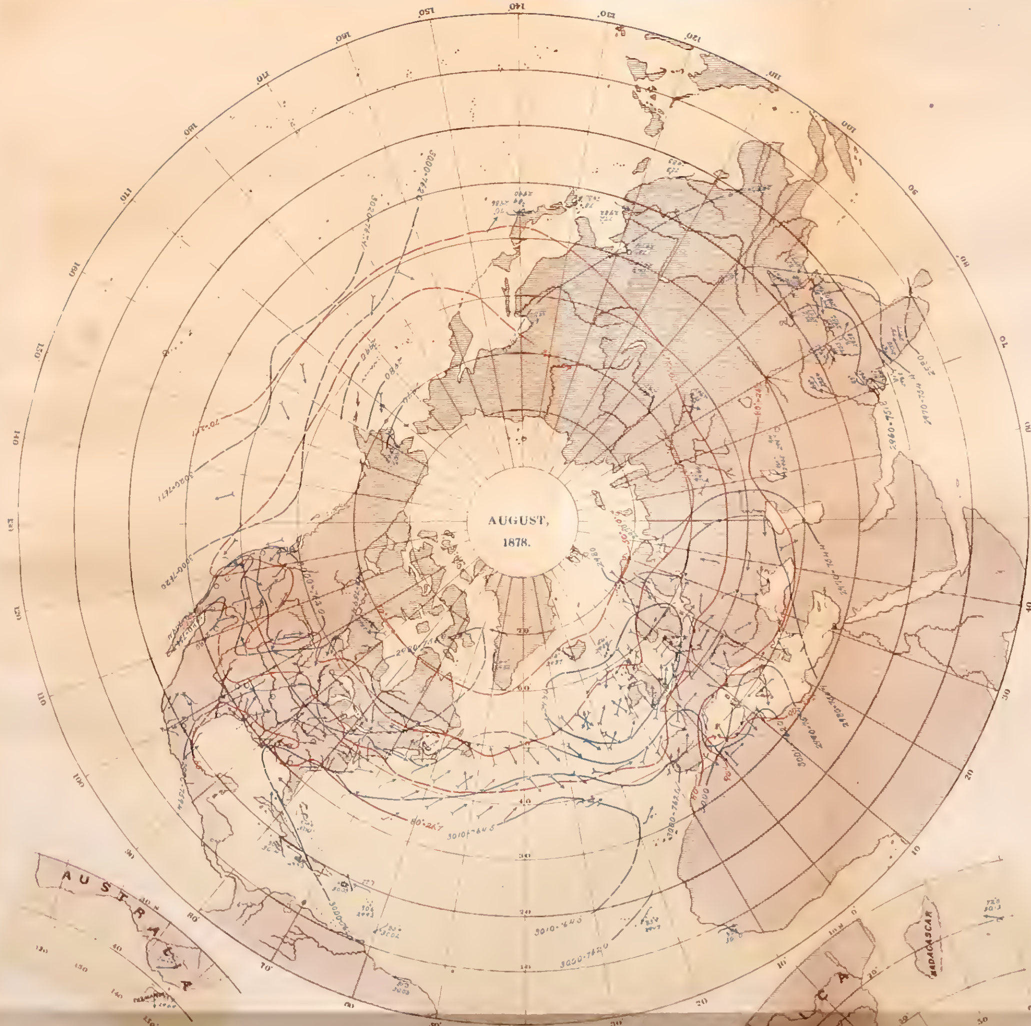
Continued from p. 547.

both may have come from very small depths.

Office of the Chief Signal Officer,

UNITED STATES ARMY.

Charted from Actual Observations taken Simultaneously. Series commencing October, 1877.



PREVAILING WINDS.

Arrows shows the direction of, and fly with, the wind
Force is shown as follows:

Symbols	Force.	Velocity	
		Miles per hour.	Metres per second.
	1, 2	0 to 9	0 to 4.0
	3, 4	9.1 to 22.5	4.1 to 10.1
	5, 6	22.6 to 40.5	10.1 to 18.1
	7, 8	40.6 to 67.5	18.1 to 30.2
	9, 10	67.6 up.	30.2 & over.

PUBLISHED BY ORDER OF THE SECRETARY OF WAR.

Albert J. Myer

BRIG. GEN. (BVT. ASSG'D) CHIEF SIGNAL OFFICER, U. S. A.

ISOBARS AND ISOTHERMS.

Isobars in *blue*, detached barometer means in English inches.

Isotherms in *red*, detached temperature means in degrees Fahrenheit.

INTERNATIONAL MONTHLY CHART

Showing mean pressure, mean temperature, mean force and prevailing direction of winds at 7:35 A. M., Washington mean time, for the month of August, 1878, based on the daily charts of the International Bulletin the proportionate sizes of the planets, but our readers will see that for purposes of instruction Signor Perini's inven-

be seen at 77, Newman Street, Oxford Street.

DEEP-SEA DREDGING AND LIFE IN THE DEEP SEA[1]

II.

THE surface-water of the ocean is inhabited by an abundant animal fauna peculiar to itself, and termed pelagic. In ubiquity of geographical distribution the animal forms composing this fauna approach very nearly the fauna of the deep-sea bottom. There appears to be a marked relation between the pelagic fauna and the deep-sea fauna. Almost all the deep-sea forms have closely-allied representatives floating or swimming near the ocean surface. The deep-sea sea-anemones are represented on the surface by floating sea-anemones. There are surface-worms, hydroids, bryozoa, barnacles, and fish represented by close allies on the deep-sea bottom. Lastly, there are abundance of surface Rhizopoda corresponding with the vast quantities of them below (Fig. 10).

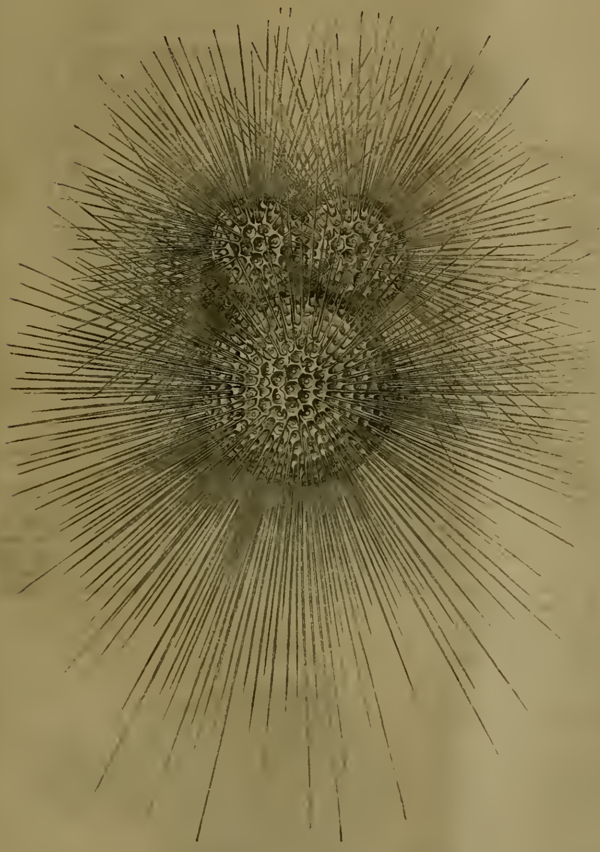


Fig. 10.—Pelagic Globigerina. Much magnified.

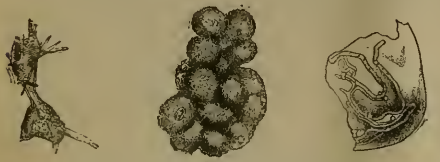
Here is one of these surface Rhizopods, a Globigerina which, like most, but not all, of the Globigerinæ occurring at the surface, is covered with delicate calcareous spines projecting from its shell. That the deep-sea bottom is over vast areas covered by a mud composed mainly of Globigerina shells like this one, but without the spines, is well known to all my hearers.

An important question which has been much disputed is, whether the Globigerina mud is entirely derived from the surface, being made up of dead shells fallen from above, or whether the shells composing it live on the bottom. Mr. Henry Brady, after examining all the *Challenger* collections, concludes that the main components of the mud do live on the bottom. Certain species found there do not occur on the surface at all, and Globigerinæ occur on the bottom near our own shores, where none have ever been found on the surface. Further, the shells of the specimens found on the deep-sea bottom are much larger and thicker than any yet found on the surface. Here are some deep-sea Rhizopoda, concerning which there has never been any doubt as to their living on the deep-sea bottom. Dr. Carpenter described many such long ago. The accompanying illustrations (Fig. 11, *a*, *b*, *c*) are from Mr. Brady's figures. These Rhizopods are called arenaceous, because their shells are mostly made up of sand particles and foreign bodies of all kinds glued together. These arenaceous Rhizopods are abundant all over the world, and reach down to the greatest depths. One, shown in the figure (*a*), from 2,760 fathoms, has included sponge spicules in its test. Another one (*b*) is from 2,900 fathoms. It is chambered somewhat like a Globigerina. This other one (*c*) is attached to a heavy body, a sufficient evidence, were any required, that they lived on the bottom.

Supposing that Globigerinæ do live at the bottom as well as at the surface, do they also live at intermediate depths? This opens the most important question which at present remains to be solved with regard to deep-sea life. It applies not only to Globigerinæ, but to all the vast pelagic fauna to which I have referred. Do the jelly-fish, the crustacea, the mollusca, and other animals so abundant in surface waters inhabit also the depths of the mid-ocean, or is there a vast azoic area between the surface and the bottom untenanted by life in any form? To this question we can at present return no answer of any value. The trawls used by the *Challenger* swept, in going down to the bottom and coming up again, the whole stretch of the sea from top to bottom, and it is impossible to tell whether pelagic animals found in it when it reached the surface were caught there or at the bottom. Mr. Murray used the towing-net at various depths, but the same objection applies to the results. Deep-sea Medusæ have been described by Prof. Haeckel and deep-see Siphonophora by Prof. Studer, but both may have come from very small depths.

[1] Friday Evening Lecture delivered at the Royal Institution on March 5, by H. N. Moseley, F.R.S., Assistant Registrar of the University of London. Continued from p. 547.

What is wanted to determine the problem is a net which can be let down to any required depth, securely closed, then be opened and towed for some time, then closed again and brought to the surface. Its contents would then be certainly derived from the depth at which it was towed. I devised, some months ago, a net which will, I believe, answer these requirements. Its mouth, which is fastened on a hinged frame, is kept shut by means of springs, but can be opened by the action of a pair of electromagnets excited by a battery on board



a b c

FIG. 11.—Arenaceous Rhizopoda. *a*, *Astrorhiza catenata*, 2,760 fathoms; *b*, *Sorosphæra confusa*, 900 to 2,900 fathoms; *c*, *Hyperammina vagans* attached to a piece of shell, 2,000 fathoms. (After H. B. Brady, F.R.S., *Quart. Journ. Micro. Sci.*, vol. xix., new series).

ship. A rope is used to tow the net, which contains an insulated wire. Whilst the net is being towed, the magnets are maintained in action and keep its mouth open. As soon as the net is to be drawn to the surface the current is stopped, and the net closes. Mr. Agassiz intends to use this net or some better contrivance during this summer on the American coast, and we may await the results with great interest.[1]

It has long been known that pelagic animals change their level constantly, appearing sometimes in swarms at the very surface of the sea, and again disappearing. Some come up in calm weather, others only at night, but it is quite uncertain to what depths they descend. Probably the different pelagic animals vary very much in this respect, and they may each have their definite zones of range. It would be most interesting to learn the exact habits of such animals as Pteropods in this matter. The question could easily be determined by the use of such a net as I have described for a short period at any one locality, and most valuable results might be obtained by any one who cared to take the matter up in the neighbourhood of our own coasts.

Very possibly the pelagic animals do not range to any great depth, 100 or 150 fathoms, or less. Prof. Weissman concludes from his researches at Lake Constance that the surface animals there sink to a depth of about 50 feet in the day-time in order to escape the sunlight, and rise slowly in the evening, following the rising limit of darkness in the water.

It is quite possible that a vast stretch of water between the surface and the bottom is nearly or absolutely without life.

There are a large number of animals, some of the most curious forms, which most probably do not live at the bottom of the sea, but which constantly appeared in our trawl-net when used in great depths. Amongst these are a large number of fish of great rarity. They may have come from 20 fathoms or from 2,000. We cannot tell. Possibly they live at 60 or 100 fathoms, and rarely reach the surface; hence their scarcity. Some certainly pelagic animals, which are very scarce, probably live at a considerable depth from the surface.

Here (Fig. 12) is a very scarce animal indeed, a pelagic Nemertine worm. The Nemertines mostly live on the sea-bottom, and are long and worm-like. This is one which has become so modified to live a pelagic existence as to resemble them in appearance very little. Its body has become transparent like glass, that the animal may become almost invisible to its enemies, whilst the branching intestine, the only part which could not be rendered translucent, has become brown-coloured, as in several other pelagic animals, to imitate floating sea-weed. The proboscis projected from the head shows the animal at once to be a Nemertine. I have called it Pelagonemertes. One speci-

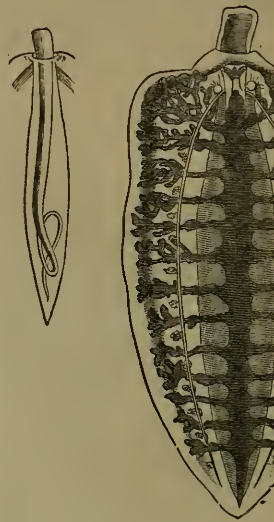


FIG. 12.[1]—*Pelagonemertes Rollestoni*. On the left the proboscis sheath with the proboscis coiled up inside.

men of this animal was found in the trawl after it had been down to 1,800 fathoms, to the south of Australia. Another was got off Japan when the net had been down to 755 fathoms. The animal was only found on these two occasions at these widely distant spots. Fifty years ago Lesson, on the voyage of the *Coquille*, found in abundance, on the sea-surface between the Moluccas and New

FIG. 13.—*Himantolophus Rheinhardti* (Ltk.). About one-sixth of the natural size.

Guinea, a closely allied animal, the nature of which he failed to understand. He must have fallen in with the animals just when they were at the surface. No doubt they are abundant at some depth or other all over the Pacific.

It seems probable that some animals which live near

[1] Since this lecture was sent to the printers I have heard from Mr. Agassiz that Capt. Sigsbee has invented a net which he expects will do all that is wanted with complete efficiency.

[1] From "Notes by a Naturalist," p. 573.

the sea surface when young in all the pleasures of warmth and sunlight, sink when fully grown to lead a sluggish life on the cold and dismal bottom. Here (Fig. 13) is a remarkable deep-sea fish. It is nearly allied to the Angler of our aquariums. It was found dead off the Greenland coast, but closely similar fish were obtained by the *Challenger* in great depths down to 2,400 fathoms all over the world. Mr. Agassiz also got plenty of them. The fish has a very near ally which lives on the surface amongst the gulf-weed, from which it builds curious ball-like nests. You see the fish has no ventral fins, and must be, like its surface relative, a very feeble swimmer. It has very small eyes and a huge mouth, and on the top of its head is a lure set on a movable stalk, with which, like the Angler, it attracts its prey within reach of its mouth. The fish is black all over, as are most deep-sea fish, except on the lure. This is composed of numerous tentacle-like branches, which are covered with white spots, probably phosphorescent, when the animal is living. At the bases of the branches are two horn-like appendages which are white, probably also phosphorescent. The fish most likely thus manufactures its own light, whilst its tentacles, spangled with bright spots, swayed to and fro, no doubt lure many a victim to destruction. This fish is sixteen inches in actual length.

Here (Fig. 14) is what Prof. Lütken, from whom these figures are taken,[1] believes to be the young of this curious

FIG. 14.—Young Himantolophus (Rheinhardtii?) from the stomach of an Albacore.

fish. It was found in the stomach of an Albacore Thynnus, a surface-living predatory fish which was caught in the tropical Atlantic. You see the little fish has, like the adult, no ventral fins. The eye is very much bigger in proportion than in the adult, but that is merely an instance of retention in the young of what has been nearly lost in the adult by disuse. Certain deep-sea blind crustacea similarly have young with fully-developed eyes. The lure on the head is just growing.

If the animal is not the young of the species just shown, which probably extends from Greenland to the tropics in the deep sea, it is certainly that of some closely-allied form. The young of other deep-sea fish have been found in the stomachs of Albacores. The young of most shallow-water bottom-living fish, such as the Angler and the flounder, pass their early existence at the sea-surface. If this deep-sea fish really develops in the early stage at the surface, how do the eggs reach the top of the water? Possibly they rise slowly from the bottom. Perhaps some other deep-sea animals go through their early stages at the surface.

According to Prof. Geikie[2] the deep ocean basins date from the remotest geological antiquity, and Dr. Carpenter in his late lecture here maintained the same conclusion. Whether such be the case or not, any changes which may have taken place converting deep seas into shallow must have occurred very slowly, so that ample time for migration of deep-sea forms to fresh deep seas must have been afforded. Why is it therefore that very many ancient forms do not occur in the deep sea? If the ancient deep sea had been colonised say in the Silurian or Devonian

[1] "Vidensk. Selsk.-Skr." 5te Række, 11te Bd. v. p. 319.
[2] *Loc. cit.* p. 428.

epochs, we should expect to find in its vast area many remnants of the fauna of that age and of subsequent geological epochs; and such was the conclusion of the late Prof. Agassiz, and of many other naturalists. It was expected that all kinds of ancient forms would be brought up by the deep-sea net. Contrary to anticipation, the deep-sea fauna is mainly composed of more or less modern shallow-water genera and their allies. The fish of the deep sea comprise amongst them no Dipnoi, no Ganoids, and no lampreys; they are allies of the cod, the salmon, and the Angler. There are no Trilobites in the deep sea, and no Graptolites, no Bellemnites. All the most ancient forms which now survive occur in shallow water. Lingula, most ancient of all, is abundant in two or three feet of water, and has, I believe, never been found below ten fathoms. Trigonia and Limulus survive in shallow water, and so do Amphioxus and Cestracion. Heliopora, the only living representative of a vast number of palæozoic corals, is a shore form.

It is true that corals which come within Milne-Edwards's definition of the Rugosa occur in deep water, but that group needs great modification, and the structural difference between the deep-sea forms and ordinary Caryophyllias is probably of comparatively little zoological importance.

Though stalked Crinoids occur in deep water, they are

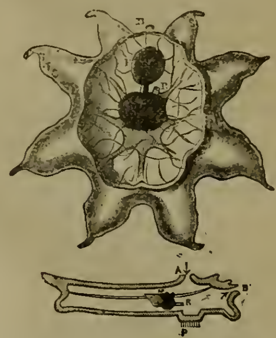


FIG. 15.[1]—Deep-sea Ascidian (*Octacnemus Bythius*). Above.—The animal viewed from below; of one half the natural size. The nucleus is seen in the centre through the transparent base of the animal. P, pedicle of attachment; B, exhalant orifice; R, rectum. Below.—Diagrammatic section through the middle line of the animal's body. A, inhalant orifice; M, muscle attached to nucleus; other letters as in figure above.

also found in a depth of only forty fathoms. There are a certain number of forms in the deep sea which do not occur now in shallow water, and do occur as fossils in the chalk or elsewhere, but they do not form a very high percentage of the total number.

We might have expected to find surviving in the deep-sea missing parts of the branches of the zoological family tree, animals of ancient pedigree which might for example have explained the affinities of the Bryozoa or the Brachiopoda, but scarcely a single animal thus of first-rate zoological importance was obtained in great depths. This is a most extraordinary fact, for in our deep-sea dredgings we have explored for the first time nearly three-quarters of the earth's surface.

The most important new animal, zoologically speaking, obtained from deep water by the *Challenger* Expedition is, as far as I know, this Ascidian (Fig. 15), which I have named Octacnemus. Most of its body is transparent. It has eight radiate arms. Its viscera are gathered together into a small nuclear mass as in Salpa, but the nerve ganglion lies on the mass. The animal is attached to

[1] From H. N. Moseley, "Notes by a Naturalist on the *Challenger*," p. 588. (Macmillan and Co., 1879.)

the bottom by a small pedicle here. It is extremely aberrant in structure. It is from 1,070 fathoms.

Most of the interesting forms obtained by us are from comparatively shallow water. As an example may be cited *Syllis ramosa* of Dr. McIntosh, which is from 90 fathoms. It is a worm which branches in a most extraordinary manner, quite unlike any other annelid known. The entire body divides up into a series of complex ramifications. Nevertheless, as shown by Dr. McIntosh,[1] the worm belongs to a well-known shallow-water genus, Syllis. The head or heads of the animal were all broken off the single specimen obtained, and it is uncertain how many it may have had. The animal lives embedded in a sponge, in the canals of which its ramifications are received.

(*To be continued.*)

NICHOLAS ZININ

WE have already briefly alluded to the death of the veteran Russian chemist Prof. Zinin, which occurred at St. Petersburg, February 19. Nicholas Zinin was born August 13, 1812, at Choucha, in the Caucasus district. After completing the course of studies in the Government Gymnasium at Ssaratow, on the Volga, he entered the University of Kasan, where he is recorded as the recipient of two gold medals for superiority in mathematical and physical studies. In 1833 be finished the ordinary course of studies in the mathematical faculty. In 1836 he received the degree of Master of Sciences from the university, and in the following year was appointed assistant professor. At first his lectures were confined to physics and mechanics; later they embraced chemistry. At this epoch the educational authorities of Russia began to feel the necessity of a more intimate familiarity with the rapid progress then being made in chemistry in Occidental Europe, and it was decided to send the young professor to gain a personal knowledge of the methods then in vogue in the laboratories of the West for furthering chemical research. His face turned naturally towards Giessen, where Liebig had already gathered about him a brilliant circle of young and enthusiastic chemists of the most diverse nationalities. A special favourite of the great master, his abilities as an independent investigator were rapidly developed. After passing some years at Giessen, and in journeying through England, France, and Switzerland for the purpose of scientific observation, Zinin returned to Russia to receive the degree of Doctor of Sciences from the University of St. Petersburg. Until 1848 he continued in his professorship. At that date, however, attention had been so strongly drawn to his talents as a lecturer and as an investigator, that he was elected to the chair of chemistry in the Imperial Academy of Medicine at St. Petersburg. This position he continued to occupy until 1874, when he retired from active professiorial duties.

Zinin's first researches, made under Liebig's direction, were devoted to the products of decomposition of the oil of bitter almonds, to a new method of preparing benzilic acid, and to the formation of various compounds in the benzoylic series. They indicated painstaking labour and an unusually thorough insight into the nature of the reactions taking place. In 1842 he published a short research which attracted universal attention in the chemical world. It was entitled "Organic Bases Resulting from the Action of Sulphuretted Hydrogen on Nitro-naphthalene and Nitro-benzene," and described for the first time the formation of bases from nitro-compounds by means of reducing agents. It is chiefly in connection with this discovery that Zinin's name will remain closely associated. The interest excited at the time of its announcement was purely of a scientific character, but after a lapse of fifteen years it assumed a commercial importance of the highest kind, and to-day manufacturing interests involving many millions are based on that simple reaction of reducing nitro-compounds, to which we owe all the wealth of colour derived from aniline and its homologues. In 1844 he followed up the same line of discovery by producing the bases derived from the dinitro derivatives of benzene and naphthalene. By means of the same reaction he obtained also in 1854 the amido acid from nitro-anisic acid. In this connection should be mentioned likewise the interesting production of oxanaphthalide and formonaphthalide from oxalate of naphthylamine under the influence of heat (1858). In 1852 he discovered the formation of diamidodiphenyl by the action of sulphurous acid on azobenzene, a reaction which he found some twelve years afterwards to be induced also by hydrochloric acid. The nitro-derivatives of azobenzene and azoxybenzene were also submitted to a thorough investigation by him (1860). In 1852 he discovered likewise the aromatic thiosinnamines due to the action of mustard oil on aniline, naphthylamine, &c. 1854 witnessed the discovery of the ureides, the important class of compound ureas obtained by exposing urea to the action of acid chlorides or anhydrides. In this manner he prepared the first types of this group: acetureid $CO\begin{matrix}NH_2\\NH.C_2H_3O\end{matrix}$, benzureide, butylureid, and valerureide. In the following year Zinin increased the then comparatively limited number of organic compounds occurring in nature, or resulting immediately from the simple decomposition of natural bodies, which could be prepared artificially, by the synthesis of oil of mustard from allyliodide and potassium sulphocyanide. At the same time he claimed for the allyl group its now accepted position among the alcohol radicals, and prepared a number of allylic ethers in order to prove its ability to replace hydrogen atoms in acids. In 1857 he returned to the field of investigation which had enlisted his interest while under Liebig's guidance, viz., the study of benzoïn and its derivatives; and with few exceptions his researches up to the close of his life were confined to this subject. At this date he succeeded in introducing acid radicals into benzoïn by exposing it to the action of acid chlorides, and prepared in this way acetyl- and benzoyl-benzoïn. In 1860 he was successful in regenerating benzoïn from benzile—the product of its oxidation—by making use of reducing agents. At the same time he prepared a number of derivatives of benzile. Hydrobenzoïn was also obtained by him in 1862, as the result of reducing the oil of bitter almonds. In this connection may be mentioned his elaborate study, in 1868, of Laurent's *benzimide*—the complicated amide resulting from the action of acids on the oil of bitter almonds—in which he showed it to be a combination of the latter with the imide of formobenzylic acid. In 1867 Zinin submitted benzoïn to the action of hydrochloric acid, and obtained a compound, $C_{28}H_{20}O$, named by him *lepidene*. This body was studied exhaustively by him throughout a series of years. While unable to fathom the mysteries of its constitution, he prepared an extensive array of derivatives, oxylepidene, dioxylepidene, oxylepidenic acid, many products of substitution, &c., of nearly all of which two or more isomerides were obtained. So thorough was the study of the relations existing between the members of this series, that they will all fall into naturally-assigned places when once the bond between the lepidene group and bodies of known constitution is fairly established. In 1861, by the reduction of benzoïn, he obtained desoxybenzoïn, $C_{14}H_{12}O_2$, a compound which the reduction of chlorobenzile likewise yielded him a few years later. This body he changed by the action of nitric acid into nitrobenzile; and in 1868, by successive treatment with phosphorus pentachloride and reducing agents or potash, he changed it into stilbene and tolane, thus throwing an interesting light upon the constitution of benzoïn and its derivatives. In 1870 he

[1] Linn. Soc. *Journ. Zoology*, vol. xiv. p. 720, 1879.

obtained from desoxybenzoïn, by united oxidation and treatment with alcoholic potash, a peculiar body, $C_{70}H_{56}O_4$, to which he gave the name of *benzamarone*, and which he decomposed into desoxybenzoïn and *amaric acid*, $C_{46}H_{42}O_6$. This latter he decomposed, in 1877, into benzoic acid and so-called *pyroamaric acid*. Various homologues were obtained by varying the alcohol used as a solvent for the potash, and pyroamaric acid was shown to be a benzyl-ethyl-benzoic acid. One of his later investigations showed the peculiar property possessed by zinc of regenerating hydrocarbons from the solutions of their addition compounds by extracting the halogens from the latter.

The researches published by Zinin during the latter portion of his career, while marked by careful study and minute elaboration, lack much of that originality and generality of application characteristic of his earlier discoveries. As contributions to the development of the use of reducing agents in organic chemistry, they occupy, however, an important place in the annals of the science, while the *ensemble* of reactions and derivatives of the benzoïn group forms one of the important sections of the chemistry of the aromatic series.

Prof. Zinin's merits were warmly appreciated in his own country, and he was the recipient of numerous decorations, some of which were due to the important services rendered by him in the solution of questions connected with the Russian military department. In 1855 he was elected to the Imperial Academy of Sciences at St. Petersburg. He was the only Russian among the corresponding members of the Chemical Section of the French Academy of Sciences, and was likewise one of the few honorary members of the London Chemical Society and of the German Chemical Society.

T. H. N.

WILHELM PHILIPP SCHIMPER

PROF. SCHIMPER, to whose death at Strassburg on March 20 we have already alluded, was one of the most prominent scientific men in Alsace. He was born, January 8, 1808, at Dosenheim, near Elsass-Zabern. After taking a course of theological studies at the University of Strassburg, he devoted his attention to natural history. A period of travel was succeeded by his appointment in 1835 as assistant in the Natural History Museum at Strassburg. In 1839 he became director of the establishment, and was elected Professor of Geology and Mineralogy in the University. Before this date he had already attracted attention in the botanical world by his studies on mosses, and he soon became one of the leading authorities on this branch. A monument of his work as a specialist is left in his famous "Bryologia Europæa," which appeared in six volumes with 640 plates, from 1836 to 1855; and was provided with an extensive supplement in 1866. Other well-known important works in this connection are his "Recherches anatomiques et morphologiques sur les Mousses" (1850), "Mémoire pour servir à l'histoire Naturelle des Sphagnum" (1854), and "Synopsis muscorum europæorum" (1860; 2nd edit. 1876). As a palæontologist Schimper has produced—1869-1874—a "Traité de Paléontologie végétale," in three volumes, which ranks among the best text-books on the subject. Much of his attention and time was directed to the rich fossil remains of Alsace itself, and it is to these studies that we owe the valuable monographs, "Plantes fossiles des Vosges," written in 1844 in connection with A. Mougeot; "Palæontologica Alsatica" (1854); and "Le Terrain de transition des Vosges" (1862). The marked talent for botany in the Schimper family is something unusual; Prof. Schimper's two cousins having gained, like himself, honoured places in the annals of the science. Karl Schimper, who taught at Munich and Heidelberg, and died in 1867, was distinguished as the founder of the modern theory on the position of leaves, so ably expanded by the late Prof. Braun; while Wilhelm Schimper has widely increased our knowledge of African flora by his researches in Abyssinia, where he was released from imprisonment by the English expedition in 1868.

NOTES

MM. W. DE FONVIELLE and D. Lontin described to the Paris Academy last week a magnetic gyroscope, the object of which is to give a movement of rotation to movable pieces of soft iron of various forms. M. de Fonvielle is at present in London with the apparatus, from which some very curious results have been obtained. We hope to give a full account of the invention, with illustrations, in our next number.

M. B. BRUNET has presented the sum of 20,000 francs to the French Association for the Advancement of Science, the interest to be distributed annually for the promotion of scientific research.

AMONG recent deaths announced are those of Dr. Joh. Eman. Zellerstedt, the Swedish bryologist; Dr. M. A. F. Prestel, of Emden, the meteorologist; and Dr. Mulder Bosgoed, of Rotterdam, author of a "Bibliotheca ichthyologica et piscatoria."

THE French Academy of Sciences numbers seventy-eight. At present two seats are vacant: one in the section of mechanics and one in that of geography and navigation. The number of foreign associates and corresponding members allowed by the statutes is 108. There are now four vacancies: two in the chemical section, one in the botanical, and one in that of geography and navigation. The classification of this portion of the Academy by nationalities affords an interesting view of the judgment of Parisian scientific men on their *confrères* according to "geographical distribution." France, outside of Paris, heads the list with 30 members; then follow Great Britain, 21; Germany, 17; United States, 8; Russia, 6; Switzerland, 6; Scandinavian countries, 5; Italy, 4; Belgium and Holland, 4; Austria, 2, and Brazil, 1.

IN a letter in yesterday's *Times*, deserving the serious attention of those in authority, Mr. Merrifield strongly advocates the appointment of an independent commission for inquiry into the whole question of the construction of our heavy guns. Mr. Merrifield seeks to show that the system at present in use is accompanied with the most serious disadvantages.

A PROSPECTUS has been issued by the Wilts and Hants Agricultural College, of which we spoke last week. Every arrangement has apparently been made for the improvement and comfort of students.

IN a paper in the *Journal* of the Royal Society of New South Wales, on the Forests of Tasmania, by the Rev. J. E. Tenison-Woods, the author gives some interesting data as to the probable age of the stately trees which people these forests. Judging from their size one would be inclined to attribute to them great antiquity. Mr. Woods was very anxious to collect data on the subject; but to nearly all his inquiries he only received mere guesses: from 200 to 300 years was the general reply. Mr. R. Hill, the proprietor of an extensive saw-mill at Honeywood, on the Huon, gave him, however, some more trustworthy data. Mr. Hill assured Mr. Wood that some of the gum-trees, and perhaps all of them, shed their bark twice in the year. The stringy bark (*E. obliqua*) is one of the most striking instances of this. He further informed Mr. Woods that, hearing a lecture from Mr. Bicheno on the growth of trees, and the statement that a ring of wood was added to the diameter each year of growth, he was induced to test the truth of this. There was a blue gum-tree in his garden in Hobart Town, the age of which he was sure of, as his brother had planted it eighteen years previously. He felled it and counted the rings, and found them to be thirty-six in number, or two for every year. From this, and from shedding the bark as described, and a long series of observations, he concludes that the sap rises twice in the year. He has for many years watched the growth of the trees, and he believes that for the first twenty years the average growth is about one inch in diameter for each year. Out of thousands of trees felled or cut in his mill, he has not found one over seventy-five years old, and a very large proportion of the serviceable timber is composed of trees about fifty years of age. Quite recently he has had a very interesting opportunity of verifying these observations. At Ladies' Bay (between Port Esperance and Southport), a paddock on the farm of Mr. D. Rafton was cleared for the purposes of cultivation. It was exactly sixteen years in 1877-78, since a crop was taken off it, and was quite overgrown with saplings, which were all cut down. Mr. Hill, at Mr. Wood's request, wrote to Mr. Rafton, requesting him to examine the stumps. In his reply he gives the number of rings in the longest saplings as thirty-three; size across the heart-wood where the rings cease one inch. The rings he observed were not an equal distance from each other, some of them being three times the size of the others. From these facts Mr. Woods thinks we may safely adopt Mr. Hill's conclusion that there are two rings of growth for each year, and that the tallest trees of the forest, the giant timber of Tasmania, range from fifty to seventy-five years old.

WE take the following item of Yankee ingenuity from *Industry*, commending it to the attention of the Guilds' Technical Institute:—The Bridgeport *News* very cleverly describes an invention, credited to a Bridgeport Yankee, to prevent marketmen from palming off old eggs for fresh ones. The inventor proposes to arrange a rubber stamp in the nest of every hen, with a movable date. This stamp is arranged with a pad that is saturated in indelible ink. When the hen lays an egg, as is well known, she kicks slightly with her hind leg. An electric disk is arranged so that her foot touches it, and the stamp turns over on the ink pad, and then revolves, stamping the date on the egg. The hen then goes off about her business, the farmer's hired girl removes the egg and replaces the stamp, which is then ready for another. On each evening, after the hens have retired to their downy roost with the roosters, the date of the stamp is altered for the next day, and the work goes on. In this way there can be no cheating. You may go to the grocery and ask for fresh eggs, and the grocery man tells you he has some eggs of the vintage of January 29, 1880, for instance. You look at them, and there are the figures, which cannot lie.

THE *Illustrated Scientific News* of New York describes and pictures a remarkable meteorite in the collection of Prof. W. E. Hidden, of the New York Academy of Sciences. It was found, July 19, 1879, on a plantation at Lick Creek, Davison Co., N. Carolina. When found it was covered with a thick scaly crust of oxide. It weighs 1·24 kilos., or 43$\frac{3}{4}$ ounces avoirdupois. It is one of the rare class that does not show the Widmanstätten figures or lines indicating the characteristic crystalline structure of meteoric irons. A thorough analysis in duplicate of the specimen is now being made. Mr. Hidden has in his cabinet three other undescribed meteorites from the Southern States, which will be noticed in due time. One of these weighs 14·5 kilos, or 32$\frac{1}{4}$ ounces avoirdupois.

PROF. SILVESTRIA, of the Catania Observatory, the *Times* Paris correspondent states, reports the fall on the night of March 29 of a shower of meteoric dust, mingled with rain. Besides the usual characteristics of colour, chemical composition, and the mixture of mineral and organic particles and minute infusoria, there was a considerable proportion of iron, either in a purely metallic state or in metallic particles, coated with oxide. The size varied from a tenth to a hundredth part of a millimetre, and the form was either irregular or spherical, as if it had undergone fusion. This phenomenon, according to the correspondent, was first observed in the Indian Ocean, south of Java, in 1859, and has been corroborated by Prof. Nordenskjöld's Arctic observations.

MR. HUGH O'DONOGHUE MCCANN, of Bedford School, has been elected to an Open Scholarship for Natural Science at Queen's College, Oxford. The scholarship is tenable for five years, and is of the annual value of 90*l*. There were only two candidates.

ON Tuesday next, April 20, Mr. Robt. H. Scott will give the first of a course of four lectures at the Royal Institution on Wind and Weather.

THE 60th Ergänzungsheft of *Petermann's Mittheilungen* consists of an elaborate monograph on the Sea-Fisheries of the World, by Moritz Lindemann.

THE Medical men of New South Wales have decided to form there a branch of the British Medical Association.

WE have received a very favourable report of the progress and present condition of the City Industrial Museum of Glasgow.

A TERRIBLE cyclone occurred, the *Sydney Morning Herald* states, in New Caledonia and the Society Islands on January 24, resulting, so far as is known, in the loss of fourteen vessels in the vicinity of Noumea and the death of sixteen persons. In Noumea and its suburbs the amount of damage done was incalculable. It was certified by old colonists that there was never so severe a hurricane in those regions, or one which caused so much loss. The plantations up the country were destroyed and trees were uprooted or bereft of their branches. In many parts of the town, especially near the wharf, the eye was arrested in all directions by heaps of ruin. During the storm the harbour was completely invisible, owing to the thick fog caused by the rain and the spray of the waves being dashed about by the force of the wind. All the small boats were wrenched from their anchors and swept on to the piers. At sea the disasters were numerous; no fewer than fourteen vessels either sank or were thrown on some distant coast.

WITH the aid of an improved lantern for the oxyhydrogen light, invented by Mr. Holman, of the Franklin Institute, Mr. Outerbridge, Jun., lecturing lately to the Institute on "Coins and Coinage," made some interesting experiments, projecting enlarged images of ancient and modern coins on the screen with great sharpness and brilliancy, and showing the cupellation of gold and silver. In this latter a little "cupel" or crucible of calcined bone-ash was held in the focus of the condensing lens by means of a ring of thick copper wire, and its image appeared on the screen much enlarged. The cupel was then heated white-hot with an oxyhydrogen blowpipe. A weighed sample of gold alloy containing base metal was inclosed in an envelope of sheet lead pressed into the form of a bullet; this was dropped into the cupel, and was immediately melted. As the lead became oxidised it was gradually absorbed in the cupel, forming a dark ring at the bottom. A little sheet of light was noticed moving over the surface of the molten metal as the precious metal became exposed; then, at the moment when the lead was completely absorbed, carrying with it all the base metal of the alloy, the purified precious metal became visible as a brilliant globule, reflecting the light like a mirror.

THE Leadville *Herald* reports, on the authority of "a gentleman who has, during the past two years, traversed the mountains in the vicinity of Leadville, and penetrated almost every one of their recesses," the fact of the existence of a veritable glacier, presenting all the characteristics of the Swiss glaciers, both in magnitude and motion, within twenty-five miles of that city. When first discovered several years ago, the report affirms, it was nearly a mile in length, and at the bottom of the "gulch" presented a sheer precipice of ice about 150 feet in height. Later in the season it had been considerably reduced both in length and bulk; but earlier in the following year it had regained first dimensions. The rocks on the sides of this immense mass of moving ice are said to show all the characteristic signs of glacier action. The location of this interesting natural curiosity is said to be in the Mosquito Range, about fifteen miles north of the Pass; and, being very inaccessible and out of the ordinary line of travel, the fact of its being discovered at this late day is accounted for.

THE experiment of sending up three connected balloons will be tried in Lille at the end of next May. The balloons are now fitting in the vestibule of the Palais de l'Industrie of the Champ de Mars, Paris; there will at the same time be a descent in a parachute by M. Tavis.

M. YON, one of the administrators of the Paris Captive Balloon, is publishing a pamphlet on the construction of a new directing balloon, devised on the plan worked out by M. Giffard in his great experiment executed at Paris in 1852. The only difference is that the motive screws are two, and placed laterally and attached to the ring. A captive balloon fitted up according to the principles practised so successfully by M. Giffard in Paris and in London is being constructed now at Brussels, in the vicinity of the next national exhibition, which will be opened on June 19 to celebrate the fiftieth anniversary of Belgian independence. The number of exhibitors amounts to 6,000, so that an exceedingly fair specimen will be offered to the world of Belgian resources and industry.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from West Africa, presented by Mr. L. Samuel; a Garnett's Galago (*Galago garnetti*) from East Africa, a Marsh Ichneumon (*Herpestes paludosus*) from South Africa, presented by Mr. A. Chirnside; an African Civet Cat (*Viverra civetta*) from Africa, presented by Mr. P. Lembery; a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, presented by Mr. A. Ferris; a Common Jay (*Garrulus glandarius*), British, presented by Mrs. A. Dutton; two Graceful Ground Doves (*Geopelia cuneata*) from Australia, deposited; a Black Saki (*Pithecia satanas*) from the Lower Amazons, a Cape Hyrax (*Hyrax capensis*), a Robben Island Snake (*Coronella phocarum*) from South Africa, a Great-billed Rhea (*Rhea macrorhyncha*) from South America, purchased; an Amherst Pheasant (*Thaumalea amherstiæ*) from Szechuen, China, received in exchange.

OUR ASTRONOMICAL COLUMN

THE SOUTHERN COMET.—Dr. Gould, Director of the Observatory at Cordoba, has addressed to Prof. Peters of Kiel an interesting letter with observations of the great southern comet. The tail was seen at Cordoba on January 31. Two evenings later, when Dr. Gould first perceived it, the length was certainly 35°. Careful drawings of its position amongst the stars were made independently by two observers until February 14, after which it had not been distinguishable; it was then not less than 37° in length, but was seen with difficulty, and was scarcely brighter near the head than at its extremity. Even at greatest brilliancy about February 7, its light was nowhere superior to that of the Milky Way in Taurus. Dr. Gould states that from the first no nucleus had been discernible in the telescope, the head always appearing "cloud-like and filmy, and elongated in the direction of the tail, which it did not very much surpass in brilliancy;" indeed "the inordinate length of the tail and the great faintness of both tail and head" were very remarkable features in the appearance of the comet. Observations for position were obtained on six evenings between February 6 and 15, which have enabled Dr. Gould to claim priority in pointing out the probable identity of this comet with the great comet of 1843. Calculating from the observations on February 6, 9, and 12, he deduced the following first approximation to the elements:—

Perihelion passage, January 27·4185 M.T. at Washington.

	°	′	″
Longitude of perihelion	280	26	59
,, ascending node	7	50	28
Inclination	35	5	30
Logarithm of perihelion distance	7·719160		

Motion—retrograde.

So that, he remarks, the perihelion distance given by this first rough approximation is such that the comet's centre of gravity would have passed at a distance from the solar surface equal to only one-eighth of the sun's own radius.

Dr. Gould also refers to the discussion which took place in 1843 as to the possible identity of the comet of that year with the one observed in southern latitudes in 1668, and concludes:—"Although Hubbard's discussion shows that the observations of 1843 can be best represented by an ellipse of more than 500 years, and although the intervals of 175 years between 1668 and and 1843, and 37 years from the perihelion of 1843 to the present time, are not commensurable, still this argument against identity does not seem very forcible."

The "*Argus* Summary for Europe," published at Melbourne on February 19, contains three positions of the comet, communicated from the Observatory, which are as follow:—

	Right Ascension. h. m. s.	Declination. ° ′ ″
Feb. 9 at 9 p.m. ...	23 41 14·5 ...	− 33 43 52
10 at 9 p.m. ...	23 58 23·0 ...	− 33 44 58
14 at 9 p.m. ...	1 2 15·6 ...	− 33 21 7

These places are termed approximate, and on comparing with the positions received from Dr. Gould and Mr. Gill's rough ones, it is evident that the declination of February 14 has been misprinted, and should be − 32° 21′ 7″. It is stated that on this date the nucleus had become very faint, and "even with the great telescope the tail could only be seen as a thin wisp extending eastwards from the head for a couple of degrees. The head itself appeared simply as a faint nebulous mass with a slight central condensation." Beyond the fact that the comet had passed the perihelion and was rapidly receding from us, nothing definite appears to have been known of the orbit at Melbourne up to February 19, and it is clear that at the Cape up to February 24 its similarity to that of the comet of 1843 had not been remarked, the elements which we have published from Mr. Finlay being entirely different. So that, as we have remarked, it is probable that Dr. Gould has priority in drawing attention to one of the most striking facts connected with the periodicity of comets.

From the first approximate position determined at Cordoba, and the Melbourne observations of February 9 and 14, Mr. Hind has calculated the following orbit, which still further adds to the probability of the identity of the great comets of 1843 and 1880:—

Perihelion passage, January 27·5272, M.T. at Greenwich.

	°	′
Longitude of perihelion	278	3·7
,, ascending node...	0	5·7
Inclination	36	9·3
Logarithm of perihelion distance	7·81749	

Motion—retrograde.

Prof. Winnecke also has found that the elements of 1843 represent, with very trifling differences, Dr. Gould's place of February 4 and Mr. Gill's rough positions of February 10–15, and thinks there can hardly be a doubt that the bodies are identical.

PHYSICAL NOTES

M. PAUL BERT lately described a tele-microphone to the Académie des Sciences of Paris. The instrument thus denominated differs only in detail of construction from a form of microphone publicly described eighteen months ago in England. The transmitter of the telemicrophone consists of a tolerably thick disk of ebonised rubber, suitably mounted, to the centre of which one of the carbons is attached; the other carbon is kept lightly in contact with it with a pressure which can be adjusted by magnetic means, a small armature of iron being affixed to it, to which a steel magnet can be approached at will. The receiver is an ordinary Bell telephone. It is claimed that the voice is transmitted with less alteration of timbre than is usual with other telephones, and that there is a remarkable absence of the scraping noises that are almost inseparable from the employment of carbon transmitters.

IF rumour speaks truly, we are to hear shortly of another scientific invention worthy to stand beside the telephone or the phonograph in point of interest. Announcements of a mysterious *telephote* or *diaphote*, the discovery of two rival American inventors, have lately appeared in the paragraph columns of the non-scientific press, the instrument or instruments in question being declared capable of transmitting light as the telephone transmits sound. The rumour to which we allude, however, and of the truth of which we have authoritative information, is based upon the fact that Prof. Graham Bell has deposited in the Smithsonian Institution a sealed package containing the first results obtained with a new and very remarkable instrument first conceived by him during his sojourn in England in 1878.

M. MARCEL DEPREZ has recently described two important instruments to the Physical Society of Paris. The first is a galvanometer adapted for measuring very strong currents of electricity, and consists of a series of soft iron needles placed between the limbs of a steel horseshoe magnet of great directive force. Parallel to the plane of these needles and of the poles of the magnet are wound a few coils of stout wire to carry the current. The needle sets itself almost instantly in the position of equilibrium; hence it is suitable to measure currents which exhibit rapid variations in strength. The second invention of M. Deprez is an apparatus adapted for continuously registering the total amount of energy developed by a current; an industrial problem of great importance. The current is passed through an electrodynameter, being, however, bifurcated; the larger portion traversing the outer coils, the smaller portion traversing a wire of high resistance and then passing through the movable inner coils. The product of these two partial currents is proportional to the energy of the current; and as the mutual action of the two coils is also proportional to the product of the two partial currents, nothing more is needed than an appropriate registering apparatus to integrate the various portions of the total amount of energy. In this manner the amount of energy expended in the production of an electric light under any particular circumstances may be determined.

AT a recent lecture before the Society of Arts Dr. Heaton exhibited a large number of applications of Balmain's luminous paint, a substance based upon the famous "phosphorus" of Canton, and upon the phosphorescent powders investigated by Becquerel. Amongst other interesting matters it was shown that a can of hot water placed upon a shining surface of the paint dims its brilliance, though it recovers on cooling. The application of a lump of ice produces a contrary effect. A tube of "Canton's phosphorus," prepared more than a century ago by Canton himself, was shown still to possess phosphorescent properties.

WITH regard especially to the spectra and composition of nebulæ, M. Fiévez, of the Brussels Royal Observatory, has recently, following the example of Huggins, experimented as to whether an alteration in the luminous intensity of a gas, *without modification in the temperature or the pressure of this gas*, may involve disappearance of one or several lines in the spectrum. The method he adopted was that of projecting, by means of a lens, on the slit of a spectroscope, a real image of the luminous body (part of a Plücker tube), and then altering the intensity of this image, either by reducing the aperture of the projection-lens or by displacing a diaphragm pierced with a circular opening between the lens and the image projected. Hydrogen and nitrogen were the gases. With the former, as the brightness diminished the line H disappeared first, then the line C, the line F remaining last. The lines which disappeared did so by gradually diminishing in length. Nitrogen gave like results, and the following additional experiment was of a confirmatory nature:—If, at a moment when most of the lines are extinguished, the aperture of the slit be increased without changing the position of the screen, the lines that had disappeared return. It seems, then, well established that a gas, though possessing several spectral lines, may be manifested in the spectroscope by presence of a single line, the others remaining invisible by reason of the little brightness of the luminous body. On this ground certain nebulæ showing the lines of nitrogen and hydrogen which longest resist extinction are considered by M. Fiévez (with Dr. Huggins) to contain those gases, and the *relative* invisibility of the other lines (*relative* because they might probably be perceived with more powerful telescopes) is attributed to an absorption in space acting equally on rays of any refrangibility.

SOME experiments by M. Ziloff on the magnetisation of liquids are described in the *Journal de Physique* for March. It appears, *inter alia*, that the magnetic coefficient of the aqueous solution of perchloride of iron is not constant, but that it is a function of the magnetising force. As the latter is increased the magnetic coefficient increases, reaches a maximum for a determinate value of this force, and then diminishes, at first rapidly, and then slowly.

THE action of salts on water-absorption by roots, as studied by Sennebier, Sachs, and Burgerstein, having been left in some doubt, M. Vesque has recently made fresh experiments, and on the following plan:—First, the influence of salt and salt mixtures was tried on the absorption of water by the roots of uninjured plants whose aërial parts were subject to unchanged atmospheric conditions. Then their influence on water absorption by a severed branch, then on that of severed roots. M. Vesque's conclusions from the first series of experiments are as follows:—1. Under ordinary conditions, *i.e.* the plants suffering no lack of mineral nutriment, distilled water is better absorbed than solutions of salts and nutritive liquids. 2. When plants have been exposed a longer or shorter time to the influence of distilled water they absorb better the solutions of salts and nutritive liquids than pure water. 3. Even a short contact of the roots with distilled water acts favourably on the absorption of salts, and conversely a temporary contact of the roots with a salt solution on that of distilled water. 4. The influences are greater the more concentrated the solutions of the salts and the nutritive liquids. 5. There is no qualitative difference between absorption of the solution of an isolated salt and a nutritive liquid. The experiments with severed roots and branches yielded similar results. These also absorbed more distilled water when they had previously been in salt solution, and took up more salt solution when they had stood for more or less time in distilled water.

AT a recent lecture at the Conservatoire des Arts et Métiers, on the Industrial Applications of Artificial Refrigeration, M. Raoul Pictet produced a veritable sensation by coining a medallion in frozen quicksilver of the weight of fifteen kilogrammes.

GEOLOGICAL NOTES

DEVONIAN ROCKS OF BELGIUM.—We have just received the first descriptive memoir issued by the Geological Survey of Belgium. It is a quarto pamphlet of some seventy pages by Prof. Malaise, containing an account of fossiliferous Devonian and Cretaceous localities. The author has been at work collecting his materials for more than twenty years, and he now publishes a list of 173 places in Belgium from which Devonian fossils have been obtained. These places are arranged stratigraphically, and the names of the fossils found at each are given. As a contribution to the local geology of Belgium the pamphlet will doubtless prove of service. It is evidently a piece of laborious and painstaking work, of the kind that ought to precede the broad generalised summaries which the Survey will eventually be able to present for the information of the world. There is attached to it an index map, on which each of the fossiliferous localities is marked with a coloured spot, to which is attached a symbol indicating its geological horizon. Though the map is not, in the ordinary sense, a geological one, it tells its story clearly, and will be a convenient guide to those who purpose to visit the fossiliferous sites among the Belgian Devonian rocks. Prof. Malaise prefixes to his statistics a short introduction, in which he traces the history of Devonian classification in his own country and gives the subdivisions of the Devonian system which his own labours have led him to adopt. He modifies Prof. Gosselet's arrangement, taking the Couvin shales and limestone with *Calceola* out of the Inferior and placing it in the Middle Devonian group, together with the Givet limestone, but leaving the shales with *Spirifer cultrijugatus* in the Lower. These shales he regards as containing a fauna transitional between that of the Lower and that of the Middle division of the Devonian system. Prof. Gosselet has observed that if the Couvin limestone is bracketed with that of Givet, we must also place there the limestone of Frasne, as was done by Dumont. But M. Malaise replies that Dumont's classification was founded on mere lithological considerations, and that we can now trace palæontological differences among these subdivisions. It is interesting to observe among his fossils from the Upper Devonian Psammites du Condroz some of the forms which occur in the Barnstaple and Marwood beds of Devonshire, with remains of fishes (*Holoptychius nobilissimus*) of the Upper Old Red Sandstone of Scotland, and of ferns (*Palæopteris Hibernica*) identical with those of Kiltorcan in Ireland.

GEOLOGY AND PHYSICAL GEOGRAPHY OF THE ARALO-CASPIAN BASIN.—The veteran geologist Count von Helmer en last year presented to the Imperial Academy of Sciences of St. Petersburg an interesting communication relative to the geological changes which have taken place within tertiary and recent times in the remarkable depression in South-Eastern and Asiatic Russia. Considerable activity has for some years past prevailed among Russian officials in regard to railway communication with the new acquisitions in that part of the empire. In June, 1877, the Grand Duke Nicholas placed himself at the head of an expedition which started from Orenburg with the view of exploring the shortest railroad route to Tashkend—the chief point in the central area of Russia in Asia. During the progress of this expedition a sketch-geological map was constructed and a collection of specimens was made which, carefully labelled and accompanied with notes, were sent to Count von Helmersen, whose life-long acquaintance with Russian geology enables him to make the data thus supplied tell a connected and interesting story. He points out that a much larger area of Southern Russia and adjoining lands was covered by the sea in Jurassic than in Cretaceous times; that the expanse of salt water was further diminished in the Eocene and Miocene, and still more in the Pliocene and Post-pliocene periods, and that it is visibly decreasing now in the remnants of it left in the Aralo-Caspian basin. That this should not be regarded as a mere local phenomenon he thinks to be made clear by well-known facts in Northern Russia and the surrounding regions. In Siberia, for instance, the shells of molluscs still living in the Arctic Sea are found southwards to a distance of 700 versts (nearly 500 English miles) from the northern coast, and all round the Baltic recent marine shells are found up to heights of sometimes 600 feet above the present sea-level. Whether this retreat of the sea is to be explained by a general subsidence of the ocean or an elevation of the land, or by both causes combined is, he believes, a question which still awaits solution for the whole northern hemisphere, though it has been studied by so many observers from the times of Linnæus and Celsius down to our own. After the floor of the Miocene sea had been in large measure raised into land, the United Aralo-Caspian Sea must have been connected with the Black Sea, and must have had the form of a large arc, of which the vertex passed through the country of the Turcomans and Khiva, and of which the eastern limb stretched northwards beyond the present Aral Sea. It has been commonly supposed that during some part of the later Tertiary or Post-Tertiary periods a connection existed between this united Aralo-Caspian Sea and the Arctic Ocean. But the Count holds that for this belief there is no proper foundation. At the eastern base of the Ural Mountains, he asserts, there are in the superficial deposits no vestiges of any living species of marine shells. The mollusca cited by Pallas and others from the plains of Western Siberia are all referable to freshwater species. With regard to the probable cause of the subsidence of the level of the Caspian, Count von Helmersen believes that it is to be sought in the gradual sinking of the ground. In the deeper southern half of the Caspian, notably about Derbend and Baku such a sinking is actually proved. Not there only, but over the area of the sea itself, as far as the island Tscheleken, on the eastern shore, an enormous quantity of carburetted hydrogen escapes from the ground, and has perhaps been doing so for thousands of years. The area over which this takes place loses in substance, the ground gets looser, and is unable to withstand the great pressure of the water of a deep sea and of the superincumbent rocks. It is consequently pressed together, and sudden infalls sometimes occur. The wide extent of the area which supplies the gas and naphtha emanations of the Caspian may be understood from the statement that even as far north as Astrakhan carburetted hydrogen gas instead of water has come up in Artesian borings. But besides this subterranean cause of diminution the Count is of opinion that the facts indicate an absolute decrease in the waters of Central Asia. Though the dwindling down of the Miocene and Post-miocene seas gives no certain proof of such a decrease, yet the desiccation of the rivers of the Steppes and the drying up of the lakes point to a change of this nature. The author instances the rivers Sārafscham, Emba, and Irgis, and all the streams descending from the north towards the Lake Balkash. This lake is fed only from the mountainous country lying to the south. Everywhere all over the vast Steppes and across into Persia and Afghanistan ancient wide lakes are now represented by greatly diminished sheets of water, which the rivers in many cases are unable to reach, as their currents are gradually lost in the wastes. An interesting practical question is connected with these discussions. Is it possible to form a continuous water-way from St. Petersburg, by the Volga, Caspian, and Oxus, to Khiva or the borders of Bokhara? Could the ancient channel of the Usboi again be filled with water so as to afford a route from the Caspian eastward? This matter is being investigated by an expedition sent out for the purpose. Count von Helmersen, however, believes that the desiccation of the Usboi is only part of the vast continental diminution of rainfall and water-supply, and that the artificial restoration of that channel is impossible. Still it is difficult sometimes to define what is impossible to modern engineering skill.

GEOGRAPHICAL NOTES

As an example worthy of being followed by our own and other geographical societies, we call attention to the "Memorie della Società Geografica Italiana," vol. ii., parte prima (Rome, 1880), which is the first part of a volume intended to be dedicated entirely to the zoological results of the Italian expedition to equatorial Africa, under the command of the Marquis Antinori, whose portrait serves for frontispiece. It is prefaced by a communication from the Secretary of the Society (Sig. G. della Vedova), giving an itinerary of the expedition, and in connection with this there is a very excellent map showing the route. As is well known, the expedition principally explored the kingdom of Schoa, immediately south of Abyssinia—a district of which we have heard a good deal lately in connection with Egyptian politics, and of which we shall no doubt hear a good deal more. We have here an enumeration of the lepidopterous insects of the expedition, drawn up by M. Charles Oberthür, of Rennes, illustrated by a folded plate, apparently carefully executed after the manner of lepidopterists, on which eight presumably new species are represented. The list of known species shows but little of the palæarctic element; this has already become dissipated, and we enter upon African ground as such; but the species captured were conspicuous, and include several of extremely wide distribution. A note explains that this part is not absolutely original, and that it also appears in the "Annali del Museo Civico di Storia Naturale di Genova," vol. xv., and the introduction indicates that the whole of this zoological volume will receive attention from the naturalists on the staff of, or in connection with, the now renowned Genoa Museum.

AT the meeting of the Geographical Society on Monday evening the Rev. Chauncy Maples, of the Universities' Mission, read a paper on Masasi and the Rovuma district of East Africa. Masasi appears to be the name of a district rather than of a town, lying in about 11° S. lat. and 38° E. long., and some 120 miles south-west from Lindi on the coast; it consists of four mountains lying east and west, and rising out of a dense forest. The station of the Universities' Mission, which was formed in 1876, is situated at the western extremity of the region, and to their west again a vast forest stretches away towards Lake Nyassa. In describing the nature of the route to Masasi, Mr. Maples took occasion to remark that if a road should ever be constructed to connect Lindi with Lake Nyassa, it would have to pass along the valley of the Ukeredi, which presents no engineering difficulties. A noteworthy feature of the Masasi district is its great fertility; the cassava attains an enormous size, and the rice, &c., grown are famous for miles round. The water is strongly charged with iron, and salt is obtained in large quantities from the moist ground under the hills. Ironstone is common, and extensively worked. The missionaries have introduced several kinds of fruit, and intend to try wheat. Mr. Maples afterwards described a journey which he made in November, 1877, to the valley of the Rovuma River and the Makonde country. Throughout his paper he furnished many interesting particulars respecting the tribes inhabiting the country between the coast and Lake Nyassa.

THE Naples correspondent of the *Daily News* states that a plan has been proposed for an Italian Antarctic expedition, to leave Genoa not later than May, 1881, touch at Monte Video, Terra del Fuego, Falkland Islands, and the South Shetland Islands, remain in the Antarctic region two winters for the purpose of scientific investigation and exploration, making use of the period during which the ice is firm for sledge excursions, and return, touching at Hobart Town or Capetown, to Naples. It is calculated that the sum required will not exceed 600,000 lire. The number of persons on board not to be more than forty, part of them being selected from the Italian Royal Navy, part from the Italian whale-fishers who frequent the Southern Seas.

IT is announced that two French explorers, MM. Wallon and Guillaume, have been assassinated while ascending the River Tengung, in Northern Sumatra.

THE American Society of Civil Engineers have issued, in pamphlet form, speeches delivered before it in discussing Mr. A. G. Manocal's paper on interoceanic canal projects.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale des Sciences de Belgique, No. 2, 1880.—On the discovery by Prof. Scacchi, of Naples, of a new simple substance in the lava of Vesuvius, by M. Stas.—A word on some cetaceans which perished on the coasts of the Mediterranean and the west of France during 1878 and 1879, by M. van Beneden.—Researches on the relative intensity of the spectral lines of hydrogen and nitrogen in relation to the constitution of nebulæ, by M. Fievez.—Note on certain covariants of binary algebraic forms, by M. le Paige.

Journal de Physique, March.—Phenomena called hydro-electric and hydromagnetic; fundamental theorems and their experimental demonstration, by Prof. Bjerknes.—Specific heats and fusion points of various refractory metals, by M. Violle.—Magnetisation of liquids (second part) by M. Ziloff.—Areometer giving the density of solid substances, by M. Buignet.—Application of the telephone to electric and galvanic measurements, by Herr Wietlisbach.

Rivista Scientifico industriale, No. 3.—Influence of surface-impurity on areometric measurements, by Prof. Marangoni.—On the nature of the electric current; considerations and experiments, by Prof. Magna.

No. 4.—On two new species of parasite crustaceans, by Prof. Richiardi.—Fossiliferous caverns discovered at Cucigliana, and fossil remains belonging to the genera Hyæna and Felis, by S. Acconci.—Aspirators and compressors, by Prof. Marangoni.—New system of electric illumination, by S. Milani.—Ammonites and belemnites found in the neighbourhood of Narni, by S. Terrenzi.

Atti della R. Accademia dei Lincei, February.—The Fierasfer; studies on the systematic anatomy and biology of the Mediterranean species of that genus, by Dr. Emery.—Comparative researches on the structure of the nervous centres of vertebrata, by Dr. Bellonci.—The living mollusca of Piedmont, by S. Lessona.—On the action of cold and heat on the human blood-vessels, by Dr. de Paoli.—On the first phenomena of development of Salpa, by S. Todaro.—Geological notes on the environs of Civita Vecchia, by S. Meli.—On the vibrations of isotropous elastic bodies (prize memoir), by Prof. Cerruti.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, April 8.—C. W. Merrifield, F.R.S., president, in the chair.—Mr. J. Barnard was elected a Member, and Mr. T. Olver Harding admitted into the Society.—The following papers were read:—A (presumed) new form of the equations determining the foci and directrices of a conic whose equation in Cartesian co-ordinates is given, by Prof. Wolstenholme.—The application of elliptic co-ordinates and Lagrange's equations of motion to Euler's problem of two centres of force, by Prof. Greenhill.—Theorems in the calculus of operations, by Mr. J. J. Walker.—On the equilibrium of cords and beams in certain cases, by Mr. W. J. Curran Sharp.—On steady motion and vortex motion in an incompressible viscous fluid, by Mr. T. Craig.—On functions analogous to Laplace's functions, by Mr. E. J. Routh, F.R.S.

Zoological Society, April 6.—Prof. W. H. Flower, F.R.S., president, in the chair.—The Secretary read some extracts from letters which he had received from Mr. W. A. Conklin, of New York, relating to the birth of an elephant which had lately taken place in a travelling menagerie at Philadelphia.—Prof. T. H. Huxley, F.R.S., read a paper on the distinctive characters of the species of the genus *Canis*, as shown in certain points of the structure of their skulls and in the proportions of their teeth.—Dr. Francis Day read a paper on the fishes of Afghanistan, based principally upon a collection which had been made for him in the highlands of Kelat and Quettah, by Dr. Duke.—A communication was read from Prof. Julius von Haast, F.R.S., containing a description of a specimen of a rare Ziphioid Whale (*Epiodon novæ-zealandiæ*), which had been cast ashore at New Brighton, New Zealand, in July, 1878.

Geological Society, March 24.—Robert Etheridge, F.R.S., president, in the chair.—H. T. Burls, Paramaribo, Dutch Guiana; John Allen McDonald, and Rev. Thomas Edward Woodhouse, B.A., were elected Fellows of the Society.—The following communication was read:—The newer Pliocene Period in England—Part I. Comprising the Red and Fluvio-marine Crag and Glacial Formations, by Searles V. Wood, jun., F.G.S. The author divided this part of his subject into five stages, commencing with—Stage I. The Red Crag and its partially fluvio-marine equivalent. The Red Crag he regards as having been a formation of banks and foreshores mostly accumulated between tide-marks, as shown by the character of its bedding. The southern or Walton extremity of this formation, which contains a molluscan fauna more nearly allied to that of the Coralline Crag than does the rest of it, became (as did also the rest of the Red Crag south of Chillesford and Butley) converted into land during the progress of the formation; while at its northern or Butley extremity the sea encroached, and an estuary extending into East Norfolk was also formed, during which geographical changes a change took place in the molluscan fauna, so that the latest part of the Red Crag proper and the earliest part of the fluvio-marine (both containing the northern species of mollusca and those peculiar forms only which occur in older glacial beds) alike pass up without break into the Chillesford sand and laminated clay which form the uppermost member of the formation. He also regards the principal river of this estuary as flowing into it from North Britain, through the shallow preglacial valley of chalk, in which stands the town of Cromer, and in which the earlier beds of Stage II. accumulated in greatest thickness. The forest and freshwater beds, which in this valley underlie the beds of Stage II., he regards as terrestrial equivalents of the Red Crag; and having observed rolled chalk interstratified with the base of the Chillesford clay in Easton-Bavent cliff, he considers this to show that so early as the commencement of this clay some tributary of the Crag river was entered by a glacier in the Chalk country, from which river-ice could raft away this material into the estuary. He also regards the copious mica which this clay contains as evidence of ice-degradation in Scotland having contributed to the mud of this river. In Stage II. he traced the conversion of some of this laminated clay, occupying sheet 49 and the north-east of sheet 50 of the Ordnance map, into land, the accumulation against the shore of this land of thick shingle-beaches at Halesworth and Henham, and the outspread of this in the form of seams and beds of shingle in a sand originally (from its yielding shells in that region) called by him the Bure-valley bed, and which Prof. Prestwich recognised under the term "Westleton Shingle." As the valley of the Crag river subsided northwards as the conversion of this part of the Chillesford clay into land occurred, there was let in from the direction of the Baltic the shell *Tellina balthica*, which is not present in the beds of Stage I. The formation thus beginning he traced southwards nearly to the limit in that direction of the Chillesford clay about Chillesford and Aldboro'. The Cromer Till he regards as the modification of this formation by the advance of the Crag glaciers into the sea or estuary where it was accumulated, such advance having been due partly to this northerly subsidence, but mainly to the increase of cold. Then, after describing a persistent unconformity between this Till and the Contorted Drift, from the eastern extremity of the Cromer cliff (but which does not appear in the western) to its furthest southern limit, he showed how the great submergence set in with this drift, increasing much southwards, but still more westward towards Wales. The effect of this was to submerge the area of Red Crag converted into land during Stage I., so that the Contorted Drift lies upon it fifty feet thick, and to cause the retreat of the ice which had given rise to the Till to the slopes of the Chalk Wold; whence masses of reconstructed chalk were brought by bergs that broke off from it and were imbedded by their grounding in this drift, contorting it (and in those parts only) by the process. He then traced, in the form of gravels at great elevations, the evidences of this submergence southwards and westwards, showing it to have increased greatly in both directions, but mostly in the western; and he connects these gravels with the Contorted Drift by the additional evidence of one of these marl masses, in which he found a pit excavated near the foot of Danbury Hill, in the London clay country of South Essex, and which hill is covered from base to top by this gravel. The gravel which thus covers Danbury Hill, of which the summit has an elevation of 367 feet, rises in North Kent to upwards of 500 feet; to between 400 and 500 feet on the Neocomian within the Weald; to 600 feet in North Hants (where it overlooks the Weald), and also in Wilts, Berks, and the adjoining parts of Bucks; to 420 feet in South Hants; to 540 feet in Oxfordshire; to 400 feet in Cornwall; to upwards of 700 (and perhaps 1,000 and more) in the Cotteswolds; to 1,200 feet in Lancashire, and to 1,340 feet in North Wales. Eastwards, through Kent towards France, their elevation falls, and in the North of France appears to be about 130 feet; from whence the evidences of the submergence are furnished northwards by the Campinian sands and the diluvium of North Germany and Holland. In Stage III. the author traced the rise from this depression, the increase of the ice from the greater snow interception, caused by it on the Penine chain, and the consequent advance of the glacier- or land-ice. This advance gave rise to the chalky Clay, which was the morainic mud-bank which preceded this glacier, and was pushed by it as it advanced and the land rose, partly into the shallow sea (where it covered and protected for a time the gravel which was synchronously forming there), and partly on to the land; and by the aid of maps he showed the islands that were overwhelmed by it. He then showed, by a line on a map, the limit up to which this ice, as it thickened, cut through and destroyed this first deposited moraine and the gravel which it had covered, as well as such beds of Stage II. as were formed there, all this material being pushed on to add to later deposited moraine. Outside this line the gravel for the most part remains undestroyed, its contents, particularly in the uppermost layers, showing that it was fed by the approaching moraine. By the level at which the junction of this gravel with the moraine clay occurs he traces the position of the sea-line at this time (towards the end of the formation), and finds it to rise along the south-eastern edge of the clay, from 40 feet in North-East Suffolk to 160 feet in South Essex, and from that along the south-western edge to upwards of 350 feet in North Warwickshire and the parts of Northamptonshire adjoining, all this agreeing with the original increment of submergence in Stage II. He then showed, from evidence afforded by the Yare and Gipping valleys, that this ice, ceasing to advance in East Anglia, shrank into the valleys of that district, exposing the moraine it had previously laid down to the growth of vegetation, and issued only through these valleys to the sea. The Hoxne palæolithic brickearth he regards as the deposit of a lagoon produced from the interception of the drainage of this surface by the glacier-tongue thus passing through the Waveney valley. The Brandon palæolithic brickearth he regards as connected with the same state of things. In Stage IV. he described the plateau and cannon-shot gravels of Norfolk as resulting from the washing-out of the morainic clay by the melting of this ice, which, though shrunken into the valleys of the East of Norfolk, still lay high and in mass in West Norfolk; and showed that, by having regard to the different inclination of the land thus traced, the position of this gravel is reconcilable in no other way. The cannon-shot part of it he attributed to the torrents pouring from this high-lying ice over the west side of the Wensum valley; and the plateau gravels to the deposition of other parts of the same spoil carried into East Norfolk at the commencement of the process and while the ice had not thawed out of the valleys, this gravel afterwards, as the valley-ice thawed, being deposited in them. He also traced the excavation of the trough occupied by the Bain and Steeping rivers in Lincolnshire to the same cause. The finer or sandy part of this material has an extensive spread in South-West Norfolk, forming thick beds; and in a thinner form spreads over North-West Suffolk, where it wraps the denuded edges of the Hoxne and Brandon palæolithic brickearths. In Stage V. he traced the line of gravels that overlie the Chalky Clay where this clay entered the sea. This entry to the sea over the Severn drainage system took place by way of the watershed between the Welland and Avon, and by the valley of the latter. Its entry into the sea over the Thames system was by way of the watershed between this system and that of the great Ouse in South Bucks, as well as by the valley of the Colne, Lea, and Roding, and over the lower part of the watershed in South-East Essex. Its entry into the North Sea was by the valleys of the Blackwater, Gipping, and other Essex and Suffolk valleys, the entry by the Yare and Waveney being far out beyond the present coast-line. He also traced, by similar evidence, the extent to which the sea entered the Trent system after the ice vacated it. This line of gravel (after allowing for the case that the level of the junction of the gravel beneath the clay represents that of the sea-bottom, while that over the clay more nearly represents that of the sea-top), he showed to correspond with that of the junction of the gravel beneath the clay so far as this is not destroyed in the parts where the ice did not shrink into the valleys; and it also agrees with this line, supplemented by the amount of rise in the interval where the ice did so shrink. Along the south-western edge of the clay this line of gravel, subsequent to the clay, falls from near 400 feet in Bucks to 150 feet in South Essex; from whence northwards along the south-eastern edge, it falls uniformly to Ordnance datum in central East Suffolk, and probably continued to fall to 100 feet or so below this at the extreme point where the ice from the Yare valley entered the North Sea far beyond the present coast. Along the north-western edge of the formation this line falls northwards in a corresponding way to that on the south-eastern edge, save that, starting there from near 350 feet, it does not fall below, if even quite down to Ordnance datum near the Wash. He then traced the extent to which the sea on the west, deepening in that direction in accordance with the original depression of Stage II., entered the valleys of the area covered by the ice of the Chalky Clay as this vacated it; the carrying out through the Welland and Avon valleys of the red and white chalk spoil of the Bain-Steeping trough, and its deposition in the Cotteswold gravel up to a high level, coming from the Avon system over the Gloucestershire water-parting into the valley of the Evenlode, a part of the Thames system. All river-gravels north of the point where the line of gravel over the clay sinks below Ordnance datum, he regards as concealed below the alluvium, and at depths proportional to the fall of that line. Examining in detail the grounds for the contrary opinion heretofore held by himself and by geologists in general, that the great submergence succeeded the principal glaciation of England, he rejected that opinion; and no longer regarding the basement clay of Holderness (with its ancient molluscan facies) as identical with the Chalky Clay, but as moraine synchronous with the Till of Cromer, he considered the gravels with shells at extreme elevations in Lancashire to have preceded all glacial clays but these, and to have escaped destruction by the advance of the ice during the rise only at the south end of the western slope of the Penine chain, those on the eastern having been wholly swept away; but that gravels were deposited on the east side of the Penine after the dissolution of the Chalky-clay ice up to the reduced height of the sea-level at that time, and so far as the ice of the purple clay allowed the sea to come. He then relinquished the opinion formerly held by him that the passage of the Shap blocks was due to floating ice, and referred this to the land-ice crossing the Penine chain consequent upon greater snow interception from the progress of the rise; and to the same cause he referred the drift which rises high on the eastern slope of the Penine ridge north of the Aire. To this crossing of the ice having diverted first a part and then the whole of the ice-supply of the Chalk-clay glacier he attributed first the shrinking of that glacier into the valleys in East Anglia, and afterwards its dissolution by the agencies always rife in the Greenland ice (but which are there balanced by continual reinforcement), when by this diversion its reinforcement by ice from the Penine chain ceased. The purple clay of Holderness, being thus in its lowest part in Holderness coeval with the valley-formed portion of the Chalky Clay of Norfolk and Suffolk (or "third Boulder-clay" of Harmer), was the moraine of this invading ice, which, after crossing at Stainmoor, divided against the eastern moorlands of Yorkshire; and one branch going north of these moorlands through the valley of the Tees, sent off an arm down their eastern flank, the moraine from which is the narrow belt of purple clay which skirts the Yorkshire coast north of Holderness, and spreads out wider in Holderness. This arm, in consequence of the Chalky clay ice not having (from the westerly increment of depression), descended the eastern slope of the Wolds, found sea there covering the basement clay of Holderness, in which sea it stopped between the Humber and the Wash, by means of which the lower part of the purple clay up to the level of about 150 feet, contains intercalated in it beds of sand and gravel, and contains shells and shell-fragments, as does the Lancashire clay similarly extruded beneath the sea. The other branch came south along the western flank of the east moorlands and through the Vale of York, where it ended, and became stationary in the sea as this entered the Trent system on the final dissolution of the chalky-clay glacier. The author discovers no trace of anything like the intercalation of warm periods up to the stage with which he concludes this part of his memoir; and leaves the description of the later beds, as well as an examination how far arboreal vegetation and the coexistence of Pachyderms and Proboscideans can be reconciled with the contiguity of extensive land-ice for the concluding part of it.

Mineralogical Society of Great Britain and Ireland, April 5.—Dr. M. F. Heddle, F.R.S.E., president, in the chair.—Prof. F. J. Wick, of Helingfors, and Mr. Richard Pearce, of Denver City, Colorado, were elected as ordinary members.—Prof. A. Geikie, F.R.S., read a paper on the microscopic structure of some Scottish nitreous basalts. The paper was illustrated by a fine series of drawings and by a number of microscopic sections.—Mr. J. B. Hannay, F.R.S.E., gave an account of his recent experiments in the production of the diamond and other precious stones, and exhibited some fragments of artificial diamonds.—Dr. Heddle announced the occurrence of xonaltite, turgete, martite, and other minerals in Scotland, now discovered for the first time in that country.

Victoria (Philosophical) Institute, April 5.—A paper on life and its physical basis was read by Prof. Nicholson, M.D., F.R.S.E. The paper treated of the physical and chemical properties of the protoplasm, of the phenomena exhibited by simple masses of protoplasm in a living condition (such as the monera, the amœba, and the yeast plant), of the distinction between dead protoplasm and living protoplasm, of the nature of "Vitality," and of the nature of the temporary connection which subsists between protoplasm and life. A communication from Prof. G. G. Stokes, F.R.S., of Cambridge, having been read, several present took part in considering the subject.

Paris

Academy of Sciences, April 5.—M. Edm. Becquerel in the chair.—The following papers were read:—On some applications of elliptic functions (continued), by M. Hermite.—Application of the theory of sines of superior numbers, &c. (continued), by M. Villarceau.—On some theorems of kinematics, by M. Resal.—On determination of high temperatures, by MM. Deville and Troost. This describes the application of their method to determining the boiling temperatures of cadmium and zinc. With air as the thermometric substance, the results closely agreed with M. Edm. Becquerel's. It is noted that the boiling points for zinc increased in using successively hydrogen, air, and carbonic acid.—On the heat of formation of oxides of nitrogen, by M. Berthelot. This paper relates to the bioxide and the protoxide. He measured the heat of formation of the former by detonating cyanogen (or ethylene) mixed with the bioxide in theoretic proportions, and from the heat of combustion in that case deducting that in the case of the same gas (cyanogen or ethylene) being burnt with pure oxygen. The heat of formation of protoxide of nitrogen was got by burning carbonic oxide with this gas and with free oxygen, and deducting. The numbers arrived at were, for the bioxide -21.6, protoxide -10.3. Tables of the thermal formation of oxides of nitrogen, nitrates, and ammoniacal salts, are added.—On the cyclone of January 24 last in New Caledonia, by M. Faye. The wind-movement is not spiraloid or convergent, but purely rotatory or circular. M. Faye remarks on the geometric exactness with which the winds acted, and the importance of good knowledge of the laws of storms as illustrated by the success with which Capt. Reveillere managed the frigate *Dives* in this cyclone.—On the points of the Siberian Arctic Ocean which present most obstacles to navigation, by M. Nordenskjöld. The general opinion that Cape Tchelioukine presents most difficulty is mistaken; for numerous rivers there cause a current which frees the ice. Most difficulty occurs near the east coast of Novaya Zemblya and in the strait south of Wrangel's-land.—On the manner of presenting the theory of potential in the hypothesis generally admitted of the discontinuity of matter, by M. Boussinesq.—Winter of 1879-80 at Clermont and Puy-de-Dôme, by M. Alluard. In those parts, whenever a zone of high pressures covers Europe, and especially France, there is interversion of the temperature with the altitude (more manifest at night); it is less cold at Puy-de-Dôme than at Clermont, some 1,100 m. lower. M. Faye remarked that this contradicted the notion that areas of high pressure are due to so-called *anticyclones* (with imagined descending motion).—Meteorological observatory of Puy-de-Dôme; glazed frost of November 21, 1879, by M. Alluard.—Continuous gyratory movements produced by a rotative induction machine, by MM. de Fonvielle and Lontin. A star or other shaped piece of soft iron is put on a pivot within the frame of a galvanometric coil, through which coil is sent the current of an induction-coil in which the inductive force of the direct and the inverse current are as equal as possible. A horse-shoe magnet supported above in a vertical plane by a rod may accelerate or stop the rotatory motion of the star according as its polar line is parallel or at right angles to the galvanometric wire.—Metamorphosis of the puceron of the ligneous galls of the black poplar, *Pemphigus bursarius*, by M. Lichtenstein.—Studies on chronometry; compensation, by M. Rozé.—On the algebraic equations whose first member satisfies a linear differential equation of the second order, by M. Laguerre.—On the measurer of energy, by M. Deprez.—On the specific heat and the conductivity of bodies, by M. Morisot. This describes the method (theoretical and experimental) of a new research.—On sulphides and selenides of chromium, by M. Moissan.—Thermochemical study of earthy sulphides, by M. Sabatier. Sulphide of magnesium (MgS) = + 36·8 cal.; of aluminium (Al_2S_3) = + 62·2 cal.; of silicium (SiS_2) = + 20·2 cal.—On crystallised oxalic acid, by M. Villiers.—On the amidised acids of α-oxycaproic acid, by M. Duvillier.—Relation between the sugar and the mineral and azotised matters in normal beets and beets grown to seed, by M. Pellet. It appears, *inter alia*, that the order of utility of substances in manures for beet is (1) phosphoric acid, (2) magnesia, (3) lime; then potash and soda, and lastly, nitrogen. In the two classes of beets referred to the difference exists chiefly in the leaves and stems.—On some alterations of subrenal capsules, by M. Bochefontaine.—On the simultaneous reproduction of orthose and quartz, by M. Hautefeuille. This he accomplishes by using phosphates concurrently with fluorides, producing the minerals associated as in their natural beds.—On an earthquake experienced at Poitiers and in the environs on March 22, 1880, by M. de Touchimbert.

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THURSDAY, APRIL 22, 1880

THE ST. GOTHARD TUNNEL

THE news that the two advance borings had met in the middle of the mountain traversed by the St. Gothard tunnel resounded like a joyful echo in every civilised country. It announced the success of the greatest work hitherto attempted by man; and, on the completion of so important an event, the scientific public must with good reason insist on having some details of the gigantic labours which have excited the attention of all intelligent men, and which, though well nigh finished, still demand much skill and energy.

The St. Gothard Tunnel is intended to form part of the railway connecting the North Sea with the Mediterranean; the ports of Belgium, Holland, and Germany with Genoa; the Rhine basin with that of the Po, by passing through the chain of the Alps at its most central point. If this point has been chosen in preference to any other, it is because the line through St. Gothard is the most direct. A proof that the passage is well selected is that, if one compares all the roads crossing the Swiss Alps, he will find that the St. Gothard one is more frequented by travellers either walking or riding than all the others together.

If, therefore, the Mont Cenis railway preceded that of St. Gothard, it is because there were political reasons for its accomplishment; it is because science had not yet discovered the means of boring, in a relatively short time, long tunnels without shafts. But the experiments made in Mont Cenis being conclusive, the governments, cities, companies, and private persons who were interested all set to work, and the great international line subsidised by Italy, Germany, and most of the Swiss cantons was commenced in real earnest.

Before the Company was formed, a most thorough inspection was made on the spot, and the engineers concluded that the great inevitable tunnel could have its openings only near the small village, Goeschenen (Canton Uri), on the north, and near Airolo (Canton Tessin) on the south. Goeschenen is 1,109 metres above sea-level, and 672 above the Lake of the Four Cantons. Airolo is 1,145 above the sea. Considerable works, therefore, are necessary to reach so great elevations by means of a railway. But to lower the level of the tunnel by only a few metres while awkwardly increasing the length, and to ascend higher to lessen that length, only alleviated the difficulty to a trifling extent, especially on the south slope, where Airolo is almost the only possible point of entrance.

Both openings being thus decided upon, the first thing to do was to lay down the plan of the tunnel and ascertain its direction and level. Thanks to the excellent topographical map possessed by Switzerland, it was evident, even without examination made on the spot, that the tunnel might be straight, and that its length would be about 15,000 metres. Afterwards it was thought preferable to complete it at the southern end by a slight curve, to give more facilities for building the Airolo station, but the tunnel throughout was opened in a straight line, and it was not till later that a curved bifurcation of 125 metres was made near the mouth.

In St. Gothard there were not the same topographical advantages as in Mont Cenis. In the operations made to trace the tunnel under the latter, there was at the highest part of the ground a starting-point from which could be seen, if not the two openings, at least points in their neighbourhood placed on the continuation of the very axis of the tunnel. They were able accordingly to build at a high elevation an observatory supplied with a field-glass rotating in a vertical plane passing through the middle of the tunnel. From that observatory two other observatories were determined in the same vertical plane towards the mouths of the tunnel, and the field-glasses of the two new observatories very easily supplied, when necessary, the direction of the tunnel axis.

On St. Gothard it was entirely different. The mountain presents several ridges over the tunnel. At no point can the places near both openings be seen at once, and some of the summits are so steep and high that it is impossible to take observations, and any *direct* tracing of the line over the mountain is impracticable. It was therefore necessary to make an *indirect* tracing, that is, to connect the extremities of the line of direction by means of a chain of triangles, calculate the relative position of the two openings, and thence deduce the angle formed by the tunnel axis either with the sides of the triangles of which Goeschenen and Airolo are the vertices, or with the meridian. This operation was facilitated by the great triangulation of the map of Switzerland, five vertical points of which are near the tunnel and could be utilised, but only as checks, since the entire work was done afresh, and it was even necessary to reconstruct the points of observation, many having disappeared, and nearly all of them being on peaks placed above the perpetual snow-level. M. Gelpke, the engineer who had charge of the triangulation, measured a base line of 1,450 metres in the Urseren Valley, and then measured all the angles not only of the eleven triangles connecting the two mouths, but also of several triangles used for verification. It was necessary to work with extreme care, as a mistake in direction of only five seconds would produce a deviation of 40 centimetres in the middle of the tunnel. Besides the verification indicated, another was made by a system of arrows continued from the point where the tunnel-axis was calculated to intersect the observer's base line in the direction of the line forming with the base the angle given by calculation. This measurement by arrows was continued as far as Goeschenen, and led precisely to the mouth of the tunnel.

When measuring the angles of the triangles, M. Gelpke also took the vertical angles, and was able to calculate the difference in altitude of the tunnel-mouths. The level moreover was ascertained directly, and connected with the great European triangulation of precision, which passes directly over the Col of St. Gothard.

The direction and level having been thus obtained, observatories were placed near the tunnel-mouths, to serve as direction-points for the miners. At Airolo there was no difficulty in fixing the observatory, the site being suitable; but at Goeschenen, where the direction of the tunnel forms with the narrow and deep valley a very acute angle, there was not a sufficient line of sight, and it was necessary, in order to have one, to traverse two projecting rocks with two small bores 115 and 93 metres long, and only then could observations satisfactorily be made either as to direction or level.

In each observatory was placed a large theodolite, and after a very large number of angular measurements and astronomical verifications, arrows and levelling-marks were placed in the exact direction of the tunnel, so that at every moment during the first stage of the tunnelling works the direction in which the miners were advancing could be verified.

In spite of the success of the verifications of M. Gelpke's labours, the managers of the St. Gothard Company thought it right to recommence the triangulation in 1874, employing another engineer, M. Koppe, and a different system. Instead of limiting himself to summits in the neighbourhood, and having moderately-sized triangles

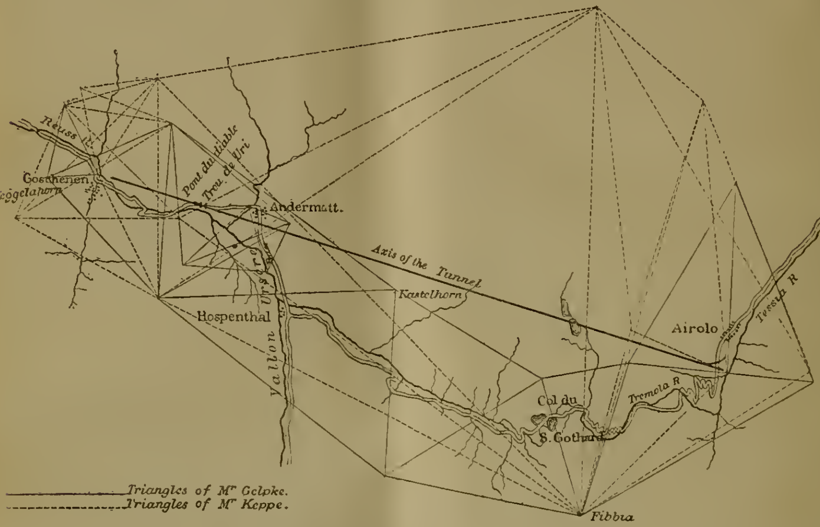

Fig. 1.—Plan of Triangulation for the St. Gothard Tunnel, $\frac{1}{133,333}$.

(the longest side being under 7,000 m.), M. Koppe preferred to use as large triangles as possible, in order to connect together by a minimum number of intermediary stations the two tunnel openings. No doubt, since these openings are at the bottom of valleys, a certain number of triangles was necessary to descend from the heights; but the sides of triangles of from 10 to 15 kilometres connect directly the signals on the heights above Goeschenen with those of the heights near Airolo, and several triangles for the purpose of verification were laid down. The two operations proving the accuracy of the works were (1) the correspondence *within two seconds* of M. Koppe's triangulation with that of M. Gelpke; (2) the following almost direct and very interesting verification. M. Koppe started

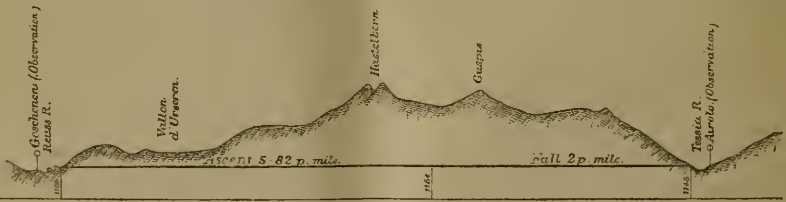

Fig. 2.—Profile along the length of the Tunnel.

a system of arrows from Airolo northwards along the axis of the tunnel over the mountain, following the direction given by the observatory to the highest attainable point near Kastelhorn, where he erected a mast. Being unable to reach this point from Goeschenen by going south, on account of the local difficulties, he started northwards also from that opening, in the direction of the continuation of the tunnel-axis. He thus ascended the flanks of a mountain till he could observe in the distance the mast he had erected near Kastelhorn. Then observing the level of Goeschenen with a theodolite, he moved his field-glass in a vertical plane, and directing it upon Goeschenen, he was delighted to see his mast almost in the centre of his field of vision, at a distance from his estimated axis of about 15 centimetres. It might therefore be assumed that that axis traced in air is of great accuracy.

As to the operations for verifying the direction within the tunnel, they are in theory very simple. So long as the boring was not far advanced it was given directly by the direction-points by means of field-glasses fixed in the observatories. At Goeschenen this was done till they had bored to a depth of 1,300 metres, but at Airolo the atmosphere was saturated with vapours, and thus they could not advance more than 600 m. Beyond those limits, therefore, it was necessary to have several stations. By means of the observatory, lamps were fixed in the exact direction of the axis. Then, a theodolite being placed behind the lamps in a line with them, its telescope was reversed, and the direction thus determined from the bottom of the boring. Lamps were then placed in this line of direction on hooks fastened to the roof of the tunnel. They could thus advance and increase the numbers of observing stations as they found necessary, either from the increased length of the boring or the want of transparency in the air. This operation, apparently very simple, is in reality very long and complicated, and to effect it various instruments were made use of which were improved during the works. As to the lamps, after trying different modes of lighting, they came back to ordinary petroleum lamps with round wicks, which were placed on stands carefully hung up and centred, and on which the instrument was then placed. To effect communication between the different stations of the instrument and lamps, experience soon proved that the simplest and most economical plan was to use a field telegraph, which was lengthened as they advanced.

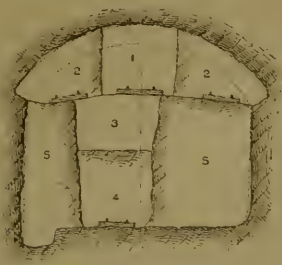

FIG. 3.—System of excavation, $\frac{1}{200}$. 1, Advance Gallery; 2, Side workings; 3, 4, "Cunette de Strosse"; 5, "Strosse."

Direction-points were given to the contractor every 200 metres, and they were fixed by producing the direction of the preceding points of reference. Twice or thrice a year, however, the operation of tracing the direction from the observatories was recommenced, as if that work had never previously been done; only when passing under each hook which had been fixed in the previous operations they compared the new result with the preceding, and thus ascertained the changes of direction. In the northern boring the greatest deviation was two centimetres, and that of the south, owing to the vapours, seven.

The result of that operation was a tunnel 14,920 metres long, starting on the north at the level 1,109, rising at the rate of 5·82 in a thousand to the level 1,152, which was attained about the middle of the tunnel, and a small level being left in case of any possible error in levelling, it fell at the rate of 2 in a thousand to the level 1,145 at the Airolo station.

Having thus indicated how the direction of the tunnel was traced, let us examine the procedure employed in the works properly so called.

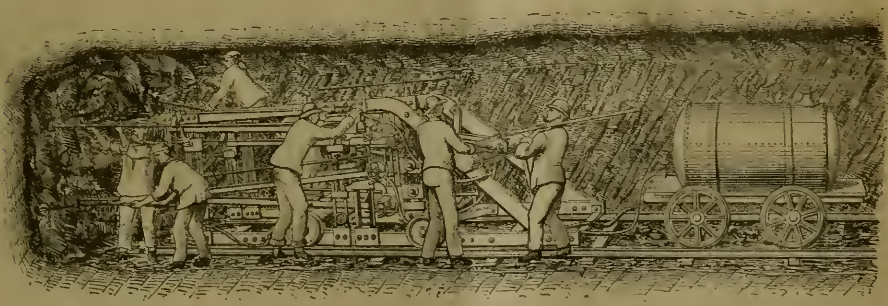
FIG. 4.—The borers at work.

After the experiment made in Mont Cenis, they had only to follow it and at the same time take advantage of the improvements since made on the system; the two principles without which the work would have been impossible being mechanical perforation of mine-holes and the transmission of force by compressed air.

Without the English invention of machines for boring rocks, the opening of a long tunnel without shafts or external openings would have occupied so long a time that no company could undertake it. But, thanks to the experiments made elsewhere, M. Louis Favre, the contractor of the tunnel, was able to utilise those excellent boring machines which have powerfully assisted in hastening the work. His object was constantly in the direction of suppressing hand-boring, and he almost attained it by making use of several models of machines which cannot be described here, but which are distinguished by the names of their inventors, Dubois and

François, Ferroux, Mackean, and Turrettini. All these machines have one common object, to project forcibly, and with blows of the greatest rapidity, a tool against the rock, and, as it is drawn back, force it to rotate slightly on its axis. Some of the machines advance by an automatic movement; others require a workman to push them. But to keep these boring machines in action some considerable motive power is necessary, and in the Alps that motive power can only be water. The question, then, is How to collect it and transmit it into the tunnel?

Close by the Goeschenen opening runs the River Reuss, which has just passed under the legendary "Devil's Bridge," and precipitates itself into its narrow and rocky bed with an average fall of 10 per 100, forming a volume of water which is never less than 1,000 litres per second. M. L. Favre utilised a large rock standing in the channel to fix his dam, below which the water is received in a reservoir to deposit its sand and gravel. Thence it is led to the machines by a cast-iron pipe ·85 m. in diameter and 800 m. long. The useful fall from the pipe is 85 m., and it can supply 1,200 litres a second. This water works four Girard wheels with horizontal axes. Their diameter is 2·4; they revolve 160 times a minute, and are each of 250 to 280 horse-power. When turning a horizontal axis with cranks and wheels attached, the number of revolutions is reduced to 80 per minute.

At Airolo, the nearest river being the Ticino, which has no rapid descent, it would have required a very long canal to procure enough of fall. M. Favre therefore followed the advice of engineers who had studied the matter and assured him he would find enough water by making use of the Tremola, a torrent close by the tunnel, which falls into the valley with an average descent of 20 per 100, and is said to supply at least from 300 to 400 litres a second at the bottom. By collecting the water at a height sufficient to allow of the receiving reservoir giving a useful fall of 180 m., the necessary motive power could thus be found. The works were completed in 1872, but in February, 1873, the supply of the Tremola fell to 100 litres, and there was not sufficient power to turn the water-wheels. This did not last long, it is true, but the same scarcity of water reappearing next year, M. Favre resolved to form an auxiliary supply by collecting the Ticino water 3 kilometres up the river, and thus have a new fall in order to meet all eventualities. By this means four tangential water-wheels with vertical axes are turned; they are of bronze, with a diameter of 1·2 m., and revolve 350 times a minute, each being of about 200 horse-power. By means of conical gearing they turn a horizontal axis with cranks revolving 85 times a minute. When the supply of the Ticino is insufficient, it is made to act on a smaller number of wheels; and then on the vertical axles, which are no longer turned by that stream, there are other water-wheels slightly different on which the water of the Ticino is brought to bear.

The power communicated to the horizontal axis at each opening is transmitted into the tunnel by means of the remarkable system already employed at Mont Cenis, and the inventor of which is Prof. Colladon of Geneva. This engineer conceived the idea of using for that purpose compressed air. The immense advantage gained by it is the transmission of a motive power, whatever the temperature or distance may be; moreover, it serves for ventilation and the supply of fresh air.

But the compression of air develops great heat, which injures the machine. At Mont Cenis, to avoid this heating, the air was compressed by means of pistons of cold water, which were themselves pushed by ordinary pistons moving up and down in pump cylinders. In order that the piston pushing the water should move it without splashing it must itself be moved very slowly, and the quantity of air required being considerable, the slowness of the movement must be compensated by the size of the pumps. At St. Gothard the following new invention of M. Colladon was utilised to prevent the temperature from becoming too high. The body of the compression-pump is double, and between its outer and inner cylinder circulates a current of cold water introduced by pumps. This cold water also circulates in the hollow rod of the piston and in the piston itself, which is also hollow. Moreover, cold water under the form of fine dust is injected even into the interior of the body of the pump, and then expelled by each stroke of the piston along with the compressed air. In this manner air compressed at 8 atmospheres only assumes a temperature of 32° C., which is lowered in the reservoirs to which it is exposed before passing into the tunnel. By this ingenious arrangement we can give much more rapidity to the pistons and proportionately diminish the volume of the pumps.

At Airolo and Goeschenen there are fifteen such pumps, divided at each place into five groups of three. They are horizontal, and their pistons are set in motion by beams connected with the cranks of the main axis. They serve a double purpose: at the bottom of each pump cylinder there are two expiration valves and one for supply. The Airolo pumps are of ·46 m. interior diameter, and at each stroke of the piston (through ·45 m.) a pump receives 71 litres of air, and by compression reduces this volume to a seventh part. In this manner, when the supply is adequate (160 litres for each wheel), four groups of three pumps (one of the five groups being generally left at rest) receive in twenty-four hours 208,000 cubic metres of air, whereas the volume required is 104,000. At Goeschenen the pumps are of ·42 m. diameter, and at each stroke of the piston (through ·65 m.) 87 litres are received; but the number of strokes of the piston is rather less.

The compressed air is sent into reservoirs, where it is cooled, and the water in suspension deposited. Thence it is conducted by tubes into the tunnel. These conducting tubes are pipes of hammered iron of ·20 m. diameter, which are bolted together end to end, and placed all along the tunnel. At each new stage of the work the expenditure of air diminishes as they advance, and the diameter of the pipes is accordingly reduced to ·14, then to ·10, till at last they terminate in india-rubber tubes of 5 centim., which supply the compressed air for working the advanced gallery.

The process being now known, let us examine how the work is organised. The tunnel being 8 m. wide and 6 m. high above the rails, since it must be vaulted, it is necessary to make a clearance as high as 6½ m. above the rails. The first thing is to make a preliminary or advanced boring 2½ m. high and 2½ m. broad. For this first boring M. Favre adopted the Belgian system, according to which the preliminary gallery is entirely at the top of the tunnel. To open this boring, six perforating machines were arranged on a cast-iron stand placed on rails. These machines, first of all, perforated six holes in a horizontal direction. Then shifting the points, they made six new holes, and again a third set and a fourth set. This ought to have produced twenty-four perforations; but as there was always some delay from the change of drills or other hindrances, they seldom had more than eighteen or twenty. As the tools striking on the rock became very hot, and much dust was produced in the holes, they required to be constantly moistened by a jet of water. The water was carried on a train behind the cast-iron stand, and, by means of an india-rubber pipe to convey compressed air, was projected forcibly in several jets.

The holes bored were generally 1 m. deep. When the face of the rock was, in the opinion of the head miner, sufficiently perforated, the stand was drawn back and the holes were charged with a mixture of dynamite and clay. Then they were fired by means of slow matches, so arranged that the central holes should explode before the others. After that they broke the large fragments, loaded trucks with the rubbish, and rolled them towards the opening; and thus the gallery was advanced about 1 m. Then placing rails in front, the stand with its boring-machine was brought back, and the mining recommenced.

The advance was more or less difficult according to the nature of the rocks, but on the whole the contractor was fortunate in this respect. The rock was hard, but its hardness was almost always suitable for perforation. About three-quarters of an hour were necessary to make a hole 1 metre deep; and under favourable circumstances four operations would be made in twenty-four hours, that is to say, an advance of 4 metres on each side. The most favourable rocks were granite, gneiss, mica gneiss, and mica schist. The layers, which were almost vertical, lay from east to west, and were therefore at right angles to the direction of boring. There were, however, three unfavourable circumstances which greatly hindered the works at certain times:—(1) The infiltrations of water in the Airolo tunnel during the first months of the operations, and in such quantities that a regular river flowed from the southern opening. Fortunately dynamite is not affected by water, and after boring several hundred metres the infiltration stopped. (2) Rocks of exceptional hardness were met with from time to time blunting the best drills, and scarcely an advance of 1 metre a day could be made. (3) In the Goeschenen gallery, at 2,700 m. from the mouth, they came upon a bed of rock entirely disaggregated, where they could only work with the pickaxe and were afraid of being buried. Under the enormous pressure of the mountain the props were crushed, and even the arches of masonry overthrown. At this part the advance was from 30 to 40 m. a month, and it continued for more than four months. There was some danger even of the rock falling behind where the workmen were engaged, and so isolating them and all who were beyond. In order to strengthen this dangerous part it was necessary to employ a special system of arches strengthened with iron.

When the advanced boring was completed, it was enlarged on the right and left. After that was done, they proceeded to build the arches of the roof, and then dug to the level of the tunnel's base a trench of about 3 m. wide, called the Cunette de Strosse. It is not dug in the middle, so as to leave as long as possible the way clear on the higher level. Then all is removed that remains on the right and left of the trench, and which is known as *Strosse*.

These different excavations are almost all done by perforations, and the holes being bored downwards, the work is more easy, whether for boring or exploding.

The transport of rubbish and materials had to be performed as often as possible by more powerful agents than manual power or horse-power. Steam-engines were out of the question, the air being already vitiated by the constant percussion of the boring-drills. The compressed air was employed to move the locomotives, just as if they were acted upon by steam. It was collected in reservoirs placed on the locomotive trains, and by simply turning a cock the machine was moved or stopped. But as the air of the atmosphere did not furnish a "course" sufficient, except by means of enormous reservoirs, they constituted "compressors" of the same system as those already in use, but which compressed the air to fourteen atmospheres. With so considerable power the locomotives were sufficiently supplied by ordinary reservoirs.

Charge of the works was handed over to the contractor, M. Favre, in October, 1872, on condition of completing them within eight years; should they occupy nine years a heavy penalty was attached. On February 29, 1880 the two advanced borings met with great accuracy. By a mistake the general direction only was taken, and therefore the exact amount of error was not ascertained, but it could not have exceeded 10 centimetres (or less than 4 inches)! This meeting did not take place in the middle of the tunnel, but at a point about 600 m. nearer Airolo than Goeschenen. The newspapers fully reported the event, the joy of which was greatly mingled with sorrow on account of the death of Louis Favre, the energetic and intelligent contractor, who was to have presided at the ceremony, after having organised and directed all the details, and at the very moment when he was about to realise the aim of his efforts. He died suddenly in the tunnel, the offspring of his labours, on July 19, 1879. Born in 1826 in Chêne, near Geneva, he left his native place as a journeyman carpenter, and by his intelligence and talent returned to Switzerland thirty years afterwards to be intrusted with the greatest undertaking of the present time. As he had thoroughly well organised everything, the works were continued without him, and also completed; but when shall we find such another man to begin again such another undertaking?

There is still much to do in the tunnel—rocks to clear away, mason-work to be built, &c.—but now the ground is known, and there is no fear of being able to complete the tunnel within the stipulated time. But what purpose would it serve? The lines of approach could only be finished long after the tunnel, being much less advanced. It is proposed, however, to have carriages running next winter between Goeschenen and Airolo, driven by atmospheric locomotives. That would no doubt be an advantage, but would the result be worth the great exertions necessary?

Much has been said of the extreme heat which prevails in the tunnel, and there is no doubt it is almost intolerable, being 32° to 35° C., and is injurious to men, and especially to horses. But when the tunnel is entirely cleared out and there are no more dynamite explosions, a current of air will set in; and as there are only 3 kilometres more than at Mont Cenis, there is no reason why, in respect of ventilation, it should be more dangerous.

We may therefore confidently utilise this magnificent way of communication, and be proud of living at the period during which it has been opened.

Geneva ADOLPHE GAUTIER, Engineer

COLLOIDS

The Influence of Colloids upon Crystalline Form and Cohesion. By W. M. Ord, M.D. (London: Stanford, 1879.)

THE series of researches which Dr. Ord has put into the hands of the public in the volume before us possess a double value, as dealing with problems in molecular physics of the deepest intere t to the physical investigator and of the highest importance to the surgical practitioner.

The starting-point of Dr. Ord's work is to be found in very remarkable research made more than twenty years ago by Mr. George Rainey, on the spherical forms assumed by carbonate of lime and other crystalline substances when deposited in the midst of gummy or colloidal liquids. The process by which this assumption of a globular form is effected Mr. Rainey termed "molecular coalescence." He also assigned the name of "molecular disintegration" to another process by which the conditions are reversed, and which breaks up the spheres into forms possessing a structure more nearly approaching a crystalline character. The most important of his deductions was undoubtedly the conclusion that the rounded forms of organised bodies depended on physical and not on so-called vital conditions. If solutions of gum arabic (containing malate of lime) and concentrated carbonate of potash are placed together in a bottle with as little mixing of the two as possible, the most perfect microscopic spheres are slowly deposited. They exhibit both concentric and radial markings, and in polarised light present a distinct "cross." They consist of carbonate of lime for the most part, but inclose portions of gum also. When plunged into stronger solutions of gum these spheres lose their globular arrangement and break up into radial lines, and subsequently into smaller particles. This is Mr. Rainey's fundamental fact; and others entirely analogous have been observed by Harting, Guthrie, and Montgomery, with different substances, and by somewhat different processes. Mr. Rainey was of opinion that these artificial spheres were the exact analogues of the globular masses detected by the microscope in bone, shell, in the testa of crustaceans, as in the tail of the shrimp, for example, and in ossified tendons, and he proceeded to argue that by a purely physical process in which the colloidal environment was concerned, not only bone, but starch granules and even the crystalline lens of the eye were formed. To these fundamental experiments Dr. Ord has himself contributed parallel observations on the disintegration of crystals of uric acid, carbonate and oxalate of lime, murexide, &c., which, when inclosed in gelatin, glycerine, or glycerine jelly, lose their sharpness of outline and transparency of substance, and progress by degrees towards the spherical form.

Dr. Ord now points out the very important relation held by these obscure molecular processes to the production of spherical and spheroidal concretions of calcareous matter in the renal and urinary organs, and he has sought to establish this relation by two lines of investigation: (1) by microscopic observation of calculi and other urinary deposits obtained under certain morbid conditions; (2) by synthetically obtaining identical forms from the various salts, phosphates, urates, &c., in the presence of colloids under varying conditions of temperature and hydration.

The substances thus investigated were uric acid, urates, oxalate of lime, phosphates, and carbonates; and the colloids employed were gum, gelatin, albumin, grape-sugar, starch, &c. The experimental results were throughout compared with the microscopic observations of Thudicum, Beale, and Prout, and a very large proportion of the forms observed in nature were artificially reproduced, thus affording pregnant suggestions as to the varying circumstances which prevailed in their natural production. Many of these comparative observations are of considerable interest. Thus we learn, on p. 55, that the collospheres of uric acid are always very small and homogeneous when deposited in urine, though they are rare; and a "dumb-bell" form is still rarer. Both are found in albuminous urine of small density. The experiments with watery solutions of egg-albumin always gave large and brilliant spheres. The conclusion is that the presence of small quantities of urea may retard the formation of the collospheres of uric acid. This supposition is strengthened by the known effect of urea in small quantities in modifying the crystal form of chloride of sodium. Another deduction is of equal moment. Two-thirds of all urinary calculi are composed of, or start from, a nucleus of uric acid. This uric acid would be quite unlikely to cohere in globules without the presence of a colloidal body—the mucus which would undoubtedly be present. "To make calculi of uric acid without colloids would be as hopeless a task as making ropes of sea-sand." This should be remembered in attempting to prescribe a regimen for suspected calculous disease. Whenever the urine is for any length of time purulent and ammoniacal, the formation of calculus is to be looked for. This conclusion is confirmed by a case given in detail by Dr. Ord, in which paralysis led to renal disease, and which he sums up as follows:—"First comes the paralysis leading to retention; retention permits decomposition and the formation of carbonate of ammonia; then come cystitis and the mixture of mucus and albuminous fluid with the triple phosphate and the spherical urates; and so a calculus is formed." Some of the calculi figured by Dr. Beale—notably those of dumb-bell form—were experimentally found to be reproduced by a scarcely suspected substance—oxalate of lime. It was further shown that pre-existing crystals may be resolved into dumb-bell forms in two ways: either by the formation of a dumb-bell within the crystal, or by a disintegration of the crystal and its subsequent conversion in mass into a non-crystalline, homogeneous dumb-bell.

Catching at a suggestion of Rainey's that the peculiar action of the colloid resulted from its *viscosity*, Dr. Ord conceived that some independent evidence for or against this notion might be afforded by the influence of the apparent viscosity of the magnetic field. Without appending any criticism on the admissibility or otherwise of this analogical piece of reasoning, we will simply narrate the results of putting the question to the test of experiment. When oxalate of lime was deposited in a gelatin plug between the poles of horseshoe magnets, "there was an extraordinary increase in the size of all the forms, crystalline and non-crystalline, where the plug or gelatin was subjected to the action of magnetism, but there was no production of new forms or greater tendency to sphericity." Similar experiments with a large electromagnet yielded crystals which in several cases *appeared to have their axes slightly twisted.* This observation, if confirmed, and if presenting any assignable relation between the direction of magnetisation and that of the alleged axial twist, would be in the highest degree interesting. Up to the present moment, so far as we are aware, no crystal presenting tetratohedral dissymmetry or optically active in the polarimeter has been procured by artificial synthesis. Is it possible that Dr. Ord's observation contains the germ of the method by which we may hope to procure the synthesis, not of the active tartrates and sugars only, but of quinine and other alkaloids also? Experiments with electric currents were also tried, but proved less satisfactory, though the electrolytic actions set up produced several unexpected results.

Later chapters in Dr. Ord's book are devoted to renal and biliary calculi other than those mentioned—including a very singular case of an indigo calculus—and to a short scheme for the qualitative examination of calculi, which contains valuable hints to the general practitioner.

Concerning the production of the collospheres themselves there does not appear to be any one assignable cause. Harting dwells strongly on the influence of the "nascent" state in which the crystalloid body is deposited by double decomposition within the colloid. This term will probably fall out of use by chemists so soon as they perceive that it is a term convenient only as a cloak for ignorance. A more satisfactory point is made by Dr. Ord in the suggestion that there exists a relation yet undiscovered between hydration and the colloidal state; the hydrate of fresh uric acid being a colloid. Dr. Ord is of opinion that hydrated colloids and strong solutions of very soluble salts alike prolong the colloidal state of certain crystals, thus favouring the production of spheroids. Dehydration, which in certain cases appears to determine the production of spheroidal forms, is obviously inadmissible as the cause in the majority of cases. Nor does the difference of crystalline form between one crystal-system and another appear to affect the collospheric condition, in which absolutely no smallest modifications attributable to this possible cause can be detected. Solubility undoubtedly has much to do with the matter, since insoluble crystalline substances yield the best spheroids; but by evaporation and by deposition from hot strong solutions even sulphate of copper and ferrocyanide of potassium can be thus obtained. We must therefore fall back upon the conclusion that the one important factor in the production of the collospheric condition is the influence of the colloid. Mr. Rainey, who came to this conclusion, attributed this action to the "viscosity" or tenacity of the colloid fluid; and hence he associates with true colloids such substances as glycerine (which is a true crystalloid) and other viscid substances. Dr. Ord, on the other hand, is disposed to regard the influence of the colloid as "a result of intestinal molecular movement inherent to the constitution of the colloid."

Arrived at this point, however, we cease to perceive any definite coherence between the various speculations which follow and in which the effects of pressure, of strain, and of hypothetic spiral waves, are mixed up with Brownian movements and chemical interaction. It is a pity that the all-important bearing of surface-tension at the boundary of two media, and of the elegant and instructive researches of Plateau, including his production of liquid spheroids, is not once alluded to, even in the remotest manner, by Dr. Ord. For our own part, we are disposed to attribute a very large portion of the influence which determines the production of these collospheres of solid matter to the same molecular actions as those which produce the surface-tensions between solids and liquids, and which cause the rise of liquids in capillary tubes and the production of liquid spherules in the experiments of Plateau.

In conclusion we must not omit to quote one experiment of Dr. Ord, that in which the rapid production of the collospheres is conducted under conditions suitable for lecture demonstration. A solution of pure urea of density 1·026 usually throws down shining white flakes of nitrate of urea on the addition of an equal bulk of strong nitric acid. If, however, a little egg-albumin be added to the urea solution before the nitric acid is added, spheres are formed of the greatest beauty, and appear "floating like snowballs" in the yellowish liquid.

OUR BOOK SHELF

A Guide for the Electric Testing of Telegraph Cables. By Capt. V. Hoskiær. Second Edition. (London: E. and F. N. Spon, 1879.)

THIS very unpretentious but very useful little manual has reached a second edition, and now reappears with several valuable additions. In his original preface the author states that he does not expect an electrician to discover anything new in its pages. Be that as it may, the electrician will acknowledge the debt he owes to Capt. Hoskiær for the precision and brevity with which all his directions concerning the practical details of testing are given. Without philosophising or going into mathematical reasons of why and wherefore, he gives the necessary formulæ in the shape most useful for practical calculations; and the necessary tables of logarithms, trigonometrical functions, and temperature coefficients are sufficiently complete to save reference to other more extended works. The twelve lithographed diagrams leave nothing to be desired in point of clearness.

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.*]

The Antiquity of Oceanic Basins

IT seems to have escaped Dr. Carpenter's notice[1] that, in a Report on the results of the Deep-sea Dredgings of Mr. Pourtalès

[1] Lecture before the Royal Institution, January, 1880.

for 1866, 1867, 1868, Prof. Agassiz[1] had already called attention to the probable great antiquity of the oceanic basins.

Dr. Carpenter seems also to have overlooked the series of physical observations of the depths of the sea commenced by the United States Coast Survey[2] in 1850, and carried on without interruption to the present day.

The statement made by Mr. Wild[3] that the deepest sounding of the *Tuscarora* is not trustworthy, because "no sample of the bottom was brought up," is apparently endorsed by Dr. Carpenter, who says: "The sounding wire of the United States ship *Tuscarora* twice broke without reaching bottom . . . . at depths considerably exceeding 4,000 fathoms." This should be modified by stating that the *wire broke while reeling in* twice, once the bottom was not reached, and five casts were made over 4,000 fathoms, bringing up each time a specimen of the bottom.[4] Capt. Geo. E. Belknap, of the *Tuscarora*, says,[5] speaking of the casts beyond 4,000 fathoms in depth: "The wire parted at the last two and deepest casts. . . . the result of momentary carelessness on the part of the men at the *reeling-in wheel*."

The method of sounding with wire has now been in use long enough to show that even if the *Tuscarora* had not brought up a single specimen of the bottom during her whole trip, and if the wire had *invariably broken while reeling in*, we could not for that reason alone have rejected those soundings as inaccurate.

Those who have sounded with wire know that the instant the sinker has touched bottom is recorded on deck, and the precise depth is then known, whether the cylinder is brought up or not. There is no more reason for rejecting the deepest sounding of the *Tuscarora* of 4,655 fathoms than for rejecting the 480 other casts which are accepted because a bottom specimen came up.

Cambridge, Mass., April 5 ALEXANDER AGASSIZ

On the Alum Bay Flora

IN the list of fossils appended to the paper upon the Alum Bay flora, brought before the Royal Society by Baron von Ettingshausen and reported in NATURE, vol. xxi. p. 555, the new species have Ett. and Gard. attached to them, implying that Ettingshausen and myself are their authors. It is only fair to Ettingshausen to state that I had no share in making the determinations, and to myself, that I accept them simply as provisional. Associated as he is with me in the work upon the British eocene floras, he felt that he could hardly publish preliminary work connected with it in any other way. I completely disagree with him, however, as to the utility of publishing new specific names unaccompanied by drawings or descriptions of any kind, and think that a simple list of genera, with the number of new species in each, would have been unattended with any inconvenience. He appears to me to attach altogether undue weight to mere priority in nomenclature, and the existence of such provisional lists, far from aiding research, must prove a serious difficulty to our fellow workers. In the highly probable event of an author being unable to come from some distant country to examine the specimens themselves, is he, for instance, to forbear naming every undescribed species of such common Tertiary genera as *Ficus*, of which eight new and unpublished species are in the list, of *Celastrus*, of which there are five, or of any other of the some fifty genera containing new specific names? He could not safely name even any indeterminable leaf or fruit, for fear it might be one of the long list of Phyllites or Carpolithes for which Ettingshausen has devised specific names.

[1] *Bulletin* of the Museum of Comp. Zoology, 1869, vol. i., No. 13.

[2] Coast Survey Reports, 1850 to present day; also Bibliography of Biological Results (*Bull.* Mus. Comp. Zool., vol. v., No. 9, 1878).

[3] "Thalassa," 1877, p. 15.

[4] "Deep-Sea Soundings in the North Pacific obtained by the United States ship *Tuscarora*" (Washington: Hydrographic Office, 1874, No. 54, p. 30):—

1874.	Fathoms.	
June 11	4,643	Wire broke; *bottom not reached.*
,, 17	4,340	Yellow and clay brown mud.
,, 17	4,356	Yellowish mud and sand and specks of lava.
,, 18	4,041	Yellow and clay-coloured mud and gravel.
,, 18	4,234	Rocky; point of cylinder came up battered.
,, 18	4,120	Yellow and clay-coloured mud mixed.
,, 18	4,411	No specimen; wire broke (*while reeling in*).
,, 19	4,655	,, ,, ,, ,,

[5] *United Service Magazine*, July, 1879.

But were our supposititious author to go on with his work, in spite of this "sword of Damocles," would Baron Ettingshausen claim priority and deprive the man who had first figured and *published* descriptions of them, of the pleasure of christening them in accordance with his views and wishes? If not, *cui bono?*

To show the purely provisional light in which the list must be regarded, I may mention that, unfortunately just as the Baron left England, a large collection, that of the late M. Watelet from the Grès du Soissonnais, came into my possession, and seems, on a cursory examination, to contain a preponderance of species identical with those of Alum Bay. None of Watelet's published species appear in the list of the Alum Bay flora, which therefore must of necessity be considerably modified to include them. The same may be said of the flora of Gelinden, of which a large series has also reached me.

Again, even in the only section of plants yet worked out by us for the palæontographical memoir, the ferns, discrepancies occur. Two ferns occur in this Alum Bay list which are not included in our fern flora from that locality. These are inserted on the authority of Heer, who states that he has seen them from Alum Bay; but as on the occasion of that gentleman's visit or visits to England many years ago the floras from the different localities had not been systematically collected, and were generally mixed together in museums, in the same drawers and cases, and cannot always be identified by the matrix, I prefer to adhere to the opinion of that indefatigable collector, Henry Keeping, who lived within a short distance of Alum Bay, and to my own, Mr. Mitchell's, and all other workers' experience, that no fern but *Marattia* is found there. At all events, if they are to be included in the Alum Bay flora, they should be so with reserve, especially as Prof. Heer's ideas as to the position of the localities and their ages are so hazy that he puts the Alum Bay leaves in the "Bartonisem" (above, if anything), or about 1,000 feet too high, and thinks that Bournemouth is somewhere in the Isle of Wight.

An illustration of the inconvenience caused by publishing names without proper figures and descriptions occurs to me. Heer named a small fern fragment which he supposed to be from Alum Bay, *Asplenium martinsi.* This name has got into works by Saporta and Crié, who have each tried to fit ferns of their own into Heer's meagre description. Neither had seen the original, nor could they give any information, and it was only after several attempts to obtain it that Ettingshausen received a rough sketch from Heer showing conclusively that the "species" in question was a fragment of the abundant and well-known *Anemia subcretacea* of Sézanne. I do not even now know whether it was upon this fragment or some other that Heer wrote that he had "seen this form" (*Anemia subcretacea*) from Alum Bay.

J. STARKIE GARDNER

Negritoes in Borneo

HAVING had inquiries addressed to me as to the existence of a Negrito race in Borneo, I think it may be useful to recall attention to, and possibly save from oblivion, a statement on this subject which was published by Windsor Earl in the *Journal* of the East Indian Archipelago. Mr. Earl says that a Capt. Brownrigg, who had been shipwrecked on the east coast of Borneo, informed him (*J.E.I.A.*, No. 9) that he had lived several months at a town some distance up the Berau River, and that during his stay the town was once visited by a small party of men from the interior, "who must have been of the Papuan race" (*sic*). He described them as being short, strongly-built people, black in complexion, with hair so short and curly that the head appeared to be covered with little knobs like peas; and with many raised scarifications over the breast and shoulders. He described them as being on good terms with the people of the town, mostly Bugis, and as supplying them occasionally with jungle produce.

Of this account it may be remarked that Mr. Earl would not have retailed it unless he had had some confidence in the credibility of his informant—that, so far as it goes, it is curiously circumstantial—and that these people are said to have come exactly from that district in Borneo where we might expect *à priori* to find Negritoes if they existed at all.

Whilst on the subject of Borneo, may I suggest that ethnologists should make a more sparing use of the term "Dyak" when treating of the Malay Archipelago? It should only be applied to tribes who themselves use it as the distinctive appellation of their people. As more than one tribe so uses it, there should always be prefixed some word still further limiting its application in each particular case. As employed by Malays, who are followed both by Dutch and English travellers, the word has scarcely better standing-ground in a scientific terminology than has "Alfuro."

The following fact with regard to the Sea Dyaks may be of interest. When Europeans first entered Sarawak the Kayans, properly so called, were dominant in the great Rejang River, and the Sea-Dyaks were strictly confined to the Batang Lupar, Saribas, and Kalakah rivers. Now the Sea-Dyak population of the Rejang is some 30,000, and the Rejang Dyaks are rapidly occupying the Oyah, Mukah, and Tatau rivers further up coast. On the original Sea-Dyak rivers the people always use the expression "we Dyaks" when they mention their own race; but on the Rejang the expression "we Iban" will invariably be heard—the explanation being that the Kayans habitually designate Sea-Dyaks as "Ivan" among themselves, whence the Dyaks have applied the name; but having no v-sound in their language, they say "Iban." The Kayan proper is rich in v-sounds. I have been informed, though I cannot vouch for the accuracy of the statement, that "Ivan" in Kayan is a term carrying with it a sense of opprobrium. However this may be, it is remarkable that so large a section of the Sea-Dyaks, who are so thoroughly dominant in Rejang, and are in constant daily communication with their original seat in the rivers to the westward, should in the course of some thirty years have come to habitually speak of themselves by the name given them by their foes. And it is the more surprising because the Sea-Dyaks generally give new names of their own to the geographical features of the district into which they immigrate.

Papar, North Borneo A. HART EVERETT

Seeing by Electricity

WE hear that a sealed account of an invention for seeing by telegraphy has been deposited by the inventor of the telephone. Whilst we are still quite in ignorance of the nature of this invention, it may be well to intimate that complete means for seeing by telegraphy have been known for some time by scientific men. The following plan has often been discussed by us with our friends, and, no doubt, has suggested itself to others acquainted with the physical discoveries of the last four years. It has not been carried out because of its elaborate nature, and on account of its expensive character, nor should we recommend its being carried out in this form. But if the new American invention, to which reference has been made, should turn out to be some plan of this kind, then this letter may do good in preventing monopoly in an invention which really is the joint property of Willoughby Smith, Sabine, and other scientific men, rather than of a particular man who has had sufficient money and leisure to carry out the idea. The plan, which was suggested to us some three years ago more immediately by a picture in *Punch*, and governed by Willoughby Smith's experiments, was this:—Our transmitter at A consisted of a large surface made up of very small separate squares of selenium. One end of each piece was connected by an insulated wire with the distant place, B, and the other end of each piece connected with the ground, in accordance with the plan commonly employed with telegraph instruments. The object whose image was to be sent by telegraph was illuminated very strongly, and, by means of a lens, a very large image thrown on the surface of the transmitter. Now it is well known that if each little piece of selenium forms part of a circuit in which there is a constant electromotive force, say of a Voltaic battery, the current passing through each piece will depend on its illumination. Hence the strength of electric current in each telegraph line would depend on the illumination of its extremity. Our *receiver* at the distant place, B, was, in our original plan, a collection of magnetic needles, the position of each of which (as in the ordinary needle telegraph) was controlled by the electric current passing through the particular telegraph wire with which it was connected. Each magnet, by its movement, closed or opened an aperture through which light passed to illuminate the back of a small square of frosted glass. There were, of course, as many of these illuminated squares at B as of selenium squares at A, and it is quite evident that since the illumination of each square depends on the strength of the current in its circuit, and this current depends on the illumination of the selenium at the other end of the wire, the image of a distant object would in this way be transmitted as a mosaic by electricity.

A more promising arrangement, suggested by Prof. Kerr's experiments, consisted in having each little square at B made of silvered soft iron, and forming the end of the core round which the corresponding current passed. The surface formed by these squares at B was to be illuminated by a great beam of light polarised by reflection from glass, and received again by an analyser. It is evident that, since the intensity of the analysed light depends on the rotation of the plane of polarisation by each little square of iron, and since this depends on the strength of the current, and that again on the illumination of the selenium, we have another method of receiving at B the illumination of the little square at A. It is probable that Prof. Graham Bell's description may relate to some plan of a much simpler kind than either of ours; but in any case it is well to show that the discovery of the light effect on selenium carries with it the principle of a plan for seeing by electricity. JOHN PERRY

Scientific Club, April 21 W. E. AYRTON

Musical Sounds within the Ear

I SHOULD like to know how far the musical sounds, which we sometimes hear within our ears, are of different pitch in different persons. From repeated observations I find that my left ear gives G, and the right one B. A friend of mine, who is a good performer on the violin, finds F and A respectively.

It is perhaps not without interest that in some parts of Germany (at least in Silesia) people believe these sounds to be indicative of one's being talked about, and that the sound ceases as soon as one thinks of the person who is supposed to do so.

Carácas, March 18 A. ERNST

Ice Filaments

"THE comb-shaped masses of ice of fibrous structure" mentioned by your correspondent, in explanation of the inquiry made by the Duke of Argyll, are observed every winter in the southern portion of the United States, especially on the sloping sides of a path or country road where the surface-earth has been removed, and the natural clay sub-soil is not rendered compact by being trodden. The conditions requisite for its abundant production are a sudden reduction of temperature below the freezing-point when the clay soil is thoroughly saturated with water. When this occurs at sunset, the next morning, if the night continues favourable, will disclose a vast collection of fibrous filaments, from two to six inches in height, rising from the soil in close juxtaposition, generally holding aloft in their caps portions of the soil, the longest crystals appearing when the soil is free from surface-loam.

I have frequently given to my class this explanation of the phenomena.

The capillary tubes of the soil are all filled up to the surface with water. The sudden reduction of temperature freezes the water at the *surface*, but does not chill it within the soil below 32° F. The consequence is that this expansion, caused by congelation at the upper extremity of the capillary tube, compresses the walls of the tube externally, and causes the mouth of the tube at the surface to assume a conical shape, as in diagram. The congelation of all the water within the conical cavity causes pressure normal to the surface of the cone at a and b, and hence produces a vertical resultant, r, that raises the cone of ice. Capillary action immediately fills the little cavity with water, which in turn is frozen and elevated by the expansion force of its congelation. The filament thus grows in this simple way from its base. The soil in which these fibrous crystals or filaments form is never frozen; thus proving the correctness of the explanation.

They are formed very rapidly. I have on more than one occasion, when a sudden chill at sunset would start them growing, listened to the crackling of the little ice-crystals as they would break loose from each other, being pushed up by this expansive force.

I infer the filaments of ice formed on rotten wood are due to a similar cause, and that they will not be formed unless the reduction of temperature is quite sudden. That is, if the reduction of temperature is so gradual that the water somewhat below the surface in the cylindrical portion of the capillary tube is frozen, the crystals will not be elevated, but the ground will be frozen. WM. LEROY BROUN

Vanderbilt University, U.S.

Ophiolepis mirabilis

In a review of Lyman's description of the Ophiurans of the *Challenger*, which appeared in NATURE, vol. xxi. p. 513, I was much surprised to find a criticism relating to a remarkable species which I described last year in the *Proceedings* of the Linnean Society.

The reviewer informs your readers that *Ophiolepis mirabilis*, Duncan, is a true Ophiopholis, having all the structures of the genus, and that it is allied to *O. aculeata*. This simple statement leaves the impression that I have made a mistake, and that I am ignorant of a well-known form. I therefore extract the following from the *Proc.* Linn. Soc., vol. xiv., Zool., p. 479, 1879:—

"*Ophiolepis mirabilis*.—This common species has the disk of Ophiolepis as diagnosed by Müller and Troschel; that is to say, the scales, which are of good size, and the large radial shields are environed by rows of small scales, as by belts. But the upper arm-plates have also the supplementary rows of small scales around them, and there are also large accessory side-pieces. Moreover, there are hooks on the side arm-plates. This mixture of Ophiolepian and Ophiopholian characters is very interesting, and this species, I consider, renders the abolition of *Ophiopholis* as a genus inevitable." In fact the beautiful Ophiuran is a synthetic type, and I prefer its teachings to authoritative statements.

P. MARTIN DUNCAN

Hastings, April 9

The Stone in the Nest of the Swallow

YOUR correspondent, P. P. C. Hoek (Leiden), will find the information which he asks for under this heading (vol. xxi. p. 494) in an article which appeared in the *Zoologist* for May, 1867, entitled "An Inquiry into the Nature and Properties of the Swallow Stone and Swallow's Herb," by

J. E. HARTING

24, Lincoln's Inn Fields, London, W.C., April 14

THE SONGS OF BIRDS.—Mr. C. C. Starling asks to be informed of any book or paper which treats upon the musical properties of the songs of birds.

DEW CLAWS.—A. N. asks if any correspondent familiar with wild species of *Canis* can tell him whether the rudimentary hind toe is invariably present, or, if not, in what proportion of individuals, and whether it has bony function with the metatarsus?

THE EASTER EXCURSION OF THE GEOLOGISTS' ASSOCIATION TO THE HAMPSHIRE COAST[1]

THE head-quarters of the Association were fixed at Bournemouth. A large number of members arrived before Easter, and were able to explore the freshwater series to the west of Bournemouth, which could not be visited on the excursion. An excavation into the leaf-beds having been opened a few days previously by Mr. Gardner, Prof. Morris, Dr. Henry Woodward, Prof. Corfield, and Mr. Birch, a number of fine leaves were obtained, and Dr. John Evans, Prof. McKenna Hughes, Mr. Warrington Smyth, Prof. Bonney, and many others, were enabled to see the leaves *in situ* and the method of work.

On Easter Monday some fifty or sixty members assembled, and the party proceeded to Boscombe. On the way the director pointed out the position of the Bournemouth series in the eocene formation, and the chief geological features of the coast. Far to the west could be traced the cliffs whence had been obtained a rich dicotyledonous flora, shed apparently from forest trees, which clothed the hilly slopes of the right bank of the eocene river. It is remarkable to notice in how many respects this flora differs from those found nearer Bournemouth, most notably so in the total absence of palms. The next mass of cliffs is almost unfossiliferous, and from its confused bedding is now conjectured to present a transverse section of the actual bed, silted up, of the old eocene river. Between this and Bournemouth, for nearly a mile, extends the eastern series of leaf-beds, containing the remains of a more tropical flora, derived, perhaps, from low-lying country on the left bank of the old river. Among the palms, which are abundant, can be recognised such genera as Phœnix, Calamus, Iriartæa, Sabal, &c., and among the ferns, species scarcely differing from such magnificently tropical forms as *Osmunda javanica*, *Chrysodium aureum*, *Gleichenia dichotoma*, *Lygodium dichotomum*, &c. Beyond these cliffs, skirting the downs of nearly vertical chalk, are the Lower Bagshot beds, in which the well-known leaf-beds of Creech Barrow, and Alum and Studland Bays are situated. A very small portion, however, of the freshwater Bournemouth series could be actually examined on Monday, for the chief object in view was to investigate the recently-discovered marine series, described for the first time in the pages of the *Journal* of the Geological Society less than twelve months ago. The passage from the one series to the other was well seen, although from the absence of slips and consequent inaccessibility of the beds, few fossils could be obtained. The beds are mostly dark sandy clays, highly charged with lignitic matter, and they contain in places well-preserved fruits and teredo-bored wood. The evidence of their marine origin is amply demonstrated by the presence of casts of Bracklesham mollusca, masses of oysters, bryozoa, and crustaceans. Overlying them are the clean white sands, with flint shingle beds, of the Boscombe series. These eocene shingle beds, from the perfectly-rounded form of the pebbles composing them, show the former prevalence of heavy surf upon the old shore-line. In many cases the condition of the silex is wholly or partially changed into a soft, white, chalk-like mass, entirely free from carbonates however, and much speculation was indulged in concerning the nature of this change. The party having been joined by Dr. Alman, president of the Linnean Society, and Mr. Pike, owner of the vast china-clay pits near Wareham, the curious Honeycomb chines were explored, and the zone of nipadites pointed out, crowded in places with the empty husks of fruits which had floated out to sea. At another point proteaceous leaves and tubular borings of annelids, filled in with horizontally-disposed lignitic matter, were noticed. On the way to Hengistbury Head it became apparent that as the freshwater beds present a transverse section across a vast river channel, so the marine beds present a similar section through a great eocene beach which formerly sheltered a stagnant lagoon. These towards the east are seen to be composed of larger and larger shingle, whose well-rolled appearance indicates the distance it must have travelled. Attention was particularly called to the resemblance of the Boscombe series to the so-called Upper Bagshots of the London Basin.

Arriving at the Headland, after skirting its base and examining its remarkable geology, the party somewhat rapidly made their way through the heather on the summit, past the prehistoric double wall and ditch, and across the Stour and Avon by ferry to Christchurch, where Mr. George H. Birch gave a most interesting historical sketch of the priory.

The second day was devoted to the cliffs between Mudiford and Hordwell. The main features of the coast were well seen as the haze lifted. The sequence of the beds from Hengistbury to Highcliff was pointed out by the director, and the Barton clays and sands, the Upper Bagshots and Headon beds of Hordwell were examined, and numerous fossils collected. During the short stay for lunch Prof. Morris favoured the party with an address, in which he clearly placed before them the data for the correlation of these beds with those of the rest of Europe, and sketched in eulogistic terms the work of those who have made it possible to trace the history of their deposition. The members reached Lymington in time to return to London or Bournemouth by the 5.50 train.

The excursion, which was unusually largely attended, was keenly enjoyed, owing to the magnificent weather and the beauty and interest of the country traversed.

[1] Director, J. Starkie Gardner, F.G.S. &c.

DEEP-SEA DREDGING AND LIFE IN THE DEEP SEA[1]

III.

HOW is it that the general absence of ancient forms from the deep sea is to be accounted for? It is hardly probable that the struggle for existence in the great depths is very severe. The fact that so helpless an animal as a Pycnogonid can grow to a length of two feet points to the existence of easy conditions of life. Even if the struggle in the deep sea were as great as in shallow water we might have expected that it would extinguish these different forms from those which it exterminated near the shores. It seems on the whole probable that the deep sea may have been entirely devoid of life during the earlier geological epochs. The modifications existing in deep-sea animals as adaptations to their special modes of life are not much more important than those exhibited by animals inhabiting caves of comparative recent origin, such as Proteus or those living in the deep waters of the large lakes of Europe, which are also of no great antiquity, such as the air-breathing water-snails, which, from the necessities of deep-water life, have adapted their lungs to aquatic respiration. A long time has not therefore been required for these modifications to take place.

It has been, I believe, commonly assumed that the water of the ocean was originally fresh, or nearly so, and that it became gradually salter as the rivers brought into it salts as part of the products of denudation. But surely the primitive sea must have been highly charged with saline matters of all kinds.

When the earth was still intensely heated, the whole of the water now on its surface must have been present as gas in its atmosphere, at first no doubt dissociated, but afterwards as aqueous vapour. Since if the sea-bottom and continents were smoothed down to a uniform level, the sea would still suffice to cover the entire earth to a depth of over 1,000 fathoms, aqueous vapour equal to a layer of water of that thickness must have existed in the atmosphere and have produced a pressure of more than a ton on the square inch at the earth's surface. To this pressure must have been added that produced by all the other vapours with which the primitive atmosphere must have been filled. As the earth cooled the water condensed on the coolest spots from time to time, boiled, and rose as vapour again. Mr. Mallet[2] conjectures that the first water formed on the earth's surface may have been even as hot as molten cast-iron. At last permanent seas were established. The waters of these heated to an intensely high temperature under great pressure must have dissolved salts in abundance from the freshly consolidated earth's crust, and being constantly in a state of ebullition as the pressure diminished at the surface with the growth of the seas, or the temperature of the earth's surface varied in different places, must have taken up vast quantities of rock-matter in suspension and become thickly charged with volcanic mud. Intensely hot rain must have fallen on the land and have washed down more salts and mud into the sea. The whole ocean must have consisted of a vast mass of seething mud.

It must have required a protracted period for the ocean to become clear, and for its deposit, which was perhaps somewhat like the present deep-sea red mud, to settle, and possibly the deeper water long remained uninhabitable, being overcharged with various gases and salts and suspended mud. In connection with the question of the probable development of the earliest forms of life in heated water holding abundant salts and gases in solution, it is of importance to note that various algæ at present thrive in very hot mineral springs in various parts of the world.[1]

To this original deposit of mud on the deep ocean floor the deposits which have since been formed possibly bear but a slight proportion in thickness, for it must not be forgotten that all the Globigerina mud and other organic deposits now in course of formation on the sea bed are ultimately derived from the land. The Globigerinæ merely distribute the lime washed down by the rivers more evenly over the ocean floor, by concentrating it in the substance of their shells. The organic muds are in their origin products of denudation, and if the whole land now above the sea were washed into the ocean and evenly distributed a deposit of only about 500 feet in thickness would result.

FIG. 15.—*Umbellula Greenlandica.*

I shall, in conclusion, speak of some of the physiological conditions of life in the deep sea. Deep-sea animals, as a rule, have either no eyes at all or have very large eyes. As an example may be cited the crustacean, *Astacus zaleucus*, most closely allied to the common crayfish which Prof. Huxley has lately made illustrious. It is from 450 fathoms. It has no eyes at all, but one of its nippers is extraordinarily long and delicate, and possibly the animal uses it to feel its way with, as a blind man uses his stick. There are also abundant hairs on the animal's surface, which are probably organs of touch.

Many deep-sea crustacea, however, and fish have very large eyes indeed, evidently for the purpose of making

[1] Friday Evening Lecture delivered at the Royal Institution on March 5, by H. N. Moseley, F.R.S., Assistant Registrar of the University of London. Continued from p. 572.

[2] R. Mallet "On the Probable Temperature of the Primordial Ocean of our Globe." *Quart. Journ.* Geol. Soc., 1880, p. 115.

[1] See "Notes by a Naturalist," pp. 36, 383, 410.

use of some small quantity of light which must exist in all depths. In the absence of sunlight the only other source of light must be the phosphorescence of certain of the deep-sea animals themselves. Dr. Carpenter, Sir Wyville Thomson, and Mr. Gwyn Jeffreys came to this conclusion after some of their early deep-sea dredgings. There can be little doubt of its correctness.

Here (Fig. 16) is a deep-sea Alcyonarian, *Umbellula Greenlandica*, so named because it was first obtained off Greenland, being, like the deep-sea fish I exhibited, an example of a deep-sea form extending into shallow water in high latitudes. Umbellula consists of a bunch of polyps supported on the end of a long flexible stem, which is cut off short in the figure. This specimen was from 2,175 fathoms between Madeira and the Spanish coast. When it came to the surface it emitted a most brilliant phosphorescent light, as did also many allied forms dredged in deep water. No doubt these animals, like their congeners in shallow water, emit light in the deep sea; and the deep-sea animals with eyes probably congregate round them or grope their way in the gloom from one bunch to another as they lie scattered over the bottom, just as we half-feel, half-see our way from lamp-post to lamp-post at night in a London fog. Some lose their way, as we do sometimes, and get into shallow water, and a good many deep-sea animals have been from time to time picked up near the shores at Madeira and elsewhere, and have found their way into museums as great rarities.

FIG. 17.—*Pentacrinus maclearanus*, Wyville Thomson.

No doubt the sense of touch is the one mainly relied on by most deep-sea animals. Very many are provided with special organs of touch, such as long hairs, or in the case of fish enormously long fin-rays. Unfortunately we did not examine the organs of hearing of any of the deep-sea animals which we dredged. Nearly all were far too precious to be dissected. Possibly some of the animals have the sense of hearing highly developed.

There is plenty of oxygen for respiration in the deep sea. Mr. Buchanan found that water from even 4,475 fathoms contained 4·06 cubic centimetres of oxygen to the litre, nearly as much as at the surface, where, however, the amount varies greatly, rising to as much as 7 cubic centimetres per litre. The smallest amount observed was ·6 of a cubic centimetre per litre in a depth of 2,875 fathoms. Even this amount would probably support life, for Humboldt and Provençal showed that tench could still breathe, though with difficulty, in water containing only one-third of that quantity of oxygen.

Life must be very monotonous in the deep sea. There must be an entire absence of seasons, no day and night, no change of temperature. Possibly there is at some places a periodical variation in the supply of food falling from above, which may give rise to a little annual excitement amongst the inhabitants.

There being no plants in the deep sea except parasites, the ultimate sources of food must be derived entirely from above, from the falling to the bottom of dead surface animals and plants, and of the *débris* washed from the shores. Sea-water acts as a most efficient preservative of animal tissues, and possibly at no very great depths and at the deep-sea bottom Bacteria may be entirely absent, so that decomposition in the form in which we are commonly acquainted with it does not there take place at all.

From experiments which I made on the rate of sinking of a dead Salpa I found that it would reach the bottom at 2,000 fathoms in four days, in which time it would even at the surface be hardly decomposed at all. It would thus afford good food to the bottom animals.

A large quantity of shore *débris* and vegetable matter carried down by rivers reaches the deep-sea bed. We found leaves, branches, and fruits in deep water, and one of the latter had its interior still fresh, and was full of animals feeding upon it. Mr. Agassiz found in depths of over 1,000 fathoms orange and mango leaves, sugar-cane, nutmegs, and land-shells in profusion, and many hermit-crabs actually inhabiting tubes of bamboo instead of shells. We found a land-crab once in 450 fathoms; no doubt it had drifted out hanging on to some floating object, and had sunk to the bottom, being unable to swim.

The numbers of animals to be found in the deep sea decrease rapidly in proportion as the depth exceeds 2,000 fathoms, and very probably the greatest depths have very little life in them. We at present know only of Rhizopods as inhabiting them. Even in depths of less than 2,000 fathoms the shallower waters are most productive, and probably the deep-sea fauna is most abundant not far from the upper limit of its range. It is here, in from 200 to 400 fathoms, that such forms as Pentacrinus are most numerous. Here in many places these animals, a few years ago the greatest of rarities, cover the sea-bottom, thickly set like trees in a forest, still as abundant as ever they were in geological times. It is probably scarcity in supply of food which limits the quantities of animals in great depths. No doubt food is always most abundant near the coasts.

Some animal forms appear to be dwarfed by deep-sea conditions of life. Others attain under them gigantic proportions. It is especially certain crustacea which exhibit this latter peculiarity, but not all crustacea, for the crayfish-like forms in the deep sea, are of ordinary size. I have already referred to a gigantic Pycnogonid dredged by us. Mr. Agassiz dredged a gigantic Isopod eleven inches in length. We dredged also a gigantic Ostracod. The increase in size depends probably on lack of enemies rather than on abundance of food.

The unhappy deep-sea animals have not escaped their parasites in their cold and gloomy retreat. The tube of the Cerianthus, of which I showed a figure, was full of Nematode worms. Crinoids are beset by a Myzostomum, and one deep-sea shrimp was found with a parasitic Gordian worm coiled up inside its body, filling it almost entirely. I have already described the vegetable parasites of corals.

The existence of colour in deep-sea animals is a very interesting fact. Some of the animals, as for example many of the fish, have lost their colour in the dark, and have become simply black or white. Others are most brightly coloured, having retained through countless generations the colouring of their shallow-water ancestors. Some, like the deep-sea shrimps, which are almost always of an intensely bright red colour, seem to have developed a special amount of colouring in the depths. The phosphorescent light of deep-sea Alcyonarians, when examined by the spectroscope, is seen to consist of red, yellow, and green rays only. Hence only these colours would be effective in the deep sea, and no blue animals were dredged from any considerable depths.

Colouring matters however need not always have a decorative object in existence. Certain chemical compounds formed within the bodies of animals for various physiological purposes may happen to have a peculiar action on light so as to be coloured, but this colour-producing property may be a waste or bye-product, so to speak, and only be turned to advantage by certain animals as a subsequent improvement. The fact that our own blood is red is probably an instance in point. In most mammalia the blood is entirely in the dark throughout the animal's life, and never acts on the light so as to exhibit its colour, which is to these animals useless. In ourselves the colour has been turned to advantage for decorative purposes. The colouring matters of some deep-sea animals may thus be retained, because the substances yielding the colours are necessary for the well-being of the animals, and these substances happen to be coloured, just as sulphate of copper is blue, though chemists seldom employ it because of its colour.

As an example of the vividness of deep-sea colouring matters, may be cited that of Pentacrinus. Here (Fig. 17) is a Pentacrinus dredged from 400 fathoms near the Azores. The animal may be briefly described as a star-fish turned upside down and set on a stalk. When freshly dredged Pentacrini are put into spirit, their colouring matter dissolves out and tinges the spirit of an intense purple red. (The light was thrown upon the screen through a solution of this colouring matter in spirit, from specimens of Pentacrinus dredged in 650 fathoms.) The colour is a most beautiful red. It is red when acid, but when a few drops of ammonia are added to it, it turns to an intense green. Very probably this colouring matter is as ancient as the genus Pentacrinus itself.

The colouring matter yields a well-defined absorption spectrum. The acid solution (Fig. 18) shows two dark bands in the yellow and a faint one in the green, and the alkaline green fluid a dark one in the red, with two fainter

FIG. 18.—Spectra of the acid and alkaline solutions of the colouring matter of Pentacrinus in spirit. The acid spectrum above and the alkaline below. The fine lines are solar lines.

ones in the yellow and green. By means of this double set of lines this colouring matter can be almost certainly identified, although its chemical composition has never been investigated.[1]

A good many other colouring matters of deep-sea animals give well-marked absorption spectra, and can be similarly identified, and it is most interesting to find that the very same colouring matters found in deep-sea animals occur also in allied shallow water and surface forms. Thus numerous deep-sea corals and sea-anemonies are tinged of a madder-red colour by the same pigment, which is abundant in many jelly-fish which float on the sea surface. The red colouring matter of the deep-sea shrimps is also identical with that which occurs in smaller quantities in nearly all the microscopic crustacea with which the sea surface is crowded.

In conclusion I would merely impress upon you again that the most important subject now remaining to be investigated with regard to deep-sea life is the range of life at the various depths between the surface and the bottom of the ocean.

A MAGNETO-ELECTRIC GYROSCOPE

THIS is the name of an apparatus invented by M. W. de Fonvielle, editor of *Electricité*, after having witnessed an experiment by M. D. Lontin. This gyroscopic machine was exhibited by M. de Fonvielle to the Royal Society on the 15th inst., when a paper by him was read by Prof. Stokes. The instrument can now be seen at Elliot's, St. Martin's Lane.

The object of the apparatus is to demonstrate new properties of induction currents brought into play in a magnetic field, and which give a continuous rotatory motion to movable pieces of iron of various forms (Fig. 1). The apparatus consists essentially of a galvanometric frame of any shape. In the first model which has been brought over to England the galvanometric frame is a rectangular one, above which is placed a horseshoe-magnet, supported by a vertical axis round which the

[1] See H. N. Moseley, "On the Colouring Matters of Various Animals, especially Deep-sea Forms" (*Quart. Journ. Micro. Sci.*, vol. xvii., new ser., p. 1).

magnet can be placed in any azimuthal position which may be required. The galvanometric frame has been so constructed that the the horseshoe-magnet may be taken away and be replaced by any number of bar-magnets laid flat upon its upper side. It is possible also to place other bar-magnets underneath the frame in a space arranged for that purpose, or to place the two magnets laterally, or on the left and right side of the frame (Fig. 2).

To produce a continuous movement of rotation with

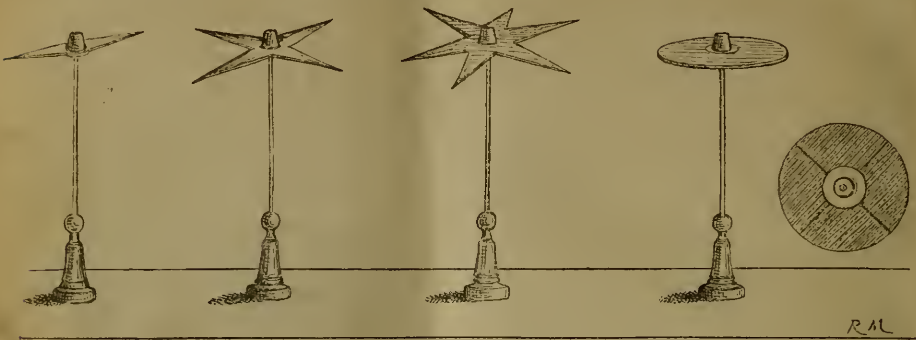

FIG. 1.—Some of the soft iron rotators used in the gyroscope.

the intervention of the magnets it is sufficient to place any movable piece of iron in equilibrium by means of a block on a vertical axis (Fig. 3) inside of the frame, and to send the current of induction into the coil. When, by

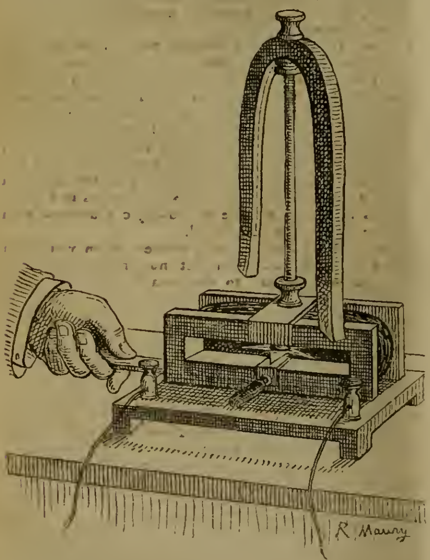

FIG. 2.—Rotating induction machine surmounted by a magnet. The operator is introducing a magnet into the space underneath the frame.

means of a commutator, the direction of the primary is changed, the direction of the motion of rotation is reversed. The same phenomenon is observed when we transfer the poles of the acting magnets from left to right, or *vice versâ*. But no sensible alteration even in the velocity is observed when we place the bar-magnets underneath which have been originally placed on the top, or *vice versâ*. If the magnets are too near or too far from the rotating piece of iron, the motion ceases, which, under favourable circumstances, might acquire a very great velocity. The rotation is also stopped when the magnets are placed in a direction perpendicular to the frame.

The movable piece may be placed also at a small distance laterally without the rotation ceasing to take place. It may be also placed on the top, and be rotated by the influence of the bar magnets placed underneath.

The same phenomena may be obtained very easily with a bar electro-magnet of which one pole is presented at a distance of several metres. In this case the experi-

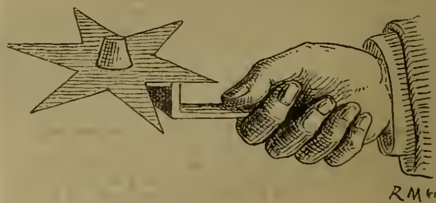

FIG. 3.—Movable piece balanced on its axis, ready to be introduced into the galvanometric frame.

ment is very curious, and looks like a conjuring trick, as two or three movables can be rotated at once. A mere change in the pole presented produces a change in the direction of rotation as well as the displacement from one side of the axis to another. But the operator must be careful not to approach too near, otherwise, the power of the electro-magnet being too great, the action of the induction-current is absorbed, and no motion at all is observed. If the operator is quite near, the movable pieces of iron are attracted magnetically, and fly from the pivots where they have been rotating, to the pole of the electro-magnet. To ascertain the velocity of the movable pieces of iron it is advisable to have them painted half in white and half in black, so that they become grey as soon as the velocity is six or seven turns in a second.

It is possible also to obtain motion without the presence of magnets by guiding an impulse to the movable by an exterior force, and M. de Fonvielle and M. Lontin insisted on that particular point in the memoir they have presented jointly to the Paris Academy in offering a theory of these curious phenomena. The rotation is not always the same, but once it is determined in a solid sufficiently balanced it continues indefinitely in the same direction. The direction does not change when we reverse the direction of the currents by means of a commutator.

The possibility of producing the same movement by means of movables of any form whatever, in presence of magnets or without their action, and notably of two spirals constructed of a flat wire and wound in an opposite direction, appears to the inventors to demonstrate that the rotatory action is exercised individually on each molecule of iron, and that the total impulse must be regarded as the integral of the individual impulsive actions. This remarkable property appears to furnish a very simple means of completely explaining all the circumstances of these curious phenomena by means of the known laws of induction, and to dispense with having recourse to any new hypothesis. It is sufficient, in fact, to remark that the molecule of iron acts in its movement of rotation in two different ways in each of the two nearly equal currents of induction which successively traverse the spires. In fact, during the whole continuance of the two phases of rotatory movement which the galvanometric frame brings closer together, each molecule of soft iron increases the intensity of the current which affects it, and which the inventors call *positive*, independently of its real direction, in order to fix the idea; at the same time it diminishes that of the current which repels it, and which they call *negative*, for the same reasons. In the two other phases of its movement the same molecule diminishes the intensity of the positive current, which then tends to draw it back, and increases that of the negative current, which turns it away from the frame. The actions exerted in the two phases of the movement, that is, in the total extent of the plane described by the molecules, tend then to keep up the continuous rotation, which progressively increases in speed until it reaches that which corresponds to the absolute intensity of the attractions or repulsions exercised by the currents induced, by the energy of the inductive current, the value of the friction of the resistance of the arc, &c.

When we bring the pole of a magnet into action, it is clear that its influence determines in each of the molecules of the movable object a transient magnetisation which strengthens the induction currents produced in the spires in the cases in which it is concordant, and which paralyses them in the opposite case. It hence results that, in presence of a permanent magnetic centre, the movement is possible only in a direction determined by its position and its nature. MM. De Fonvielle and Lontin believe that this principle applies even to the action of the earth.

When we change the position of the active pole in relation to the axis of rotation, the rotation changes its direction; but the pole of the magnet may be placed above or below, to right or left, without the rotation changing its direction. The two poles of a bar or a horseshoe magnet combine to accelerate the movement when they are placed in the direction of the frame; but if we place the magnet in a perpendicular direction, all movement is, as a rule, rendered impossible. It is the same with near position; in proportion as we approach it to that limit of position, the rotation in general will be found to slacken. It is clear that a magnetisable body so strongly tempered as not to have the capacity of being magnetised and demagnetised to the given extent, will remain insensible to these successive dynamic reactions, and consequently immovable, and that it is necessary to employ the softest possible iron in the construction of the movable objects. The same phenomena, especially with the spiral, may evidently be produced if we place it about the frame. They are accompanied, especially with the full disk, by a strident sound, by alternate magnetisations and demagnetisations. Their production appears to the inventors a new confirmation of the theories which they have advanced.

We must add that the coil used is of a peculiar construction, but that at least some of the phenomena can be observed without any Ruhmkorff's machine at all, but with an interrupter of the current from the battery.

It is impossible to say at present if the apparatus may be rendered serviceable as a motive power. But it may be used at all events not only as exhibiting a new mode of action, but as a balance to make a comparison of the force of several magnets, by placing them in opposition at various distances.

NOTES

McGill University, Montreal, has long held the lead in the cultivation of natural science among the colleges of Canada, and has already large collections, which are still further to be increased by the liberality of Mr. Redpath, a member of the Board of Governors, and Principal Dawson. Mr. Redpath proposes to erect on the College grounds, and on a site which will harmonise with the arrangement of the existing buildings, a stately and beautiful edifice for a museum of geology and natural history, primarily for the use of the professors and students of the college, but also for the benefit of the public generally. The building is to be detached and practically fireproof, and while it will be an ornament to the college grounds, will be fully up to the present idea of museum buildings in regard to space, light, and means for study and illustration. It will accommodate the whole of the present collections of the University, and will enable them for the first time to be fully accessible to students. In connection with Mr. Redpath's gift, Principal Dawson purposes to present to the University the whole of his private collections in geology, embracing the types of the species which have been described by him in his papers and other publications. In some departments of the geology of the Dominion, as in the fossils of the Pleistocene and Carboniferous, and in the geology of the Maritime Provinces, these collections are believed to be the most important extant.

The International Congress of Anthropology and Prehistoric Archæology holds its next meeting at Lisbon, on September 20–29, this year. Several important questions concerning the prehistoric archæology of Portugal will be discussed. Excursions will be made to several places of archæological interest.

A universal exhibition of prehistoric German anthropology will take place at Berlin in August. All the German States have been invited to join in this exhibition, which will comprise objects chosen from every museum in Germany. Prof. Virchow is at the head of the Committee appointed to organise the necessary details.

The Institution of Mechanical Engineers holds its ordinary general meeting to-day and to-morrow, April 23, at 7.30 p.m. The following papers will be read and discussed:—"Remarks on Chernoff's Papers on Steel," by Mr. William Anderson, of Erith; "On Permanent Way for Tramways, with special reference to Mechanical Traction," by Mr. J. D. Larsen, of London; "On Water-Pressure Engines for Mining Purposes," by Mr. Henry Davey, of Leeds; "On Electric Lighting" (second paper), by Dr. John Hopkinson, F.R.S., of London

Sir Henry Bessemer, F.R.S., has been presented with the freedom and livery of the Turners' Company.

Among Mr. Murray's list of announcements are: "The Circumnutation of Plants," by Charles Darwin; "The Life and Discoveries of David Livingstone," by Dr. W. G. Blaikie; "Unbeaten Tracks in Japan," by Miss Bird; "Siberia in Europe: a Naturalist's Visit to the Valley of the Petchora," by Mr. H. Seebohm; "Eastward Ho! Journal of a Naturalist and Botanist in the Forests and Swamps of New Guinea," by Mr. F. W. Burbidge.

The State of Connecticut has taken to heart the teachings of science with regard to the prevalence of colour-blindness, and its General Assembly has passed an Act authorising the State Board of Health to prepare rules and regulations for the examination and re-examination of railroad *employés* in regard to colour-blindness and visual power, and prescribing the method in which, and the intervals at which, such examinations shall be made. The Board is annually, in the month of May, to recommend two or more medical experts to make the necessary examinations and the Governor, on or before July 1 following, is to appoint two of these gentlemen, who will issue certificates. The Act further makes provision for inflicting penalties on any railway company employing a person who is not in possession of a regular certificate of freedom from colour-blindness, or whose certificate shall at any time have been revoked by the examiners. May we hope that our new Government will impose some such sweeping reform upon our reckless railway companies?

The *American Art Review* publishes an account by Mr. F. W. Putnam of an attempt at archæological imposture. In the course of an excavation made in December last in a small burial mound at Yalaha, Lake Harris (on the Ocklawaha), Sumter County, Florida, there was found a little figure of ordinary brick clay, identical in design with many of the statuettes so common in the Egyptian tombs, and known under the general name of Osirids. This little figure was sent to Mr. F. W. Putnam for examination at the Peabody Museum in Cambridge, U.S., and after a careful study he has little hesitation in saying that all the facts he has been able to gather bear witness against its genuineness, in so far as attributing it to the workmanship of the builders of the Florida mounds is concerned. Nor can it be made a link in the chain of supposed evidence by which it is sought to establish a belief in a connection of the early nations of America with the people of Egypt. That the discoverer is entirely clear of all attempt to impose on the public, Mr. Putnam states, is self-evident, as he was suspicious of the antiquity of the object the moment he took it from the mound, and sent it to the Museum in order to have its character determined, if possible. At the same time the finder states that, so far as he observed, the mound had not been disturbed before he commenced to dig. It would seem from this as if a careful "plant" had been made for the purpose of imposing on any one who might happen to open the mound, which, from the large number of relic-hunters who annually visit Florida, would probably be very soon. The front part of the statuette has the appearance of having been cast in a mould made by pressing an original Egyptian specimen in plaster, face down, while the back of the figure shows signs of having been cut with a knife when the clay was still soft. The freshness of the surface of the object tells perhaps more than anything else against its antiquity. In fact to one used to looking at and handling ancient pottery this little statue has the appearance of having just been taken from a place where it had been carefully kept from dirt and from hands since the moment it was made. In connection with this "Osirid" from Florida, it has been stated, Mr. Putnam says, that similar objects were recently found in South America, and are now publicly exhibited in the National Museum at Buenos Ayres. This museum is said to possess, "among the antiquities taken from tumuli in the pampas, mummies, images, and sarcophagi, as fresh, and decorated with as brilliant hieroglyphics, as any exhibited in the famous galleries of the Louvre or other foreign museums containing Egyptian collections." In the published reports of the museum in question, so far as accessible, Mr. Putnam does not find any such objects mentioned. He has therefore taken steps to ascertain the trustworthiness of the report. In regard to the antiquity of the mounds in Florida, Mr. Putnam states that while many of the burial mounds are unquestionably very ancient, it is particularly to Florida we turn to prove the continuance of mound-building by some Indian tribes down to a time long after the appearance of Europeans in that region. In support of this statement we have historical evidence, and also the fact that in many of the mounds in Florida there have been found objects of European origin, such as glass beads, iron implements, glazed pottery, and ornaments of brass, silver, and gold.

A fish and Fishing Exhibition on an unusually large scale was opened at Berlin on Tuesday by the Crown Prince of Germany. The exhibition seems to be admirably arranged, the worst represented country being England. The correspondent of the *Daily News*, animadverting on this, says: "It is a great pity that England sends almost nothing. As far as I can hear, the entire blame rests with the English Government, which refused to give any support or encouragement to the affair. The consequence is that out of the fifty-three whose names were down as exhibitors only seventeen have appeared, which means really that if Mr. Buckland had not sent a rather interesting collection of casts and Messrs. Bartlett and Sons fair specimens of rods and fishing-tackle, the English Department would have been virtually empty. I believe this is the first time that England has been last on the list in an International Exhibition, and I could not help remarking that the Crown Prince was very much surprised at this as he passed through the English Department. Switzerland beats us entirely. The public here evidently expected a great deal from England. However, they must console themselves with the very interesting collection which the United States have sent over."

A stalactite cave, with prehistoric animal remains, is stated to have been discovered near Menhadu, on the Romano-Hungarian frontier.

Prof. Prosdocismi, of the Este Museum, who discovered a prehistoric cemetery on the slope of the hills overlooking that town, has unearthed in the same vicinity eighty-two tombs, forty-four of them violated apparently during the Roman period, the rest untouched, with all their pottery and bronzes. The urns are of three periods, some coloured black, with linear ornamentation, others adorned with circles and wavy lines; others with alternate bands of red and black. Some of the accessory vases might serve as elegant models for modern potters. The bronze ornaments are also very interesting, and a onze chest bears three designs, comprising in all seventeen warriors and a priest, seven animals (horses, oxen, stags, birds, and a dog), several plants, and a kind of chariot with a man seated in it. The Professor considers these the finest prehistoric remains in Italy. Remains of lake-dwellings have been discovered in a peat-bog near Milan, and in a street in Milan excavations for a house have brought to light what are believed to be vestiges of the old Roman theatre.

In a paper read at the American Philosophical Society Mr. Horatio Hale gave an interesting account of his acquaintance with the various Indian tribes collected on the Canadian reservation at Brantford, east of London, Upper Canada; of the most distinguished surviving chief of the Six Nations, Sakayenkwaraton (disappearing mist), known to the English as John S. (smoke)

Johnson, now eighty-seven years old. His son, Chief George Johnson, bears the official title of the one of the original fifty council chiefs whom he represents. Mr. Hale described the formation of the confederation, three centuries ago, and testified to the accuracy of Mr. Morgan's history of it. He then described the "Book of Rites," which, after two centuries of verbal tradition, was reduced to writing by some one connected with the early missions. Two copies exist, and Mr. Hale is obtaining a translation of it. It is the only known American aboriginal piece of literature north of Mexico. It has many archaic words, and is engrossed, in an old-fashioned current English hand, in a common schoolboy's copybook. He also described the wampum belts of the confederation, partly preserved by the Onondagas in New York, and partly among the Indians in Canada. He told of his discovery that the Tutelos were not an Iroquois tribe, but were allied to the Dakotahs or Sioux of the West. Their first seat was in North Carolina. Brainard reported that Tutelos, Iroquois, and Delawares lived together at Shamokin, Pa., speaking three entirely different languages. The syntactical position of the personal pronoun before, after, or between any two syllables of the verb allies the Tutelo language with the two dialects of the Dahcotah, and separates it from all the other Indian dialects. But Tutelo seems to be older than the Dahcotah. So also Huron (Quebec) was older than Iroquois (Six Nations); and Delaware older than Chippeway. It looks as if the movement was from east to west, and not from west to east.

FROM an inquiry as to cetaceans which have perished on the coasts of the Mediterranean and of the West of France during the years 1878 and 1879 M. van Beneden (*Bull. de l'Acad. Roy. de Belgique*, No. 2) finds there were two species of Balænoptera on the former, *Musculus* and *Rostrata*, and two *Giphius cavirostris*, which was believed to have disappeared some years since as a living species. On the west coast of France there perished three *Balænoptera musculus*, one *Megaptera boops*, and one Ziphioid female, whose rudimentary teeth are unknown.

DR. LYON PLAYFAIR has been re-elected representative in Parliament of the Universities of Edinburgh and St. Andrews.

IN reference to the note on the Walker Prize, awarded to Dr. Leidy (NATURE, vol. xxi. p. 451), we should state that the sum awarded to Prof. Agassiz was, like that awarded to Dr. Leidy, 1,000 dollars.

THE sums placed at the disposal of the French Minister of Agriculture and Commerce for the purpose of encouraging research and experiments as to the best way of dealing with the phylloxera, amounted, in 1879, to 500,000 francs, and this will be increased during the present year by supplementary grants to 969,750f. Of this amount 200,000f. are devoted to the treatment of diseased vines in the districts specified by the superior commission, while 250,000f. will be given to doubling the grants voted by the various departmental and municipal bodies. Societies and companies formed for the investigation of the disease will also be assisted by bonuses to the aggregate amount of 300,000f. A further sum of 100,000f. is set aside towards encouraging the propagation of American vine stocks and the distribution of new plants and cuttings from the Agricultural School at Montpelier. Rewards to the amount of 100,000f. will be given for furthering microscopic researches, while 50,000f. are left for dealing with individual cases.

A CHICAGO agricultural journal gives an account of the largest plough ever known to be made, which has been recently turned out by an Illinois firm of agricultural machinery-makers for use on the St. Louis, Iron Mountain, and Southern Railway. It is attached to a platform car of a construction train in such a way as to cut its ditch a sufficient distance from the railway line. It will make one mile of ditch 2 feet deep and 3 feet wide, every four hours, thus doing the work of about 1,000 men. The beam is made of swamp oak, and is 8 inches by 14 inches, the land side being made of bar iron 8 inches wide and $1\frac{1}{2}$ inch thick, which had to be forged expressly for the purpose. Its total weight is 1,700 lb.

FROM China we hear that Mr. Molesworth has lately gone up the Yangtsze-kiang, in order to open coal-mines in the Nganhiong province, where he hopes eventually to introduce foreign machinery.

THE additions to the Zoological Society's Gardens during the past week include a Brown Bear (*Ursus arctos*) from Asia Minor, presented by Commander Atwell Lake, R.N.; two Common Wombats (*Phascolomys wombat*) from Tasmania, presented by Dr. J. C. Cox; two Nutmeg Finches (*Munia undulata*) from India, a Chestnut-breasted Finch (*Donacola castaneothorax*) from Queensland, presented by Mrs. Hylton Joliffe; a Himalayan Bear (*Ursus tibetanus*) from North India, deposited; an Eyra Cat (*Felis eyra*) from South America, a Short-nosed Perameles (*Perameles obesula*), a Stanley Broadtail (*Platycercus icterotis*) from Australia, two Scaly-breasted Parrakeets (*Trichoglossus chlorolepidotus*) from New South Wales, a Blue-crowned Hanging Parrakeet (*Loriculus galgulus*) from Malacca, two Red-naped Fruit Pigeons (*Carpophaga paulina*) from Celebes, an Elate Hornbill (*Buceros elatus*) from West Africa, two Black-necked Swans (*Cygnus nigricollis*) from Antarctic America, three Wheatears (*Saxicola œnanthe*), a Meadow Pipit (*Anthus pratensis*), European, five Eyed Lizards (*Lacerta ocellata*), South European, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE SOUTHERN COMET.—There appears now to be no reasonable doubt that the comet which has attracted so much attention in the southern hemisphere is identical with the great comet which was observed in almost all parts of the habitable world in March, 1843. Dr. Gould succeeded in obtaining observations for position at Cordoba up to the evening of February 19, though the head was then only recognised "as a scarcely perceptible whiteness in the field of the large equatorial of $28\frac{1}{2}$ centimetres aperture." On the following evening it was not distinguishable, though having a good ephemeris, the observers knew that it must be in the field of the telescope, which fully accounts for the comet having been unsuccessfully sought with large instruments in this hemisphere, amongst others with Mr. Common's powerful reflector at Ealing. Dr. Gould publishes the following parabolic elements founded upon his observations of February 6, 12, and 18; an orbit deduced by Mr. Hind from the Cordoba places of February 6, 9, and 14, which is annexed, will be seen to differ in no material degree from Dr. Gould's. The longitudes are for 1880·0.

	GOULD	HIND
Perihelion passage G.M.T. ...	Jan. 27·6188 ...	Jan. 27·62195
Longitude of perihelion ...	279° 52′ 11″ ...	279° 45′ 1″
,, ascending node	6 10 30 ...	5 55 37
Inclination	35 20 21 ...	35 22 52
Log. perihelion distance ...	7·739364 ...	7·745636
Motion	Retrograde ...	Retrograde

On comparing the accounts so far received of the appearance of the comet of 1880, while in some general features, as the great length and narrowness of the tail, &c., there is a close resemblance to the descriptions of the comet of 1843, it will be found that the head at least was probably more brilliant in the first days after perihelion in 1843, though as in the present year its brightness very quickly faded. We do not hear of the comet having been detected in broad daylight near the sun, soon after the perihelion passage as in 1843, when it was remarked only a few degrees distant from the sun's limb, at various places in the United States, in Italy and off the Cape of Good Hope; in that year the comet crossed the sun's disk without being observed in transit. In the present year the comet has not transited the sun, but according to Mr. Hind's orbit would have the following positions within the twenty-four hours after perihelion:—

Greenwich mean time.	Right Ascension.	North Polar distance.	Distance from Sun's centre in R.A.	in N.P.D.
h.	° ′	° ′	° ′	° ′
January 27, 22 ...	309 49 ...	109 33 ...	− 0 32 ...	+ 1 15
28, 0 ...	310 1 ...	109 49 ...	− 0 25 ...	+ 1 32
28, 2 ...	310 13 ...	110 4 ...	− 0 17 ...	+ 1 48
28, 4 ...	310 26 ...	110 18 ...	− 0 10 ...	+ 2 4

The following expressions for the comet's heliocentric co-ordinates to be combined with the X, Y, Z of the *Nautical Almanac*, apply to the same orbit, and may be useful to some of our readers in the other hemisphere who have occasion to learn the right ascension and declination of the nucleus in examining their observations of the track of the tail before the head was visible :—

$$x = r\,[9\cdot99922]\sin(v + 8°\ 39'\cdot7)$$
$$y = r\,[9\cdot99079]\sin(v + 279\ 22\cdot6)$$
$$z = r\,[9\cdot32714]\sin(v + 82\ 39\cdot9)$$

r is the radius-vector and v the true anomaly.

A NEW COMET.—A telegram to the Astronomer-Royal notifies the discovery of a comet at Ann Arbor, Michigan, on April 6, at 11h. Washington time, in right ascension 7h. 20m., and declination 84° 25′; daily motion in right ascension, − 30m.; in declination, − 48′; tail, 3′. From a telegram to the Academy of Sciences at Vienna, the name of the discoverer would appear to be Schäberle.

GEOGRAPHICAL NOTES

THE gold medals of the Royal Geographical Society have just been awarded as follows :—1. To Lieut. A. Louis Palander, of the Swedish Royal Navy, in recognition of the services he has rendered to geographical science as commander of the *Vega* in the Swedish Arctic expedition under Prof. Nordenskjöld, during which he safely navigated the ship along the unsurveyed shores of the Asiatic continent for nearly 3,000 miles, and took the leading part in charting the coasts of Northern Asia. 2. To Mr. Ernest Giles for leading four great expeditions and several minor ones in Australia, and for his route-surveys, geological and botanical collections, and published descriptions of his various journeys. A gold testimonial watch was voted to Bishop Samuel Crowther for his services to geography in the Niger region during the past forty years, and for having aided various expeditions on that river between 1841 and 1857. Prof. Nordenskjöld, having received a gold medal in 1869, was, we believe, in accordance with all precedents, ineligible for another, but, as we have already recorded, he has been elected an honorary corresponding member—an honour accorded to Mr. H. M. Stanley under analogous circumstances. The Council of the Society of Arts at their last meeting elected Prof. Nordenskjöld an honorary life member of the Society in consideration of the services rendered to science by his recent explorations.

MOUNT NAIGUATÁ, in the Venezuelan coast-chain near Carácas, and at a short distance towards the east from the Silla, was ascended by a party from Carácas, August 24 last year. Its height was for the first time carefully determined by Lic. A. Aveledo and Dr. Man. V. Diaz. The barometrical reading on the top was 551·20 mm. (reduced to freezing point), thermometer being at 13° C. At the same time observations made in Carácas (Colegio de Santa Maria) gave: Barom. 683·44 mm. ; therm. 24°·8, which makes Naiguatá 1,852 metres higher than the lower station, and as this place is 930 metres over sea-level, the total height of Naiguatá is 2,782 metres, or 9,130 Eng. feet. Dr. A. Ernst made botanical and other collections. The rock, wherever it is not covered by vegetation, is amphibolic gneiss, with much quartz, and therefore very hard. A swift (*Chætura zonalis*, Sclat.) was frequent on the top, but it could not be discovered whether it was nesting there. In the stomach of one specimen a large number of wasps were found. Of beetles there were some *Platyomus*, a *Pterostichus*, and a few *Chrysomelidæ*, crowded together with some wasps in a narrow cleft between two large stones. Not very far from the top a specimen of what appears to be the moss insect described by Belt ("Naturalist in Nicaragua," p. 382) was caught, clinging to the bark of a stem, which was thickly covered with *Neckera undulata*, Hedw., the likeness between the insect and the branches of the moss being indeed very striking. No butterfly was seen, though there was an abundance of flowering plants; nor were there any land-shells, which was to be expected, on account of the total absence of limestone. Amongst notable plants growing on the higher part of the mountain the following may be mentioned :—*Arenaria nemorosa*, H.B.K., *Acæna*, sp. n. (allied to *A. cylindrostachya*, Cav., and *A. macrorhiza*, Hook.), *Berberis aurahuacensis*, Ch. Lem. (after Sir J. D. Hooker; the plate in Van Houtte's, "Flore des Serres," iv. tab. 334, however, does not agree; it looks very much like *B. gulache*, Tr. et Pl.), *Liabum hastifolium*, Poepp., *Hieracium avilæ*, H.B.K., *Gnaphalium incanum*, H.B.K., *Myrsine ciliata*, H.B.K. (the only woody plant which reaches the top), *Sphacele*, sp. n., *Siphocampylus microstoma*, Hook., *Anthericum coarctatum*, R. et P., *Arthrostylidium longiflorum*, Munro, *Epidendrum alpicolum*, Reichb. (several specimens were seen with racemes ten to twelve inches long, and sending forth a sweet vanilla-like smell). It must be remembered that Mount Naiguatá was ascended some years ago by the late Mr. James Mudie Spence, of Manchester, and his party.

WE take the following from the *Times of India* :—It is said that Major Biddulph, stationed on the Kashmir boundary, has prepared a report upon the customs, the languages, and the folk-lore of the singular communities among whom he has been residing for a long time. "From Major Biddulph's peculiar advantages and opportunities may be expected," says the *Pioneer*, "a complete account of people who are a survival of the old Aryans, from whom all civilised mankind of the present day is probably descended. Surgeon-Major Bellew, meanwhile, has been examining a few men from the cantons on the south-west of Dardistan, peopled by a similar race, who in one respect are still more interesting, for their country has never yet been visited by a civilised traveller. But in appearance and language they closely resemble the Dards, and, unlike them, have not embraced the creed of their Mahomedan neighbours. The tongues spoken in all these hills are, for the most part, Aryan; not descended from Sanskrit, and, indeed, of earlier origin than that classical language. On the northern slopes of the mountains Parsee words prevail in the southern cantons. Some of the words resemble Greek, some Latin, some those of modern Europe. They make, and freely consume, grape wine, something like a crude Burgundy. Those who are not Mussulmans believe in one God, but employ the intercession of minor powers, represented by images. They also occasionally canonise great men whom they have lost by death. They are usually monogamous, opposed to divorce, and strict defenders of the chastity of their unmarried girls. These latter have blue, grey, or hazel eyes; black hair is the exception amongst them, and, when young, they are of such remarkable comeliness as to be in great demand in the slave markets of adjacent countries. Authentic information concerning these interesting races cannot but be anxiously awaited by all who realise the nature of the questions involved."

THE Rev. C. T. Wilson, of the Church Missionary Society's Nyanza Expedition, who has just arrived in England *viâ* Egypt, from Lake Victoria, will read a paper on "Uganda and its People," at the meeting of the Royal Geographical Society on Monday next. Great interest will attach to this meeting, owing to the expected presence at it of the three Waganda chiefs who have accompanied Mr. Wilson as a deputation from King Mtesa.

FURTHER details are to hand as to the projected Italian Antarctic Expedition, under Lieut. Bove and Commendatore Negri. Committees for subscriptions have been started in the chief Italian towns and the colonies, and it is hoped the expedition will be ready to sail in May, 1881. From the Shetlands the expedition will steer to the south-west, and endeavour to penetrate a line of land which was observed by Dallman, a Hamburg whaler, some few years since. Thence a movement will be made towards the land where Bellinghausen marked the lofty capes of Alexander and Peter, and the western lands observed by Wilkes in 1839. At this point a serious discussion must arise as to future movements. It would be desirable to coast along the land of Bellinghausen if there were any appearance of a "continued mass," steam for the back of the islands which Wilkes believed to exist, and thus enter on the south of Ross's Sea, where the winter might be spent. Should, however, expectation be disappointed, the winter might be passed on the Bellinghausen land, and preparations might be made for entering Ross's Sea. The voyagers think that with a strong vessel it would not be impossible to penetrate beyond Ross's Sea, and complete the studies which were made of the flora, the fauna, and the mineralogy of the Antarctic region. Having examined these lands and seas, it is proposed to move towards Adele, discovered by D'Urville in 1840, and here it is thought it might be possible to land and winter. Continuing their course to the west, they intend running along by the "Southern Continent," where the existence of land is certain, and endeavour to penetrate through the ice, as did D'Urville, Wilkes, and Ross. The hope is that canals in the ice might be found through which they might attain a remote latitude, or, running along them when massed into a continent, arrive at Kemp or Endermet, where they could pass the second winter.

A JAPANESE paper states that the Swedish skipper Johannesen, who has already done a good deal of exploration in the Spitzbergen seas, is to set out this month from Yokohama in the steamer *Nordenskjöld* to make the North-East Passage in an opposite direction to that taken by the *Vega*, viz., from Behring Straits to Europe.

PROF. NORDENSKJÖLD reached Copenhagen at the end of last week, in the *Vega*, and was received on landing by the acclamations of 20,000 persons. Every one has united to do him and his companions honour, from the Royal Family downwards.

THE death is announced, on the 16th inst., of Mr. Robert Fortune, well known as a botanical collector in China and Japan, and author of several volumes describing his travels in those countries in search of new plants. It was he who introduced the tea-plant from China into the North-West Provinces of India. He was born in 1812.

ON THE EMPLOYMENT OF THE PENDULUM FOR DETERMINING THE FIGURE OF THE EARTH

MY object in writing this paper is principally to draw attention to the course which the employment of pendulums has taken, from the time when Richer's first experiment at Cayenne, in 1672, attracted the attention of Newton; and to show in what respect the present aspect of the question is different from that which successive observers, as well as writers upon the subject, have at various times taken. It is no part of my object to discuss the observations themselves, or to discriminate between them, still less to enter upon any investigation of the figure of the earth, except incidentally in alluding to the conclusions which different writers have accepted. But as it is nearly impossible—perhaps not altogether desirable—to hold no independent opinions, I may add that I hope to be able to influence the future course of such operations in a certain direction which will be recognisable as we proceed.

The literature of the subject is very extensive,—not so much in respect of the pendulum itself, or of the use which has been made of it, as on account of the intimate relation which the laws which govern its motion have to larger questions. It is the discussion of these that experiments with the pendulum have influenced, and in general it is only with reference to such influence that the experiments have been instituted, described, and considered; and that in close connection with other operations of wholly different character. It is thus nearly impossible to have a thorough knowledge of the history of pendulum operations without at least a general acquaintance with the history of geodesy, and of that part of astronomical and mathematical literature which deals with the probable forms and constitutions of cosmical bodies. This would be less the case than it is if some of the many writers on the figure of the earth had written less exclusively from their own point of view, and (at any rate in writing of pendulum operations) had dealt more fully with the historical aspect of this particular branch of the general subject: I mean in the modern sense of the word; describing not only the sequence of experiments, but also the development of the comprehension of the questions in issue. I have felt the want of this myself so strongly that now that a somewhat protracted study has partly supplied that want I am fain to attempt this review, in aid of those who may have to prosecute the work.

It is of course impossible to present the course of pendulum operations without continually referring to their intention. At the same time one learns at last that, with one or two exceptions, the intention itself was not well grasped by those who conducted the experiments. Indeed one may almost say that even on the part of those who directed them the intention is not very clear; or more correctly, that it was more confined than we now might wish had been the case. Laplace was not perhaps the first to give utterance to the opinion that the anomalies noticeable in pendulum results were probably due rather to inequalities of figure than to errors of observation. Nevertheless it is with something of surprise, considering that the importance of his opinion lay latent so long as a practically unrecognised consideration, that we find him saying as follows:—"We shall here remark that the same anomalies. . . arising without doubt from the irregularity of the parts of the earth, are also perceived in the observed lengths of pendulums." That such irregularities existed was doubtless always a suspicion, but the fact was very slow of being recognised, and to this day it does not govern the observations.

In reviewing the course of pendulum operations then we must be prepared to put this aside as a fact which has not entered into account. It may be strange, but such is the case. It follows that a very considerable portion of the discussions and calculations, based on results which I am very far from wishing to impeach, must also be set aside as almost entirely without present value other than as evidence that the breadth of the question had not been measured.

If the absence of a true appreciation of the influence of local irregularity is apparent in the narrowness of the discussion of individual observations, or of small groups of results; it is also noticeable in the rejection of many, on the sole ground that the methods of observation were inferior; without any proof being adduced that the probable error was greater than the probable effect of local irregularity. This may be taken as indicating that there was also on the part of those who set themselves to review the produce of experiment a reluctance to accept as facts the irregularities which now we recognise as necessary concomitants.

Here again it follows that we must be ready to turn aside from conclusions which are seen to rest on the exclusion of an important consideration. But it by no means follows that, in thus finding reason on all hands to go back to the original sources, and to discard more or less summarily much which has been at one time or another accepted as legitimate deduction, there is any occasion to slight these deductions. Mere trials as they have often been, they have served many purposes which we cannot disdain, and (in ways which it is vain now to examine) have placed us in the more advanced position. There is one thing however which they must have no power to effect, and that is to obstruct us in further advance.

At the same time I confess that, for my own part, I cannot turn over the innumerable pages of vain calculations without profound regret that they represent so much labour—not thrown away—but without further use. I would give instances, but perhaps it is better to refrain. If anything could excuse it, it would be the hope of saving some other learner from spending time over them, and that object can perhaps be otherwise secured.

From another point of view I have also been led to perceive a want of distinctness in the plan of operations, which accounts for an otherwise inexplicable diversity in the individual contributions. In studying the history of these operations we are reminded of an edifice which presents different styles; and parts which make up a whole, not so much after any known design as casually. The two principal styles, to continue the metaphor, have indeed a common element which is a key to the whole construction; but though we can perceive that it is there in every part, and was present to the mind of every worker, it scarcely ever amounts to an expressed design by which future work is to be regulated. I allude to the absolute and differential methods. As we cannot properly appreciate the value of the work which has been done without understanding the relation in which these stand to each other, it is necessary to preface the merely historical account by a description of those methods in their relation both to the general purpose and to each other.

The conception of the earth as an oblate spheroid probably preceded the first use of the pendulum as an instrument by which its oblateness could be proved and measured. But the uncertainty which characterised geodetic measures—an uncertainty so great that it was, at a later date, actually the subject of vehement controversy whether the elipticity was not prolate—was such that Richer's discovery (in 1672) that the length of a pendulum beating seconds at Cayenne was notably less than that of a pendulum beating seconds at Paris, was from its very simplicity and conciseness, a revelation which promised inestimable consequences.

This was not the first time that a measurement of the seconds pendulum figures in the annals of geodesy. Picard had two years before adopted the idea—subsequently, towards the close of the next century, so nearly being given final effect to—of making the seconds pendulum the unit of length. But although he did actually determine the length at Paris, and thus unwittingly laid the first stone of the "absolute" method, it was not until the length had also been ascertained at another place and in another latitude that the firstfruits of the method could be gathered.

It is conceivable (though unlikely) that the pendulums used in the two places were the same. But this is of no consequence, since their lengths were different—the time of oscillation being constant.

Precisely the same result, in respect of variation of attractive force, would have been deduced had the same pendulum, of unchanged length, been used; the fact of observation in this case being a diminution of rate.

In the one case we have the absolute method; in the other we should have had the differential method. But in the former we have not only an indication of the variation of the force, but also a measure of its magnitude in terms of the measured lengths. Hence the designations.

It is well to remark here that unless the measurements at the two places refer directly, or can, by intermediary scales, be referred ultimately, to one and the same standard, there is no exact comparison, and no certain result. Further, that if, from any cause, the standard of reference is of unknown length, or, technically speaking, lost, the result is differential only. Thus we see that observations which were, in intention, of the absolute class, may fall into the differential class for want of reliable connection with existing standards of length.

Measurement of the absolute force of gravity at the earth's surface by means of a pendulum was doubtless contemplated by astronomers anterior to Richer's discovery of its variation. It is therefore scarcely permissible to recognise in the prosecution of this discovery the determination of the absolute force as a principal object. The object was distinctly to ascertain the variation at different parts of the surface. Such being the case, we must admit that the absolute method was not the simplest for the purpose. In due time this was recognised. It is doubtful to whom is due the credit of earliest perceiving that the measurement of the pendulum might be dispensed with, provided means were supplied of securing a constant length. Graham and Campbell (in 1732), and Bouguer (in 1735), were the earliest in the field;[1] and Bradley (in 1736) in describing Campbell's use of Graham's pendulum at Jamaica, very decidedly recommends the use of a pendulum of constant length. Bouguer and Godin at the same period were also using pendulums which were measured. From this time forward to the present day both methods have been practised.

I confess myself unable to frame arguments in favour of the measured pendulum, as an instrument for its purpose, which can at all account for its prolonged use. I mean of course if we are to presume an intimate acquaintance, on the part of the observer, with the meaning of his labours. Considering how fragmentary and scattered, and often unimportant, not to say mistaken, are the early writings on the use of the pendulum, it is scarcely invidious to say that such a presumption is sometimes gratuitous. The men who made scientific voyages in those days doubtless had something else to do than to study. Moreover, study was not very feasible when books were scarce and libraries few. Nevertheless one cannot help a curiosity as to the charm which protected the absolute method. Was it precedent?

There is something seductive, it must be admitted, in the conciseness and completeness which attends an absolute determination, as contrasted with the dependence of a differential one. To adjust a pendulum to such a length that it will beat seconds, and then to measure its length against a portable standard whose length has been ascertained—this is conclusive. When done, the worst that can happen to the instruments used is no worse than prevention of further use. This is true; and if the observer is full of confidence in the accuracy of his measurements, unconscious of the errors that lurk in reductions, and innocent of the insidious nature of instrumental mischances, why should he surrender the security of present gain? Nevertheless these flaws exist, and ultimately they are recognised and found irremediable. The more honour to those who foresee and provide against them, in preparing instructions, in conducting experiments to elucidate difficulties, or in multiplying observations by which the work of others may be consolidated.

[1] Mairan, in the same year, suggested it independently, and Lacondamine advocated and used one frequently.

Much of the doubtfulness which attaches to the earlier work is due to want of that knowledge which experience brings. Among the most important causes of error must be reckoned the imperfect comprehension which formerly existed as to the retarding influence of the air on the swinging pendulum. It was of course known that a body being lighter when suspended in a fluid than when in air, the oscillations of a pendulum when swung in air would be slower than when swung in a vacuum. No account was taken of this at first, but the time came when the effect was calculated by determining the diminution of weight due to flotation. Ultimately it was shown that there was also retardation due to the disturbance of the surrounding air, and it was surmised that this depended, not only on the bulk of the air displaced by the pendulum, but on the form of its surface as well. Of course it was immediately apparent that the old results must undergo some correction depending on the forms of the pendulums used; and equally, of course, the want of precise descriptions was then felt in a way the original observers never contemplated.

The difficulty was perhaps less real than apparent. As I have already pointed out, the magnitude of the force was not the object of the experiments, except as a means of inter-comparison. Hence any shortcoming which invalidated the determination of the absolute magnitude without rendering impossible that of the relative force, was of no real consequence. It was only necessary to abandon the idea of retaining a set of results in the absolute class, and to consider them as differential only; the *sine quâ non* being that such set were taken with one pendulum or with pendulums of the same size and construction. But I cannot remember a single instance in which the difficulty has been met in this way.

I have pointed out that the idea of measuring the force at any place absolutely arose anterior to that of measuring it relatively, and was afterwards retained as a means of securing the relative measure. Whatever interest attached to the determination of the force of gravity for itself, it is pretty certain that it went for little in the experiments which succeeded Richer's. It is therefore remarkable that even after the simpler differential method had been inaugurated it should still have held its ground. It is probable that Picard's idea[1] of a base or standard of length dominated to some extent the subsequent line of investigation. At any rate it is to his experiments that we must look for the rudiments of the instrument. I am[2] unfortunately unable to refer to the original memoirs in which these experiments are recorded, but I gather from other accounts that all the experimenters aimed at as near an approach to a "simple" pendulum as possible, and that even the celebrated form which Borda adopted in 1792 scarcely differed at all from the earlier ones. The following notice of Borda's experiments by Lalande, in his "Histoire Abregé de l'Astronomie," is noteworthy as sustaining the view which I am led to take of the vitality of the absolute method:—

"Le décret de l'Assemblée nationale qui, le 8 mai, ordonna la réforme des mesures en France, en indiquant le pendule à secondes pour mesure primitive, exigeait que la longueur du pendule fût déterminée avec une nouvelle précision. En 1735 Mairan avait fait ses observations avec bien du soin; mais alors on ne pouvait guère l'assurer d'un quinzième de ligne. Borda espéra obtenir une précision bien plus grande par des moyens nouveaux; il l'entreprit donc cette année à l'Observatoire, avec des instruments faits d'après ses idées par C^en Lenoir, et il en résulta enfin une détermination du pendule de 36p. 8l. 60 réduite[3] à la température de 10°; et dans le vide; ce résultat, qui est à un cinquantième de ligne, et mieux encore, a été obtenu avec un pendule de douze pieds de long."

The old form of pendulum consisted of a weight, of simple geometrical form, suspended by a fine wire or fibre. In Borda's the weight was spherical and attached by adhesion to a cup to which the wire was fastened. The object of this was to vary the position of the ball without detaching the wire. This attachment seems to be the *only* part of consequence which was without precedent.

In all these forms it is particularly to be noticed that the ball was made heavy and the suspension light and fine. Although the obvious intention of this was to attain to the

[1] Priority, in point of time, is due to Wren in this matter; but Mouton, from whom Picard got it (and perhaps also Huygens), no doubt evolved it independently, though some years later.
[2] This article was written in Calcutta, and no library there possesses the early volumes of the Paris Acad. *Memoirs*.
[3] Please to remark the absence of intelligible meaning in this. What is it that is reduced? and why?

nearest practical model of a simple pendulum, I cannot help seeing in it also an unconscious recognition that there was *resistance* to be met in the air as well as buoyancy. It is not credible that the resistance of the air to a body moving through it was not thought of, though it is intelligible that the effect of such resistance was so underrated or misunderstood as to be supposed insignificant.

Having mentioned Borda's pendulum in this connection, I will add that I do not find grounds for assenting unreservedly to the practice of assigning to him so large a share in the merit of inventing the measurable pendulum. He improved somewhat on an already existing form, and experimented with greater accuracy, if not with greater care, than his predecessors; but we must, I think, in justice associate Picard's name, and still more Graham's, with that form.[1]

About the year 1786 Whitehurst, carrying out an abortive idea of Hatton's, presented to the Royal Society, and afterwards withdrew and published independently, a paper describing experiments with a pendulum of the ball-and-wire construction, the use of which depended on a change in the length of the wire. I have not had access to the original paper, but if we may trust Saigey's account the experiments were singularly correct in their result. In all experiments with very long pendulums—indeed whatever be the length, but especially with long ones—the ultimate precision turns on the measurement of the distance between the upper and lower planes. The liability to error in such measurements is much better understood now than it was in Whitehurst's time, and it is somewhat doubtful if the correctness of his result may be accepted as an argument in favour of his method. But even if we had not ground for anticipating advantages in a method which secures, to some extent, the elimination of certain errors, the fact that Bessel adopted the same method in preference to employing either Borda's or Kater's pendulum, some forty years later, would go far to require that full recognition should be accorded to Whitehurst.

The result of the use of the single ball-and-wire pendulum, in whatever form, depends ultimately, as I have said, on the accuracy with which the distance can be measured between the point of support and the lower contact plane. The measurement, and perhaps also the distance itself, will vary with the temperature. The length of the pendulum also, and therefore its rate, will vary either with the temperature (if the suspension is by a wire) or with the dampness of the air (if by a fibre). If the temperature varies much during the time occupied by the experiment, the effects will be so complex—owing to the difference of the masses of the wire, the scale, and the support—that great precision can scarcely be expected. To some extent the uncertainties are eliminated when the experiment takes the form of a comparison between the rates of two pendulums of different lengths, but otherwise identical. In any case, however, there is an element of uncertainty peculiar to the quest of *length* distinct from that which is peculiar to the quest of *rate*.

It is not, I think, possible to form a correct conception of the progress of the research which was prosecuted by the help of the pendulum—still less to understand its present aspect—without grasping firmly the idea that the use of the absolute pendulum contemplated two distinct objects which had no essential connection, viz., the force of gravity and the figure of the earth; while the use of the differential pendulum contemplated one only of these. Of course I do not mean to imply that this distinction was not perceived; but I do suggest that no small portion of the difficulties which have attended the research are traceable to the frequent absence of a sufficient perception of the independence of the two quests. From the time of Graham, Bradley, and La Condamine, to the present day, while the ostensible main purpose, has been one, the methods have been two; and one of these was encumbered with a hardly acknowledged second purpose whose presence created a set of difficulties from which the single-minded purpose and method were free. This is so obvious, so well known, that it seems almost an impertinence to bring it forward. It is not so, however. Fully recognised and admitted as it must be allowed to be, the fact remains that notwithstanding the comparative failure of the absolute method and the acknowledged success of the differential, the tendency at this day is still to have recourse to the former, although the second purpose is now scarcely thought of as a real desideratum, the whole interest centring in variation, and variation only.

Let us consider the two objects of the absolute method separately; or rather, let us consider that one especially which is its peculiar object—the *length* of the equatorial seconds pendulum.

What is the equatorial seconds pendulum? It is a simple pendulum beating seconds under the force of gravity at, or near, the equator. We are obliged to add the qualifying words, because it is certain that the rate varies along the actual equator. It is necessary, therefore, either to specify some spot, or to define in some other way the force to be designated. How is this to be done?

As I remarked at the beginning of this paper, I do not propose to approach the question of the figure of the earth more nearly than is necessary. But it is perfectly clear that as soon as it is admitted that the form which we are to study by means of a pendulum actuated by gravity is to be expressed as a more or less complicated mathematical equation, the force of gravity enters as a principal variable. The limits and law of variation it is not necessary here to attempt to define. All that is necessary is to perceive that there will be one or more maxima at or near the equator, one or more minima at or near the pole, and as many means as we choose to invent functions expressing what may be called means.

The idea of a seconds pendulum as a definite length rests on the idea of gravity as a definite force. The idea of an equatorial seconds pendulum as a determinable length rests on the idea of equatorial gravity as a determinable force. We are therefore driven to consider in what sense, and by what means, it was, and perhaps is, supposed determinable.

Had France been an equatorial country there need be no doubt that, not Paris, but some equatorial village, would have been chosen as the site of experiment to be repeated again and again as time went on. But as this was not the case French philosophers went some thousand miles and sojourned for years in an equatorial country, in search of this stone. And in after time, when confirmation was wanted, voyagers experimenting in foreign latitudes made a point of getting as near to the equator as possible.

Gradually the idea of determining gravity *by experiment at the equator* gave place to the idea of determining it by experiment elsewhere. The summit lost its immediate attraction in the interest of perfecting a road to it. By degrees it became apparent that there was no summit, or at any rate that the summit could only be designated by a careful study of all the approaches; and lastly, that it was in fact only an idea. Only an idea, and that an undefined one.

The history of physical research is full of instances of this kind of baffled inquiry. From a distance the goal is clear, distinct, definite, precise; we can in thought put a finger on it. We approach, and the aspect changes, foreshortened distances extend, and small things become great; forms are changed, and though we penetrate into the very midst of what we ran for, we recognise it no longer. Had we run open-eyed we should have been prepared for the transformation and have realised better the success.

So it is with equatorial gravity. What was seen at a distance *was* that very idea, which, close at hand, we cannot readily define.

Some such difficulty appears to be the explanation of the vigour with which the more concrete idea of the actual force at a definite spot was grasped; and perhaps we may recognise in the almost extravagant pretensions of the London and Paris seconds pendulums a sense of retreat from, and abandonment of, the hopeless equatorial representative.

But in falling back from the equator upon Paris and London there was no abandonment of the length of the seconds pendulum as a linear standard. This came somewhat later, when the difficulties of precise determination even at one and the same spot were more apparent. Meanwhile the local lengths were retained as provisional units.

This appears to me to be the key of the position. It was anticipated that the exact relation of gravity at Paris and at

[1] On another point also, namely that of the general association of Borda's name with the invention of the method of coincidences, I am glad to find myself not alone in demurring. Legentil distinctly says that he followed Mairan in this; and Meyer alludes (1865) to the same misconception when he says: "Die von Mairan erfundene Methode der Coincidenzen, die gewöhnlich de Borda zugeschrieben wird" (*Pogg. Ann.*, cxxv. p. 182, note). The merit due to Borda in this connection would seem to be limited to his employment of a cross mark on the clock-pendulum as an object with which the thread of the free pendulum was to be in concert—just as Kater afterwards used a white disk and an opaque slip: out of which in after years arose a somewhat complicated and very differently understood question of precision.

London to gravity at the equator would eventually be known, and meanwhile a base of connection was wanted. It is perfectly true, as I have already said, that an absolute determinination is eminently satisfactory, and (theoretically) can stand by itself; but practically they rarely did so. It is perfectly true that if the length of a pendulum is actually measured and its rate observed, an independent determination is made; but practically the determination was almost always relative. The pendulum was generally not so much measured as to its actual length, whatever that might be, as adjusted to a certain length such as (very commonly) had been previously done at Paris or London. The distinction is very clear in some cases, less so in others. But, generally speaking, the determination has as good a right to be classed among the differential ones as among the absolute.

Consider the case of Graham's pendulum as used by Campbell at Jamaica. It was purposely designed to be adjusted *to the same length*. Or, again, consider Legentil's. He was constantly testing and adjusting the length by means of a *règle en fer*, and the only kind of measurement which took place was that of examining the equality from time to time of the length of his *pite* fibre.

It appears to me to be entirely beside the mark to insist that his *règle* or gauge had been compared or measured. It was used as a gauge and not as a measuring scale.

The same applies in nearly all cases. A gauge is always found to have been used, and some constant addition or subtraction made for the calculated position of the centre of oscillation.

That which gives to all the older determinations their apparently absolute character is that the result is *expressed* in linear measure. Considering the exceedingly doubtful character of the linear element so introduced, it is practically certain that the only chance of utilising any of these is to get back to the *observed rate* if possible, and to treat them all as merely differential.

Let it not be supposed that we shall lose anything by this. As things now stand, observations which were essentially differential and often good of their kind are under the cloud of doubtful reduction, caused by the endeavour to kill two birds with one stone. Experience has shown that this is barely possible even now, with vastly better means. Common sense suggests that it was vain before.

I have hitherto been speaking of the last century. The aspect changes somewhat as we enter the present one. Scarcely a trace remains of the absolute force of gravity as a real object. The idea of a linear standard is still active, but evidently doomed. What will be left as the *motive* for absolute determination, in preference to differential? I confess that I can give no answer. Anxious as I have been, and am, to learn and to understand the whole of this subject; careful as I may be to catch at every indication of an unexpressed idea latent in the mind; it is in vain that I try to find a *raison d'être* for absolute pendulum operations at the present day. It would be impossible to say this and not imply dissent from the views of those who advocate their prosecution, and I am well aware that such views *are* advocated by a section of the Continental geodesists. But I seem to be unable otherwise to find a solution. A year has elapsed since this paper was written—all but these two sentences—and I have learnt nothing to change my opinion. J. HERSCHEL

NOTE ON SOME EFFECTS PRODUCED BY THE IMMERSION OF STEEL AND IRON WIRES IN ACIDULATED WATER[1]

DURING a discussion upon a very interesting paper by our president, "On the Durability of some Iron Wire," I mentioned a fact which I had lately observed, viz., that steel or iron wires immersed for a few minutes in acidulated water containing one tenth sulphuric acid became excessively brittle. Our president has since kindly asked me to make a few more experiments on this subject, and to embody them in the form of the present note.

Upon repetition of these experiments I have found that this brittleness is no mere accidental result, due to some flaw in the steel or iron wires, but that the resulting brittleness is invariable in all kinds of steel as well as iron. Nor is the effect due to any specific proportions of sulphuric acid to the water; nor, in fact, as we shall see later, to any particular acid. The effects, however, seem confined to steel and iron; as by similar treatment I have as yet obtained no perceptible effect on copper or brass. At first I was inclined to believe that the effects were due primarily to a change in the molecular structure; but a more extended series of experiments has led me to adopt entirely the view taken by my friend Mr. W. Chandler Roberts, who predicted that the effects were most probably due to the absorption of hydrogen.

I have tested these wires in my induction balance, but can find no change whatever in its magnetic conductivity, nor any change which would be the equivalent of those produced by heat, strain, torsion, or tempering; but there are very evident results produced: if the conditions of the experiments are such as to favour the absorption of hydrogen. For instance, if we reduce the proportion of sulphuric acid to one-twentieth, we find that it requires some thirty minutes' immersion to produce the full effect, a few minutes' immersion producing no perceptible result. If now we place an amalgamated zinc plate in the same liquid, and join the two extremities, we have an ordinary battery, where hydrogen is given off on the steel wire. Now as the hydrogen produced by the decomposition of the water is much more rapid than before, we find that a few minutes' immersion produces a far more brittle wire than could be obtained by hours of simple immersion, and we have the result free from any doubt as to its being a mere surface action; for if we immerse the wire alone, surface corrosion rapidly takes place, but by simply connecting it with the zinc the steel is perfectly protected, retaining its original bright surface, for any time, as long as it is so protected.

It is not absolutely necessary that we should join the zinc in the same cell, for if we pass a current from a few cells of an external battery through two steel wires as electrodes in sulphuric acid and water we find that both wires have become brittle, though in a very different degree, the wire connected with the zinc or negative pole remaining bright, although excessively brittle, whilst the one connected with the positive pole is much corroded, and but feebly brittle, with this arrangement. I find that sulphuric acid is no longer required, but that all acids, neutral salts, and ordinary water produce an active effect, the time required being simply as the conductivity of the liquids employed. When water or most neutral salts are used, we find the negative pole quite bright, but brittle, the positive pole much corroded, but not at all changed as regards its flexibility.

I believe that these effects are due to the absorption of hydrogen when the hydrogen is in the "nascent" state, for I have obtained no results by continued immersion in carburetted hydrogen gas (ordinary lighting gas), but when plunged into a medium containing the hydrogen just freed from its combination, its effects are most remarkable: for if we immerse a wire into sulphuric acid and water, say one-twentieth, the effects are slow, requiring at least thirty minutes; but if we let fall into this water some scraps of zinc hydrogen is rapidly given out, and by now immersing the steel wire in this gaseous liquid, taking care not to touch the zinc, we find that the steel becomes rapidly brittle, whilst its surface is free from corrosion, due no doubt to the protecting surface of surrounding hydrogen.

Hydrogen seems to permeate through the entire mass, for iron rods a quarter of an inch thick were equally affected, requiring more time, or in other words, a supply of nascent hydrogen sufficient for the larger mass; and once the wire has become hydrogenised (if we may be allowed the expression), it retains it under all circumstances of time and change of surrounding atmosphere: heat alone, of all the means I have tried, has any effect; and if we heat a wire to cherry red in a spirit lamp we find that it is completely restored to its primitive flexibility in a few seconds. This same wire, however, on being immersed in the accidulated water, rapidly becomes again brittle; we may thus at will render the same wire flexible by previously heating it, or render it exceedingly brittle by favouring its absorption of hydrogen.

I have remarked that a wire immersed in sulphuric acid and water of any proportion, say one-sixteenth, becomes more electro-negative than at the first instant of plunging. If we take amalgamated zinc as the positive element, and a steel or iron rod or wire for negative, we find that there is such a remarkable similarity of electromotive force between all kinds of steel and iron that we are forced to the conclusion that we are simply testing the electro-negative qualities of hydrogenised iron; the force being with amalgamated zinc ·56.

I noted here a remarkable fact, and which does not agree with the results of many authorities. I found that as soon as the

[1] Read before the Society of Telegraph Engineers, April 14, by Prof. D. E. Hughes.

iron rod had absorbed its maximum of hydrogen (a few minutes after being short-circuited), it became a constant cell, giving but small traces of polarisation when or after being short-circuited for hours at a time. There occurs, however, a slight diminution of electromotive force after a few days' hard work, being then ·52, due to the acidulated water becoming more neutral by the formation of sulphate of zinc and iron. If, however, we wish to restore its full electromotive force, we have only to short-circuit the cell for a few seconds, torrents of hydrogen will be given off, and its electromotive force becomes, on testing of its highest value, ·56.

If we short-circuit the hydrogenised iron cell for one minute, and at once test its electromotive force, we shall find at the first instant a certain amount of polarisation, about 10 per cent., but it rapidly recovers, being at its full initial force in ten seconds' repose; whilst carbon, platinum, and all other negatives yet tried, did not recover their polarisation in several minutes' repose.

Taking the Smee battery as the best example of depolarisation in a single liquid, and comparing the constancy of this cell with that of the hydrogenised iron, I find that according to Mr. Latimer Clark's experiments, in his work on electrical measurements, that the electromotive force of a Smee cell is 1·017, but when in action only ·446. Thus its electromotive force in action is less than that of the iron cell, and its polarisation some five times greater than that of iron.

I have submitted these results (rather hastily obtained) to our president, Mr. W. H. Preece, and he has kindly consented to have some exact measurements made of the electromotive force of hydrogenised iron, and its comparative freedom from polarisation with all other metals employed as negative elements in a single liquid cell, the results of which quite agree with those obtained by myself.

A practical application of iron as a negative may be mentioned. If we wish to purify mercury from any zinc, or any metal less negative than iron, we have only to place the mercury in dilute sulphuric acid, and then introduce an iron rod so that its lower portion shall make contact with the mercury, hydrogen is now freely and constantly given off by the iron, and this continues until all traces of zinc have disappeared; and as a proof of this, if after a certain time, when no hydrogen is given off, we simply touch the mercury with zinc for an instant, the hydrogen at once reappears, and continues until this small portion of dissolved zinc has been separated from the mercury.

In order to render evident the remarkable depolarising power of iron, we use in the same cell several negatives, such as carbon, platinum, silver, copper, and iron; and if we test these negatives separately for its initial electromotive force, we shall find them all superior to iron. But if we join all the negatives together, and short-circuit the whole with the zinc, iron alone will freely give off its hydrogen, whilst carbon will appear to be entirely inert, and if after this short-circuiting we insultate or separate the different negatives, we shall find on testing them that they are all polarised, carbon being the most so, and iron comparatively quite free, and at its initial giving the highest electromotive force.

In conclusion I may add, that if hydrogen seems to be an enemy of iron and steel, rendering it brittle, on the other hand it is perhaps its best friend in rendering it more negative, and whilst under its entire influence completely preserving it from oxidation or rust.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The debated question of a Natural Science Degree will again come before Congregation on April 27. It is proposed to create a new faculty and to allow students in the Science Faculty to pass a modified form of Responsions and Moderations, in which a modern language may be substituted for Greek, but in which the mathematics required will be more advanced than at present. The following is the proposed form of statute:—

"*Of the Faculty of Natural Science.*—1. There shall be a Faculty of Natural Science, in which two degrees shall be granted, viz., the Degree of Bachelor of Natural Science and the Degree of Master of Natural Science.

"2. Any person duly matriculated wishing to proceed to a Degree in Natural Science shall be deemed to be a Scholar in the Faculty of Natural Science as well as in the Faculty of Arts."

In the Natural Science "Responsions" candidates shall offer two books, either (1) one Greek and one Latin, or (2) one Greek and one German, or (3) one Greek and one French, or (4) one Latin and one German, or (5) one Latin and one French. A special knowledge of the grammar of the languages of the books selected will be required. The candidates will also be examined in arithmetic, in plane geometry, including doctrine of similar triangles, and in algebra, including quadratics and ratio and variation.

In the Natural Science "Moderations" candidates shall offer *three* books, one being some portion of a Greek or Latin historical or philosophical work. The mathematical part of the examination will include theory and use of logarithms, trigonometry as far as the solution of plane triangles, the rudiments of plane co-ordinate geometry, and the mechanics of solid and fluid bodies treated by elementary methods.

After passing "Moderations" the student will be at liberty to enter the Natural Science School or the Mathematical School in honours.

A GRANT of 75*l*. has been made from the Worts Travelling Scholars' fund to Mr. J. E. Marr, B.A., of St. John's College, Cambridge, to enable him to travel in Norway, Sweden, and the islands of the Baltic, and collect evidence and specimens bearing upon the classification of the Cambrian and Silurian rocks, with the understanding that specimens be sent by him to the University, accompanied by reports which may hereafter be published.

THE Queen has signed the charter of the new Royal Irish University, the successor of the Queen's University. The Senate is large and fairly representative.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, April 15.—The Rev. G. Henslow in the chair.—The Secretary read a paper for the Rev. R. Boog Watson, on the Mollusca of the *Challenger* Expedition (Part 5). Some thirty-five species are described and compared, whereof the greater part are new forms and belonging to the families Solenoconchia, Trochida, Rissœllidæ, Litorinida, and Cerithiidæ. The author observes that temperature even more than mere depth seems an important condition in molluscan life, while both prove barriers to distribution, though great length of time naturally helps escape from these barriers. Where barriers of depth and temperature do not check distribution there is no limit to universality of distribution, and such is the case with certain existing species; still there is no trace of especial, lasting, and progressive change.—A communication was read by Mr. N. E. Brown on some new Aroideæ, with observations on other known forms (Part 1). Of the former the specimens are contained in the Kew Herbarium, and the latter are annotations, chiefly supplementary to Prof. Engler's recent monograph of the order. While following Engler, the author has given preference to the classification of Schott. Among others several interesting new Bornean forms are described.—Prof. F. Jeffrey Bell next read a note on an abnormal (quadriradiate) specimen of *Amblypneustes formosus*, and afterwards Mr. Chas. Stewart exhibited and made remarks on another but differently abnormal specimen of the same species.—Prof. Bell, after a full description of his specimen, observes: that with more or less reason some naturalists have looked on the possession of other than five rays as a character of some specific value among the Asteridæ and Ophiurida, and have considered that, on account of its greater rarity among the latter, it is of greater value as a mark of distinction; but such a view must be taken with considerable limitation. The pentamerous arrangement of parts in the regular Echinida is, then, only disturbed in one example; information and specimens are, however, at hand to show how this may have happened. The rarity of any divergence from this five-part division, in face of the numerous variations which occur in the Echinodermata, will doubtless become more and more important as a factor in determining the genealogical history of the group.—A series of microscopic sections of pearls exhibiting many irregularities in structural detail were shown by Dr. J. Murie, and their several peculiarities explained.—Messrs. S. H. Wintle and George Bay (of Tasmania) were elected Fellows of the Society.

Chemical Society, April 1.—H. E. Roscoe, president, in the chair.—The following papers were read:—On betorcinol and some of its derivatives, by J. Stenhouse and C. E. Groves. The authors have extracted from *Usnea barbata* an acid provisionally named barbatic acid, which is probably dimethylevernic acid; by distillation it furnishes carbonic acid and betorcinol (or Borcin). Betorcinol melts at 163° C., giving a bright crimson colour with hypochlorites: its ammoniacal solution is rapidly coloured by exposure to air. Chlorine, bromine, and nitroso compounds were prepared and examined.—Note on chemical equilibrium, by M. M. P. Muir. The object of this paper is to describe a few measurements of the variations caused in chemical changes by modifications in the conditions of these changes, and to attempt to generalise some of the conditions of chemical equilibrium, looking at the phenomena from a dynamical point of view.—Preliminary note on the action of the new diastase Eurotin on starch, by R. W. Atkinson, Professor of Chemistry at Tôkiô. The author has studied in detail the interesting manufacture of "saki," the fermented liquor from rice; he comes to the conclusion that the ferment solution "koji" converts the starch of rice not into maltose and dextrin, but into glucose and dextrin. Analyses of the "mash" are given at various stages from the first to the twenty-eighth day.—Note on the products of the combustion of coal-gas, by L. T. Wright. In opposition to the paper recently read before the Society by Mr. Ridout, the author concludes that ozone is not formed by the combustion of coal-gas, and that the substance which gives the blue colour with iodide of potassium and starch is probably nitrous acid, as when the coal-gas and air are carefully freed from ammonia no blue colour is produced.—On polysulphides of sodium, by H. C. Jones. The author establishes the existence of the pentasulphide, which is probably a tetrathiosulphate; this is probably the highest sulphide. On heating it is converted into a tetrasulphide. The precipitate produced by the addition of the pentasulphide to cadmium salts contains cadmium sulphide and sulphur.—On the reflection from copper and on the calorimetric estimation of copper by means of the reflection cuprimeter, by T. Bayley. The author has shown that the light reflected from metallic copper contains all the elements of white light, but that the region of the spectrum to the red side of the D line is more intense than in the spectrum of the reflection from a white surface of equal illumination; the light transmitted by dilute solutions of cupric salts is deficient in those rays which the spectrum of reflection has in excess. It follows that if we look at a copper surface through a sufficient thickness of cupric sulphate solution the metal appears silver white. Upon these facts the construction of the reflection cuprimeter is based.—On pyrene, by Watson Smith and G. W. Davies. Crude material from Dr. Schuchardt was purified by crystallisation from petroleum spirit. Light yellow monoclinic crystals were obtained melting at 149°, having a vapour density of 6·912, calculated 6·999.—Analyses of the ash of the wood of *Eucalyptus rostrata* and *E. globulus*, by Watson Smith.—On the action of organo-zinc compounds on quinones (second notice), by F. R. Japp. The author has succeeded in isolating the substance $C_{16}H_{14}O_2$, and has studied its more important reactions. From various considerations he concludes that Graebe's views, giving to phenanthrene quinone the formula of a peroxide, are correct.

Paris

Academy of Sciences, April 12.—M. Edm. Becquerel in the chair.—The following papers were read:—Nebulæ discovered and observed at Marseilles observatory, by M. Stephan.—On the explanation of MM. Lontin aud de Fonvielle's experiment, by M. Jamin. He traces the effect to the magnetisation of the direct current being greater than that by the inverse.—On some compounds of halogen substances, by M. Berthelot. A thermo-chemical study.—The plague in modern times: its prophylaxy defective or *nil*: its limitation spontaneous, by M. Tholozan. Like other evils whose secret is unknown, it appears at one or several points, extends, reaches its acme, then diminishes, and ceases; and this independently, to a great extent, of sanitary measures.—Disinfection of vehicles by means of anhydrous sulphurous acid, by M. Fatio. This relates to the effects of a spray of the acid in waggons containing phylloxerised roots and plants.—On cyclotomic functions, by M. Lucas.—Reply to a note of M. Boussinesq, by M. Bresse.—Studies on chronometry; compensation, by M. Rozé.—On a new dynamometric indicator, by M. Deprez. He sought a mechanism giving a diagram from motion of the pencil only, the paper being at rest; the problem was to impart to a point C a motion proportional and parallel each instant to the resultant of the motions of two other points A and B. The pantograph meets this want (where the three points are in a line). Point A is attached to the piston of the indicator, point B (which must be guided in a straight line) to the cord commanded by the piston of the engine, and the crayon is at C. The arrangement has several advantages.—On the deformation of glass tubes under strong pressures, by M. Amagat. He shows by an experiment (with mercury) that the glass or crystal tubes, nearly 1 mm. internal diameter, and 10 to 12 mm. external, which he has used in experiments on the compressibility of gases, do not sensibly increase in volume under pressures up to 400 atm.—On some new experiments of magnetic attractions, by M. Ader. Of various substances tried (wood, paper, &c.), elder-pith was most attracted by a magnet. With a Jamin magnet capable of holding 100 kg., and having two small polar armatures 0·002 m. apart, he attracted at 0·03 m. distance a suspended pith ball 0·005 m. diameter. He could raise it at a distance of 0·004 m., and, once attracted, it was held, spite of shocks given to the magnet.—On the freezing-point of alcoholic liquors, by M. Raoult. For solutions containing 0 gr. to 10 gr. alcohol in 100 gr. water, the retardation of the freezing-point resulting from addition of 1 gr. of alcohol is constant and equal to 0·377°. The lowering of the freezing-point below zero is proportional to the total weight of alcohol dissolved in a constant weight of water (whence, probably, the alcohol here exists in the anhydrous state). For solutions with 24 to 51 gr. alcohol in 100 gr. water, the retardation of the freezing-point, on adding each gramme of alcohol, is constant and equal to 0·528°. The total lowering below zero is not proportional to the total weight of alcohol (so that the dissolved body is probably a hydrate of alcohol, at least between − 10° and − 24°). M. Raoult gives a table of freezing-points of various fermented liquors; these are always lower than for equivalent mixtures of alcohol and water. The freezing-point descends as the freezing progresses.—On two new silico-titanites of soda, by M. Hautefeuille.—On the examination of pyrites by the gravivolumetric method, by M. Houzeau. The sulphur in pyrites can be determined much more quickly by this method.—On the formation of tetramethylammonium, by MM. Duvillier and Buisine.—On the natural and mydriatic alkaloids of Belladonna, Datura, Hyoscyamus, and Duboisia, by M. Ladenburg.—On the existence of ammonia in plants, by M. Pellet. Operating with the normal plant, he found in beet-leaves (dry) 0·155 gr. ammonia per cent.; beet-seed, 0·168 and 0·216 gr.; beet-root (dry), 0·196 and 0·147 gr.; corn, 0·16 gr.; ordinary linseed meal, 0·188 gr. The regular existence of ammonia in plants is important, suggesting that magnesia and phosphoric acid penetrate them in the form of ammoniaco-magnesian phosphate.—On some facts relative to the gastric digestion of fishes, by MM. Richet and Mourrut. Experiments with fishes of the genus *Scyllum* and with *Lophia piscatorius* seem to show that there are very great differences in the stomachic mucus as to richness in pepsine. The acidity of liquids in the stomach is extreme. (The authors give results of a number of comparative artificial digestions.)—Analyses of chlorophyll, by M. Rogalski. His results agree with those of M. Gautier and M. Hoppe-Seyler.—On the formation of the shell in Helix, by MM. Longe and Mer.

CONTENTS

THURSDAY, APRIL 29, 1880

GEODESY

Geodesy. By Col. A. R. Clarke, C.B., R.E., F.R.S., &c. (Oxford: Clarendon Press, 1880.)

IT is well that there are men brave with the pen as there are others brave with the surgeon's knife or the soldier's bayonet—to whose actions the word temerity can only be applied in the full consciousness that the moving force which impels them is neither vainglory nor ignorance, but a strong sense that providence or fate has placed them in a position where, and when, they, and they only, must obey that call which they feel to be the duty of the moment.

It is not often that this call is so clear to the literary and scientific ear as it has come to be in the province marked broadly on the map of knowledge as GEODESY. And certainly there are few men in England to whose ear we may believe that such a call could have been more directly addressed than to that of the author of this work. It is well, we say, that he has bravely attended to it.

The work to which Col. Clarke has set his hand and seal was one to be dreamt of rather than executed, and we doubt if the worst we could say of the finished deed would not find something more than an echo in the mind of so careful an author. For in truth the task was one of very serious difficulty; and it is in no depreciatory spirit, but quite the reverse, that we have to recognise, by their absence, the chapters—we might almost say the volumes—on various branches of the great subject which we cannot help looking for in a work bearing so broad a title as "Geodesy."

It would be difficult, if not impossible, to treat such a subject as geodesy in a manner calculated to enlighten the present generation as to the present position of the questions which it has raised, without constant reference to the stages through which it has passed. Cousin germane to astronomy, it may claim to be treated with some measure of the respect which has given rise to so many histories of that science; but geodesy can as yet boast no historian. It is a strange fact, and the reason of it is by no means so obvious as the fact is to be regretted. One immediate consequence is that a writer eminently competent to write a treatise on theoretical and practical geodesy is debarred from doing so without the *arrière pensée* of a neglected history—in which department he labours under an obvious pressure of other demands. Thus the first chapter of the work before us reminds one of the explanations which are given to a visitor to some manufactory, who comes out at the end of a series of workshops with a general sense of having had glimpses of interesting work, and a recollection of words having a scarcely understood connection with the processes witnessed; but quite certain, if he paid the same visit a hundred times in the same hurried manner, that he could not understand the manufacture well. There are many points in this first chapter which are either historically inaccurate or so collocated as, while capable perhaps of correct interpretation, to suggest to a mind previously unread more or less erroneous conceptions. It is needless to give instances; for besides that they would but concentrate a needless criticism on points of detail, it is evident that a full account of geodetical operations during two centuries and a half cannot be given in a chapter of thirty-six octavo pages, a very considerable portion of which is taken up with tables, diagrams, mathematical explanations, and numerical examples.

Remarking here, as elsewhere throughout the volume, the author's neglect of the opportunities which are afforded, in the course of a relation of facts, to explain causes of failure, to comment on erroneous and vitiating opinions, as well as to commend those which have borne the test of later experience; in a word, to take upon him the burden of judging wherein lay the foundations of what may now be recognised as sound principle—remarking this abstinence, we are the more pleased to notice and to give some slight additional currency to an exception, which finds expression in at least three places in different parts of the work. It is a condemnation of systems of observation which do not aim at "the 'bugbear' constant error, which is, or should be, the first and last anxiety of every observer." It will be long before a rule, which has all the appearance of courting error rather than truth, will be so generally recognised as to need no "bushing." Meanwhile let it stand forth:—

Presume the existence of a constant effect as the natural concomitant of constant conditions, and if such effect is not itself the object of inquiry, destroy it by opposing conditions, or baffle it by varying them.

At the same time let it be noted that in very many kinds of physical observation, that which is sought depends directly on a *difference* of results, and where this is the case constant errors require to be regarded in a very different light. Geodesy is full of such cases, and one of the most important is to be found in the use of the differential pendulum, where maintenance of condition is the *sine quâ non* of exact result.

The work before us consists of fourteen chapters, each of which is devoted to one particular branch of the subject; and these, on the whole, form a tolerably connected chain of narrative, argument, theory, explanation and illustration, calculation, and discussion of result. Considered as a work on geodesy, it is noteworthy that the last chapter but one (Chapter XIII.) discusses the Figure of the Earth, while the last is devoted, self-contained, to the theory, practice, and results of observation with pendulums. The inference to be drawn from this division is that whatever is to be gathered regarding the earth's form from pendulums is outside of the region of geodesy. So far is this from being our own view, that we would rather have seen this relegated chapter occupying its legitimate historical place as at least the second if not the first in the book. As such it shall be dealt with here.

The mathematics of this part of the subject are very brief and to the point. None of the numerous difficulties are even mentioned here which have at one time or another cropped up, and upon which pages innumerable have been written, printed, and published—to wonderfully little purpose, so far as the practical accuracy of pendulum observations is concerned, but not, perhaps, altogether without influence on collateral physical inquiries. The history of pendulum observations is also very briefly dismissed, with less inaccuracy than commonly falls to its lot. The "invariable" pendulum is of course described as Kater's, and the ball and wire as Borda's, the opportunity being once more lost of assigning both to their proper epoch, viz., 1735. The method of coincidences is described, but without correcting the common misapprehension of it as a modern improvement, while the introduction of the lens, by means of which Bessel separated the experimental from the clock pendulum by several feet, without impairing but rather facilitating the exact observance of coincidence, is not noticed. In selecting the data with which the recent Russian and Indian observations are to be combined for a new evaluation of the ellipticity, the materials are taken direct from Baily's table, which is open, to say the least, to considerable objection on several grounds. The absolute determinations, both those anterior to Baily's time and those of more recent data, are all tacitly excluded. Granting that this exclusion is not unreasonable, it is impossible not to feel surprise that the existence even of the enormous body of work which is thus passed *sub silentio* is not even mentioned. The recently recognised fact that most, if not all, the modern absolute determinations with the reversion-pendulum are vitiated to a sensible but unknown extent, which can at best be approximately estimated, is noticed, and might have been given as a reason for deferring their use as available data. As it is, we must reckon the estimation in which they are held from their non-appearance here. The same may be said, *mutatis mutandis*, about the older ones, which are without exception impaired, and as yet unavailable on account of the want of the reduction for air-resistance.

We have scarcely approached as yet the subject of this most valuable volume, and already a considerable portion of our available space has been swallowed up. It is in fact as impossible to give a full account of what the author has compressed into its 350 closely-printed octavo pages as it probably seemed to him to give a full and fair account of the enormous amount of work which has been done in all the many countries where surveys have been and are being carried on. Indeed, as of the history so of the present aspect of geodesy, we may say that it is scarcely more than touched on. Whatever is said of the various survey operations in different parts of the world is introduced in the course of description of methods of observing and of reducing, and by way of acknowledgment of sources and of data, or for the sake of illustration. The book does not pretend to give a digest of geodetical operations so much as to declare broadly, and of course in certain respects particularly, what does and what should constitute geodetical practice and theory.

In reviewing, it is above all things necessary to remember that an author has an indefeasible right to frame, arrange, and treat his subject and material as he pleases. But on the other hand the reader has an equal right to be pleased or displeased with the result, and to say in what respects. When, as in the present case, it happens that a very extensive field and a very difficult subject has remained unappropriated by any competent writer for half a century, and is then claimed by a writer who has been before the world as an authority in that connection, his work almost inevitably takes a place which may be said to await it, irrespective of its actual merit. In such a case an undeniable responsibility attaches to the author, and a no less clear onus lies on the reviewer—on the one hand to fall into no errors through carelessness; and on the other to judge fearlessly, rather than add unnecessarily to authority, which already has so much in its favour. If the one is a difficult task, the other is an ungracious one at best.

Passing on now to what is the real body of this work, we find Chapter II. devoted to "Spherical Trigonometry" and Chapter III. to "Least Squares." With regard to these we appeal to what has been said above about the rights of an author and the duty of a reviewer. They are pure mathematics, and we admire them honestly, as deft and elegant condensations of the principal requirements of a geodesist; but not without a sigh, as the truth dawns upon us that this is but the threshold to mathematical labyrinths, of which no plan is furnished, and in which, therefore, we run a fair chance of failing to find the broad paths to which all must keep who would be in accord and who would work together. And in effect in the next chapter we take the desperate plunge into the theory of the figure of the earth, with the method of potentials as our only guide. It is in vain to resist, but, like Christian in the Slough of Despond, we struggle through, with the burden of numberless volumes of National Surveys and Geodetical Operations on our back; and if haply thereafter we meet with a Mr. Worldly Wiseman, surely we will listen to his counsel, and endeavour to find rest without undergoing further like perils.

Towards the close of this chapter we come upon notices of the discussion of twenty years ago as to the possibility of explaining anomalous surface attractions, or the absence of them, by different suppositions as to submontane density. It would be idle to add here a single word to that discussion—not because it has been in any sense closed, so much as because there is room for almost any quantity or kind of fresh assumptions, and because we are unable to see how any decisive result can be reached where all the assumptions are contestable—as for instance that the solid crust is lighter than the plastic nucleus upon which it is supposed to float.

Perhaps the most remarkable result reached in the course of this chapter is the following:—As an example the disturbance of the sea-level is calculated which would be caused by a sphere of matter of surface density one mile in diameter, situated at or near the surface. The calculated amount is found to be only 2 inches; but small as this is, it is further shown that the maximum deflection of the normal to the protuberance thus caused would be 5″ at a distance rather less than 2,000 feet from the summit, or a relative deflection of 10″ between the two points 4,000 feet apart. There can be no manner of doubt that the sea-level surface is not of the same form as would be the case if the mountains were cast into the sea; and if we call the difference "disturbance" of form, then the extent to which the irregularities of form, of whose existence we have abundant proof, is explicable or not explicable by such disturbance is a legitimate part of geodetical study. At the same time, to some it may be a question whether the term geodesy ought not to be understood to consist of the means and methods by which the earth's form and size are discoverable, whatever these may actually be, rather than a general name for all and any studies of the causes or explanations of that form.

Chapters V. and VI. deal with the "Distances, Azimuths, and Triangles on a Spheroid," and with the difficult subject of "Geodetic Lines." By a spheroid is here meant an ellipsoid of revolution of small ellipticity. As, in the sequel, a figure will be sought for which shall, in some respects and for certain limited purposes, serve as a FIGURE OF REFERENCE more closely than any ellipsoid, it may be objected that the term "spheroid," which includes all such *quasi*-spherical forms, should be here qualified by the descriptive adjective "elliptic." And—though it has little to do with these chapters—we may here too remark that the necessity of casting calculations of triangulation into practical forms is the real reason why such non-elliptic spheroids are, and probably must ever remain, unavailable as Figures of Reference on which Trigonometrical Survey calculations can be based. Perhaps all that can be done in that direction is to vary the elliptic spheroid so as to suit the local curvature of special areas of triangulation. But this is anticipating.

The next two chapters are on the "Measurement of Base Lines" and on "Instruments and Observing." Something is said in the earlier about standards. We would gladly have seen a great deal more. Col. Clarke seems often to avoid purposely telling us anything of the origin and meaning of things, and doubtless he would reply to such a stricture that it formed no part of his design. But while bowing to that, one cannot but wish that he had devoted a few pages to giving a concise review of the antecedents of the national standards now in recognised existence. It cannot be that he does not know it all, more thoroughly, perhaps, than any other living person except Sir George Airy. It must be that he is unconscious of the sense of impotent ignorance which so many feel and lament. We know that the Toise, which is now the national standard of Germany, has its prototype in the Toise which Godin copied at the Châtelet, and that the prototype of the Metre bears a definite relation to Godin's—or la Condamine's, as it is often called, because la Condamine procured its recognition as a standard; but what do we know of the Austrian Klafter? and alas, what do we common English folk know of our own yard? Is there not in existence an Act of Parliament defining it in terms of the seconds pendulum? May we affirm that the defining clause was only provisional, and that the whole Act has been repealed? Is it true that our yard is a real entity lying at Westminster; and that there is no other *so* real and actual a standard having a tangible existence? All this we believe—but of what value is such a belief on the part of an unknown reviewer? It is true that Col. Clarke does not leave us wholly in the dark. "The standard yard of this country and its copies," he says, "are bars, an inch square in section, of iron, steel, brass, or copper." There are, we believe, one Standard, five Parliamentary Copies, and some sixty to eighty Secondary Copies—a large number of which are of *bronze*.

In this, as in so many other parts of his subject, Col. Clarke has entirely failed to appreciate the relative worth of information. He is full to overflowing of the knowledge that we want, but there is a part of it which he gives us—not grudgingly we may be sure—but hastily, sparingly, and almost apologetically, as who should say—this we all know; excuse my alluding to it. But in fact all these common things—things of which the want is common to us all—are *not* familiar; we do *not* know them; we find the greatest difficulty in learning about them; and our common knowledge is lamentably defective through the want of them. We hope earnestly that Col. Clarke will recognise this and meet the want in future editions—for that there will be future editions of such a work as this is as certain as that the vast areas being year by year colonised and brought under civilised management will likewise be brought under theodolite and chain in due course. It is with a view to this inevitable extension of surveying operations that we desire so anxiously to see the broader principles of geodesy established on a basis of economy and utility very different from those which have regulated the surveys of older lands.

The chapter on Instruments and Observing is embellished with several excellent representations of theodolites, zenith telescopes, and transit instruments. Though necessarily scarcely more than glancing at the numberless details more or less familiar to the practical surveyor and astronomical observer, it runs through the subject skilfully. We could wish that more were said about the American methods, and we miss at least a notice of the superb alt-azimuth designed by the late Col. Strange—which has never seen service—and his far more successful zenith-sectors, which have both established a reputation second to none. But we are quite aware that nothing less than a series of volumes could do justice to this branch of the subject.

Astronomical observations for the determination of latitude constitute the most important part of the work of a geodetical survey next to those for the determination of distance. These observations consist practically—where a sector is used—in determining the zenith distances of numerous stars. And since these concur to give at any one station but one co-latitude, it follows that they afford a test of the correctness of the N.P. Distances of the stars employed, to each of which is assignable an apparent error, as one of the results of the combination. Where a single station of observation alone is under consideration these apparent errors are rightly enough attributable rather to observation and graduation than to place. But where the same star is thus tested again and again under different latitudes the accordance or approximate constancy of such apparent error can have no rational explanation in any other source than in erroneous N.P.D. This is a practical result which is far from being hypothetical; and we have often thought that neglect to utilise latitude observations in this way with a view to perfect the astronomical place is a waste of material which is well worth attention. The examination here suggested may be readily put to the test of trial by any one who has access to a considerable body of published results of such observations; and if due attention is paid to the identity of the star's place employed at different stations, we can afford to prophesy with confidence that in many cases there will be found sufficient evidence to condemn—and therefore to rectify—the places used.

So much remains to be said in connection with the final chapters that we must abstain from commenting on the next in order—Chapter IX., on the "Calculation of Triangulation," and Chapter X., on "Heights of

Stations," interesting and suggestive as they both are. Few will care to master the former who have not either the misfortune to have a mass of triangulation on hand awaiting reduction, or the luck to have nearly done with one and the curiosity to see whether it is yet open to them to modify their plans. To such as are in the former predicament we may say with the most entire confidence that they will find no safer guide.

In this chapter we remark a short notice of the recent completion of the connection between the Spanish and Algerian triangulations, by a quadrilateral figure whose longer sides, spanning the great inland sea, are 170 miles in length, the longest, we believe, on which luminous signals have been observed. "Thus," remarks Col. Clarke, "a continuous triangulation now extends from Shetland into Africa."

The subject of terrestrial refraction receives ample attention in the chapter on Heights of Stations. We remark as noteworthy that a distinction is found to be necessary between the factor for rays crossing land and those crossing sea. We must here also notice one of the very few errors in the book. On p. 281 "the average amount of refraction" is said to vary from $\frac{1}{12}$th to $\frac{1}{16}$th of the arc between the stations. What is meant is no doubt the average amount of *minimum* refraction.

Our task would now be completed by an impartial review of the remaining two chapters on the "Connection of Geodetic and Astronomical Operations" and on the "Figure of the Earth." Unhappily our attitude in presence of these chapters is a prejudiced, though certainly not a hostile, one. We have regarded the earth, mentally, for so many years as an irregular spheroid, and all ellipsoids or other mathematically simple figures as mere conveniences that we cannot bring to bear upon the exact determination of any particular one of these that intense curiosity which is necessary to sustain one in the search for "the most probable." Under these circumstances it seems both wiser and more courteous not to contend against views whose only demerit is that we do not sympathise with them, but rather to confess dissent and to offer some considerations from a different point of view.

That the sea-level surface of the earth—by many called, for reasons not very clear, the mathematical surface—is an irregular spheroid, no one nowadays will dispute. Neither is it any longer open to question that an elliptic spheroid of revolution, whose compression at the poles is (say) $\frac{1}{290}$th, is *very like* that irregular spheroid. Let us regard these two things as distinct. We may speak of them as the Earth, and the Form. And we may recognise that the latter is provisional, in the sense of being liable to modification if expedient. If, so prepared, the question be propounded, What is the object of geodesy? the answer must surely be on all hands, to determine the Figure of the Earth, by reference to the Form. *By reference to*, not by confusion with, or by means of, still less by *moulding* the Form until it has ceased to be an elliptic spheroid, and has become, if possible, identical in contour with the actual Earth. The Earth remains the Earth, and the Form remains the Form; and Geodesy aims at determining the want of exact conformity between the two. This is the first consideration.

The next is, How can this be done? The answer clearly is, In the first place it cannot be done at all for the *whole* Earth, by any means at present known; but it can be done *partially* in two ways, viz., by the pendulum, wherever there is *terra firma;* and by surveying instruments where this *terra firma* has ample extension; and, in the next place, it can be done by such and such employment of these implements.

Now it seems to us that it is for the proper comprehension of the scope and bearing of this last instruction that light is needed to be thrown by those who are competent. The interest aroused by pendulum operations, for instance, is almost painfully unintelligent, if we compare the simplicity of the fundamental ideas necessary for its comprehension with the obscurity which has throughout characterised the practical development of those ideas. And though there has been no analogous obscurity in the practical development of the other method, it is not the less true that a shadow of another kind has been cast by something like a misdirection. We cannot study the history of this branch of geodesy without recognising that attention has been constantly directed, not upon the Earth, but upon the Form. The whole power of analysis and of calculation has been devoted to perfecting and to designing a "more probable" form, and to showing that on certain conditions (which the earth, if it were only moderately amenable to reason, would recognise the justice of) the form so designed comes very near indeed to what the earth *should be*. What is the inevitable verdict which results from a charge of this description? WE FIND THAT THE MEAN FIGURE OF THE EARTH IS A SPHEROID WHOSE AXES ARE IN THE PROPORTION OF ABOUT 292 : 293. The finding is brief enough, truly; but is it in accordance with the evidence? Surely, yes! for that word "mean" will cover whatever we like to put under it. But it is none the less an unsatisfactory verdict. Let it be remembered that the accuracy insisted on in trigonometrical surveying operations and reductions is far greater than is required for fiscal, commercial, or what are commonly called practical purposes. The object of this exceeding accuracy is geodetical. Thus, for instance, no one would dream of surveying a small isolated island with such accuracy. A great part of the cost of a continental survey, therefore, has to be reckoned as sunk for the sake of ultimately learning more about the exact shape of the earth than we could at present see any direct utility in. But as yet we have got very little further than a positive certainty that that shape is irregular. As surveys extend and get connected with each other, some better return for the labour expended is demanded. The geodesist begins to think of phrenology, and to speculate whether he can yet venture to map out the earth's bumps as he has already mapped out land and sea. He learns to regard what were looked on as local disturbances of the plumb-line as the means to that end. He sees in them no longer mere *errors*, to be herded by the theory of probabilities, but distinct indications of that which he has to work out.

And if, meanwhile, despairing of obtaining, by the slow and grievously costly processes of land measurement, data enough for such a purpose, his eyes should be opened to the practical facility of obtaining such, *ad libitum*, by means of the pendulum; he may well be pardoned if he turns somewhat impatiently away from the former, and demands that reason shall be shown for not diverting to the service of the latter at least a large share of attention.

Remembering that measurement of arcs and elaborate study of the earth's irregularities by the plumb-line never can extend much beyond the continents and larger islands, and never will extend far in advance of civilisation; while pendulums can, and assuredly will some day, form part of the equipment of every scientific exploring party, it does seem passing strange that we should still be discussing the ratio of the axes of a convenient figure of reference (p. 287) as a more important question than the actual nonconformity of the earth to *some* approximate figure of known form.

What we would fain see, as the *geodetical* fruit of first-class surveys—if not done, then attempted; and if not even attempted, then at least inculcated as to be done or attempted—is, a comparison of the earth's surface, as actually measured, with some provisionally adopted form, showing where possible the relative position of the actual zenith, as determined by astronomical observations, with respect to the formal zenith. And then, a discussion of such results, showing, either a traceable continuity of the irregularities of the actual surface, if such exists; or evidence of discontinuity such as to justify a presumption that the irregularities are too small in area to be susceptible of study without closer distribution of stations.

Thus we might haply arrive at one of two conclusions—that large irregularities exist which may be mapped, or that the irregularities are such as to demand special investigation by a recurrence to observation in selected localities.

If to this suggestion it is objected that the thing has been done—and we know that the irregularity in the neighbourhood of Moscow has been investigated in some such way—we reply that, even so, a short paragraph noticing the fact (p. 288) is but a meagre presentation of what seems to us one of the principal results of methodic geodesy.

And now that we have done and have to lay down the pen, it is with a feeling of regret and a sense of incompleteness. The book deserves so much better than we have said of it. We have identified ourselves too entirely with the student looking for special instruction and too little with the author giving the best he had, and have quarrelled with him because it was too good for our needs. Once more be it said that the subject is too large for a single work—it needs a series. It is but the absence of a few apologetic words that has given this sense of a subject approached at many points only as it seems to be immediately quitted, in favour of others which have more attraction to the author. Now that he has dwelt on them, may he resume his task, and enlarge where we have shown the need.

J. HERSCHEL

OUR BOOK SHELF

The Fauna of Scotland, with Special Reference to Clydesdale and the Western District—Mammalia. By E. R. Alston, F.L.S. (Glasgow: The Natural History Society of Glasgow.)

THE Natural History Society of Glasgow, having resolved to publish a catalogue of the fauna of the western district of Scotland, have secured the co-operation of Messrs. Alston, Young, Cameron, Robertson, Binnie, and Lumsden. Already one part of the catalogue of the Crustacea and one part of the catalogue of the Hymenoptera have been issued, and these have now been followed by the present part, treating of the Mammalia. The Society is doing a good work, and will be fortunate if all the parts as published come up to the standard of the one now before us. In the nomenclature of the Mammals, of which fifty-one are recorded, the author endeavours to reconcile the spirit and the letter of our British Association rules. Without entering into any details of description or economy, he has carefully worked out the geographical distribution of each species. A very interesting list is given of extinct and recent Scottish Mammals, arranged in the probable order of their arrival from the southward.

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.*]

Auroral Response in America

WHEN the full burst of auroral displays is upon us, and one brilliant demonstration treads close on the heels of another, there may be some trouble in ascertaining which corresponds to which on opposite sides of the earth. But the opening of the new cycle-season by the arc which I described in your pages on March 17, has proved so isolated a phenomenon in time, that it cannot be confounded with any other either before or since. And while your subsequent notice of the disturbance of the magnets at the Royal Observatory, Greenwich, on the same night, proved that the aurora seen in Edinburgh was an earth-ball phenomenon, and not a mere local atmospheric glimmer, the following letter, which has just reached me from Canada, shows a remarkable correspondence to have prevailed there.

The letter, written to me by Lieut.-Col. G. E. Bulger, late 10th (North Lincoln) Regiment, from Montreal on April 10, is word for word simply thus:—

"I have noticed your account (NATURE, vol. xxi. p. 492) of the aurora seen in Edinburgh on the 17th ult.; and it has occurred to me that it might interest you to hear of a similar display which I observed at this place on the same date. Your description would apply very well to the one witnessed here, excepting that the arch was higher in the sky, and its centre about N.E. The darkness below the light was very marked, although the moon was shining brightly at the time. Auroras have been singularly rare here this year, and that referred to is the only one I have seen or heard of since my arrival in August last. The weather on March 17 was bright and fine, with detached clouds, and a light N.W. breeze. The barometer (aneroid) at 9 p.m. was 30·36, therm. 14°·7."

Thus far Col. Bulger; and now we have only to wait the arrival of Australian meteorological reports to ascertain whether south responded to north, as well as west to east, on the occasion of that remarkably isolated auroral display, abundantly observable, yet observed by so very few persons, in this country on March 17 last.

PIAZZI SMYTH

15, Royal Terrace, Edinburgh, April 26

The Antiquity of Oceanic Basins

I AM much obliged to my friend Prof. Alex. Agassiz for reminding me that his distinguished father, when reporting on the deep-sea dredgings carried on by the United States Coast Survey in 1866–68, explicitly endorsed the views previously put forth by Prof. Dana (to whom, however, he made no reference) as to the geological antiquity of the American Continent and the probable determination of the general outlines of the present Continental elevations and Oceanic depressions at the very beginning of the formation of inequalities upon the Earth's surface.

Prof. Alex. Agassiz must have strangely misread that paragraph in my lecture in which I refer to the two deepest soundings of the *Tuscarora* if he supposes that I intended to cast any doubt upon their trustworthiness as indicating "depths considerably exceeding 4,000 fathoms." In the Official Report, now before me, these two soundings are thus recorded :—

"No. 15: 4,643 fathoms. No specimen (of bottom). Wire broke. Bottom not reached.

"No. 33: 4,655 fathoms. No specimen. Wire broke."

As there is no mention in the second case of the wire having broken in reeling-in (which is stated in several other cases), and as the length of wire run out corresponded almost exactly with that run out in the first, it was not unnatural that I should suppose that the wire broke by its own weight without reaching bottom. But I expressly cited these two soundings, incomplete though they were (no specimen of bottom having been brought up), as evidence in support of my case that those "gigantic pit-holes," in which extraordinary depths have been encountered, occur in regions of great Volcanic activity.

56, Regent's Park Road, N.W., April 27 — WILLIAM B. CARPENTER

Seeing by Electricity

WITH respect to the letter of Messrs. Ayrton and Perry (NATURE, vol. xxi. p. 589), in which they propose to utilise for this purpose Dr. Kerr's discovery of the rotation of the plane of polarisation of light reflected from the pole of a magnet, will you allow me to give you some details of a repetition of Dr. Kerr's experiment which I made a year or two ago.

I used an electromagnet consisting of an iron bar 2 feet 4 inches long and 2¼ inches diameter, surrounded by 70 lbs. of wire, and excited by ten Grove cells.

The total *double* rotation produced, not by slightly altering the resistance, but by reversing the current, was never more than 26′ (twenty-six minutes of arc).

To see this at all with a very delicate Jellett analyser, it was necessary for the observer to increase the sensitiveness of his eye by sitting in total darkness for some ten minutes before each observation.

Your readers can judge what chance of obtaining visible changes of illumination there would be with "little" magnets and mere variations in a current not powerful enough to fuse a selenium resistance. J. E. H. GORDON

32, Elvaston Place, Queen's Gate, S.W., April 22

Ophiolepis mirabilis

THE statement concerning Prof. Martin Duncan's *Ophiolepis mirabilis* contained in the review of Prof. Lyman's account of the *Challenger* Ophiurans was not intended to represent an expression of opinion of the Reviewer upon the matter, but simply the conclusions of Prof. Lyman as expressed in the memoir under review. The matter was not cited as a question of mistake, but of difference of opinion between two experts. Prof. Lyman enters, in the memoir referred to, at some length into his reasons for considering Prof. Duncan's species, as described, to be a true Ophiopholis. This latter genus Prof. Lyman thinks quite remote from Ophiolepis, in spite of the evidence adduced by Prof. Duncan. I am sorry that I did not make it clear that I was citing Prof. Lyman's opinion and not expressing any judgment of my own. THE REVIEWER IN QUESTION

The Ômori Shell-Heaps

DESIRING as much as possible to save space and avoid rhetoric, I shall be content to reply to the pith of Prof. Morse's amusing diatribe contained in NATURE, vol. xxi. p. 501, principally by citing extracts from a recent paper on Prehistoric Remains in Japan, read by Prof. Milne before the Asiatic Society of Japan, and printed, together with a report of the discussion it gave rise to, in their *Transactions*, published in February last, which I received about a fortnight ago.

The main object of my note in NATURE, vol. xxi. p. 350, was to show that the antiquity claimed by Prof. Morse for the Ômori mounds was not warranted by the facts. In this view I am supported by Prof. Milne, Dr. Faulds, and Mr. Aston, whose united authority I venture to prefer to that of the Salem zoologist.

Prof. Milne examined a number of shell-mounds in various parts of Japan, both in Yezo, where the Aino race still flourishes, and in the main island, including the Ômori heaps, but he does not mention having met with any human remains in any of them. Adverting to Prof. Morse's conclusions from his examination of the Ômori shells, which may be briefly presented thus:—

That changes have taken place in the relative abundance, size, and proportions of certain species and in the extinction of certain species,

Prof. Milne quotes from the Memoir: "The modification in the relative size, &c., is profound, and seems to indicate" either a shorter period of species-variation than is commonly admitted, "or else that the deposits presenting these peculiarities have a much higher antiquity than had before been accorded them." Prof. Milne (but then he is merely a "Briton in Japan," and *quâ* such disposed, doubtless, in the eyes of Prof. Morse, to sneer at everything Japanese, shell-mounds included) is inclined to think these modifications "in great measure due to the great changes which have been taking place in Yedo Bay *during recent times*." The italics are Prof. Milne's. ". . . The bay is rapidly silting up. . . during the last 800 years large cities have sprung up round its shores, all of which have added something to destroy the purity of its shallower waters. All these causes combined are and have been making changes in physical conditions, and with them we should naturally expect a rapid change in the faunæ which are dependent on them." Further on a map is given showing the ancient coast lines at and near Yedo, and proving the magnitude and rapidity of the various successive encroachments of the shores upon the waters of the bay.

Again, "The conclusion to which I am led with regard to the shell-heaps is that they are of Aino origin . . . the positions which these shell-heaps occupy are on spots which we know . . . were once tenanted by Ainos, and even down to the end of the twelfth century Ainos were living in Nipon." By Nipon is meant, I presume, the main island. I may add that I have often heard from Japanese of Aino colonies still existing in the north-eastern districts of the main island, but not distinguishable by language, or customs, or otherwise than physically from their Japanese neighbours. The average advancement of the land at and near Yedo, Prof. Milne states as varying from 38 feet to 2 feet per annum, which would account for the present distance of the Ômori heap from the shore being attained in from something under 100 to something over 1,000 years. Mr. Aston, in the course of the discussion which followed the reading of Prof. Milne's paper—I quote from the report in the *Transactions*—"was glad to observe a tendency to diminish the antiquity which had been earlier assigned to these remains (from Ômori) by some of the writers on the subject. Civilisation in Japan is a product of much more recent growth than in Europe, and we do not require to go so far back in order to meet with tokens of a primitive degree of advancement." Mr. Aston then showed that in the middle of the eighth century a large portion of the main island was exclusively Aino. Dr. Faulds assigned "600 years as the probable antiquity of the Ômori heap," and Prof. Milne in reply said that the rise of land variously evidenced round Yedo Bay, "taken in conjunction with the vast deposits of silt which are brought down by the various large rivers which flow into the bay, would make the changes in coast-line exceedingly rapid."

With regard to the pottery of the Ômori heaps, Prof. Milne says: "The designs are in very many instances similar to the designs which are carved by the Ainos of the present day." On this point Dr. Faulds's testimony is more emphatic. "The 'mat' impressions figured by Prof. Morse in Plate V. Fig. 1, are to be found repeated in the most recent pottery;" the types of pottery in the shell-heaps did not seem "to be separated by any one well-marked character from contemporary pottery of a low grade. The shell-heaps scattered along the old and recent coasts of Yedo Bay presented in their fragments of pottery a series of modifications leading up to recent times, and some of the heaps may be seen in actual process of accumulation." Further, Mr. Ninagawa of the Tokio Museum, the principal authority on the subject of Japanese pottery, decides that the "remains . . . cannot be older than 1,000 years." Dr. Faulds showed some coarse pottery of the day not dissimilar to that of the shell-heaps, and was not even prepared "to accept finally the belief that the Ainos were the founders of these heaps."

From personal investigation of many remains of shell-heaps on the coast-line and inland between Yedo and Yokosuka, I can corroborate Dr. Faulds's statement. I do, however, believe that the heaps at Ômori were the handiwork of Ainos, very possibly after they had come into contact with the Japanese, though some of the other heaps I have seen were undoubtedly raised by the Japanese themselves; in a few cases they appeared of quite recent accumulation.

Great stress is laid by Prof. Morse upon the platycnemic tibiæ found in the heap. But platycnemic tibiæ, as Prof. Milne well points out, are characteristic of the Aino race, and, I believe, though I cannot put my hand upon my authority, of other low-type existing peoples.

The "extraordinary blunder" the usual "Japanese gentleman" has with patriotic promptness reproved me for making I cannot notice, for I have not hitherto seen any statement or correction of it. But in saying that the eastern portion of the main island was probably peopled by an Aino race up to the fourteenth or fifteenth centuries, and in asserting that Yedo was not founded until the close of the sixteenth century, I was not strictly accurate. The most valuable information to be extracted from native works is to be got at by reading between the lines, and, following this system, I have for my own part arrived at the conclusion that, up to the thirteenth or fourteenth centuries at all events, the country east of the Rokugo River was peopled by a mixed Aino and Japanese race, whom I believe to have been the builders of the mounds. Ôta Dôkuwan erected a stronghold upon the site of the present castle of Yedo about the middle of the fifteenth century, but the *Yedo Meisho* (cited by Mr. McClatchie, in his paper on the Castle of Yedo, *Tr. Asiat. Soc.* Japan, vol. vi. part 1) tells us that up to the end of the sixteenth century it "was merely a small fortification" overlooking, doubtless, an inconsiderable town consisting of a mere aggregation of villages. Iyeyasu made it his capital about 1590, and gave to the city the apt name of Yedo, or Door of the Rivers. What Prof. Morse means by charging me and "so many of" my "countrymen" with "the wilful blunder of calling the principal city of the empire by its wrong name" I cannot imagine. Does he find in the practice some covert "sneer" at things Japanese on the part of the "ordinary Briton"? Then is the "extraordinary American," who sheds upon Salem its due supply of zoological light, guilty of the same offence, for in his memoir he talks of "the bay of Yedo," "maps of Yedo," &c. The fact is the expression "Tôkiô," invented by the successful party after the Revolution of 1868, would have been unrecognisable by many readers of NATURE. Again, Yedo is a Japanese word, and *is* the name of the city; Tôkiô is a mispronounced Chinese compound, meaning "eastern capital," and is, properly, a mere official designation. So under the Shôguns Yedo was often called by various Chinese styles, but never lost its name of Yedo.

My belief that the mounds were swept away was founded upon a statement to that effect I saw in a Japanese newspaper since leaving Japan, after many years continuous residence, in January, 1879. But whether my belief was right or wrong, I fail to understand how its expression could raise such ire in Salem. I sincerely trust that my inadvertence in not recognising the last plate of the memoir as a copper one will be forgiven.

Lastly, Prof. Morse complains of my review, as he terms my brief note on his memoir, being written in some "spirit" which he does not "now heed." This is deplorable, for it was written simply in the "spirit" of truth.

The question of cannibalism is discussed in Prof. Milne's paper in a most interesting manner. I would gladly give a *résumé* of his remarks on this portion of the subject, and answer some points I have left unnoticed both in the memoir and Prof. Morse's letter, but I fear that I have already trespassed terribly upon your space.

F. V. DICKINS

Arts Club, April, 1880

The Destruction of Insect Pests by Application of Yeast

THE article on the destruction of insect pests, &c., in NATURE, vol. xxi. p. 447, by Mr. E. R. Lankester, contains statements upon which I beg to make some remarks:—

"Prof. Hagen has called attention to the old practice of destroying greenhouse pests by the application of yeast."

It is very interesting to me to hear that this is an old practice. I had never known it, and would be glad to receive any notice where it is published. In the many letters which I received since the publication of my pamphlet, nobody has mentioned that the use of yeast against greenhouse pests is a well-known remedy. Mr. Hovey, for fifty years the editor of the *Magazine of Horticulture*, assured me that he never heard of it. After it was suggested by me last year, the application of yeast has proved to be successful against Aphides.

"He imagines that the yeast-fungus enters the body of the insect on which it is sprinkled, and there produces a growth which is fatal to the insect-life."

For the experiment with potato-bugs, published in my paper, 100 beetles collected the same day and in the same place were divided into two parcels, and both kept in the same room. One parcel was sprinkled on three or four successive days, and most of those beetles died on the eighth day, the last one on the twelfth day. Of the other parcel all but three were alive and bright six weeks later, and more than 50 per cent. lived through the whole winter. I found in the dead ones, which had been sprinkled with diluted yeast, in the large sinus of the wings, spores of a fungus in quantity. The spores resembled those figured by Dr. M. Reess,[1] Plate I., Fig. 15, *ed*, and were so numerous and so distinct that I could not have been deceived, the more as I am familiar with the anatomy of insects and with the blood-fluid and its contents. Not having studied, myself, fungi, I can only state that, after the beetles having died in a manner which showed manifestly an infection, I discovered cells in the blood-fluid which certainly are not to be found in the blood-fluid of unpoisoned insects, and which are similar to the figured ones.

It is a fact corroborated lately by Mr. A. Giard that a few spores of a poisonous fungus in a comparatively large quantity of water are sufficient to be propagated in caterpillars, which are sprinkled with such water. There is no doubt that a mash-tub into which a diseased insect has once fallen will keep up a sufficient supply. Nevertheless when such spores are so common in mash that Dr. Bail, in using brewers' yeast, succeeded in numerous experiments, and that here the use of dry top-yeast, as well as the use of compressed bottom-yeast, gave the same successful results, I believe that it is of no particular avail to cultivate artificially Isaria spores in beer-mash. The recommendation to use simply yeast would be sufficient, and so it was given by myself: "The general result of the most accurate investigations of the beer-yeast fungus is entirely opposed to the notion *that it can enter an insect's body* and produce a disease." I am perfectly unable to find the publications alluded to, which, of course, would settle the question at once. Nothing in the size and the form of the spores would prevent them from entering the body.

The ingenious suggestion of a collection and cultivation of an insect's disease-producing fungus was made and published in 1874 by Dr. John L. Leconte, from Philadelphia.

Cambridge, Mass. H. A. HAGEN

Recall of Sights and Tastes

I THINK the following two facts, from my own personal experience, may be of some interest to Mr. Francis Galton.

1. In 1875 I was appointed by the Venezuelan Government to organise the library of the University in this city. The collection contained then about 8,000 different works, which I arranged and numbered on their backs, having no assistant but a servant for the rough part of the labour. Since that time I have been head librarian, it being my duty to be at the library on all mornings, Sundays excepted. It is natural that I should therefore know the place of every book on the shelves; but in the case of the more important works, as soon as the title is mentioned I am able to recall to my mind the exact appearance of the books, with their corresponding numbers, the lettering being however much less distinct. It is no case of memory; for I cannot say what book is to be found under a certain number; I must first have the image of the book, and afterwards I read its number, as if it were actually before my eyes. A considerable part of later additions to our library was numbered by the assistant librarian, as amongst these books there are but few which I can recall to my mind in the manner described.

2. In Mérida (a western state of Venezuela) the people use a substance called *chimó* (pronounce *cheemó*). It is made with the juice of tobacco, inspissated to the consistency of syrup, and mixed with powdered *urao*, or sesquicarbonate of soda, from a small lagoon near the village of Lagunilla, not far from the town of Mérida. The *chimó* is black, and kept in small boxes made from the horns of cattle. When used a small quantity is put into the mouth outside the gums, where it is slowly dissolved by the saliva, and then swallowed down. Being myself pretty well accustomed to smoking cigars, I once felt desirous to try

[1] "Botanische Untersuchungen über die Alcoholgährungspilze," von Dr Max Reess. (Leipzig, 1870.)

this singular mixture, but with so bad a result that from that time (nearly four years ago) the mere recollection of the experiment produces again not only the indescribably nasty taste of the *chimó*, but sometimes even the vomiting, which was the end of my first and only attempt to use this luxury of the *Merideños*. And for this very same reason I hasten to put an end to this note.

A. ERNST

Carácas, March 18

Anchor-Ice

THE formation of anchor-ice has attracted a good deal of attention in Upper Canada, although I am not aware of any efforts having been made to describe theoretically the cause of its formation. Prof. H. Y. Hind, some time of Toronto, alludes to it in a paper read before the Geological Society (*Proc. Geol. Soc.*, xxi. p. 128), and I believe the late Sir Wm. Logan, director of the Canadian Geological Survey, also brought the matter before the same Society, though I cannot trace up the paper, and Mr. Keefer, C.E., of Ottawa, read a paper on this subject before the Canadian Institute (*Canadian Journal* (new series), viii, p 173, 1862).

The conditions under which anchor-ice forms appear to be those mentioned by Dr. Rae, as far as my own observation goes, and Prof. Hind remarks, in the paper alluded to, that it is not uncommon for the seal-nets off the Labrador coasts to be frozen, in water as deep as 60 feet, and that the anchors of these nets frequently bring up masses of frozen sand. The most interesting question in connection with this subject seems to me to be, Does the ice form, from the precipitation of the very minute ice-particles, in passing over the rapids, or does the intense cold of the ground favour the formation of *razee*, as it is locally called, independently of the floating ice-particles passing over the *stones?* I have never known it to form on clay or alluvial bottoms.

There is another form of anchor-ice to be found in the great northern lakes, which floats in large sheets at a considerable depth under the surface of the water. During the construction of a large breakwater on the Georgian Bay I had a great deal of trouble from large floes of this ice, which seemed to be floating in layers at various depths in water 14 feet deep. The local opinion was that this ice was formed on the extensive rocky shoals which abound on that coast, and more particularly in the neighbourhood of the work on which I was engaged, and that the floes became detached by storms and the hammering of the surface-ice upon them. Whatever may have been the cause of their formation, they were very destructive in their force upon the timber caissons which were being sunk.

Edinburgh, April 22 ALAN MACDOUGALL

THE SONGS OF BIRDS.—D. W., of Freiburg im Breisgau, writes that Mr. C. C. Starling (NATURE, vol. xxi. p. 590) will find an elaborate paper, "Ueber Vögelstimmen, &c." (especially on their musical properties, with many notes), by Prof. Oppel, of Frankfort-on-Main, in the monthly journal *Der zoologische Garten*, February, 1871 (vol. xii. No. 2), published by the Zoologische Gesellschaft of that place.

GEOLOGICAL SURVEY OF THE UNITED STATES

IT is now about a year since the Congress of the United States took seriously in hand the question of the national scientific surveys and made a complete reorganisation of them, consolidating the geological work into one general Geological Survey of the United States, under Mr. Clarence King as director. Some time had necessarily to elapse before much fruit could be seen from the new tree. It was especially needful in the first place to justify the large expenditure of money required for the organisation, by showing that not merely pure science, but the industrial and commercial interests of the country were materially aided by the Survey. Consequently while ordinary geological surveying has not been neglected, the chief strength of the staff has been expended upon economic geology, and more especially on the deposits of iron, lead, silver, and gold. Some of the great mining districts of the West have been very carefully explored, and the results will be embodied in the Annual Report. It is understood that Mr. King's general plan is to arrange his forces in two divisions, one charged with the investigation of the economic geology, the other with general geology or the geological map. The second division will no doubt be mainly engaged in the Western States and Territories, which will be parcelled out into large districts each under a special officer. Thus there will probably be a corps placed on the Pacific slope, another on the Great Basin, a third on the Plateau country, and a fourth in the eastern mountain ranges, or Rocky Mountains proper. But besides this general distribution of the staff there is an intention, we believe, to devote attention to special problems further east, and, in a most liberal and thoroughly scientific spirit, to employ for their study the best geologists who can be found in these regions to undertake the duty.

Rumours of this last branch of Mr. King's scheme have been rife for some months past in the Eastern States; and, like most rumours, they have doubtless exaggerated the true state of the case. In a recent number of NATURE (vol. xxi. p. 197) attention was directed to his alleged proposal to extend the operations of his staff not only over the Western Territories and other parts of the public domain, but also over the Eastern and long-settled States. In spite of the serious and emphatic protest made by Prof. Dana against this proposal, we spoke of the proposal itself as a kind of joke, meant chiefly to flutter the geologists of the East, but with no serious thought of claiming in any way jurisdiction in the Eastern States. It appears, however, that the Director, in answer to official inquiries, has written a letter, which has been laid before the Senate by the Chairman of the Committee on Appropriations, to be printed in connection with a joint resolution authorising the extension of the Survey. In this letter he states that the Survey as at present constituted, being understood to be limited in its application to the national domain or public lands, cannot possibly present a general exposition of the mineral resources of the whole country, and that in spite of its labours for their enlightenment, "the people of the United States must remain ignorant of the extent, nature, and broad practical relations of their mineral possessions." He therefore insists on receiving from Congress authority "to work over the whole United States and to study its whole economical geology," summing up his arguments by declaring that "briefly and finally, in my belief, the question of the passage or defeat of the resolution under consideration is the question whether it is or is not desirable and needful for the people of the United States to thoroughly know the nature, extent, and uses of their mineral possessions."

In Mr. King's view the work of his Survey should be to collect statistics of the annual output of minerals, to publish a yearly volume giving full information of the progress of the mineral industries, "to actually and directly aid in their development," "to promote the wise and guarded influx of foreign capital," and generally to study the mineral wealth of the country in its extent, in the relations of one kind of deposit to another, and in the relations of all the deposits to industrial and commercial progress.

Mr. King no doubt knows intimately the temper of Congress, and understands precisely the tactics to be pursued to get from that body an appropriation of $340,000. He is aware that he will be much more likely to gain his end by showing that he can augment the number of dollars in the national exchequer than by trying to persuade the legislature to believe in the importance of discovering the southern limits of the Northern Drift. He must be allowed to be a better judge of how to get a large vote from Congress than any quiet onlooker here can pretend to be. Yet even from his own point of view there are some aspects of his letter to which, with all deference to his well-known tact and great experience, objection may be taken. There surely was no necessity for the introduction of such statements as that the value of a mineral in one State might be dependent on a single chemical fact or deposit in a remote State; that a New Jersey iron-founder may have to mix ore from Virginia with ore from Michigan, and procure his fuel from Pennsylvania and his fire-brick from Connecticut; and that gold-seekers in Georgia would lack a personal knowledge of California. Does Mr. King suppose that the mining industry of his country will stand still until it is instructed by the Geological Survey? The mining owners and speculators are quite alive to everything likely to be for their interest, and may be safely trusted to look after themselves. "The iron-corps of Wisconsin," he says, "could never safely judge of a Pennsylvania ore, which was required to be mixed with the Wisconsin product, unless the two were investigated together and their direct relations studied." But the Wisconsin corps could perfectly decide as to the amount of metal in the ore and the extent and workability of the deposit. The geological relations are unquestionably most interesting and important, but ignorance of them is happily not fatal to a very thriving industry.

The Director, it seems to us, does himself and his associates injustice in taking far too low a stand on which to urge the importance of a truly national Survey. In dealing with a popular assembly it is of course necessary to show that a service for which large grants are demanded has a real practical utility. But it is possible to carry this principle too far, and thereby to defeat its object. An acute Congressman might rise and object to such large appropriations being granted for what appeared to be mainly a work of statistics. "Mr. King's letter," he might argue, "puts great stress on the collection of accurate statistics of our mineral wealth. But we don't need a corps of trained geologists with good salaries to scour the country, finding out how many tons of coal are raised here and how many ounces of gold have been crushed there. I can undertake to do all this at a fiftieth part of the cost. All I ask is a couple of clerks and a free postage allowance. I would send a printed form to every mine-owner and district agent in the country, with columns in which to enter all the industrial particulars needed. And I would guarantee to lay before Congress as full and accurate a statement of our mineral output as Mr. King could do with his corps of geologists. Of course if Mr. King is going to make a scientific survey that is another matter. Let him set his corps to work on it, getting the most highly trained men he can find for the purpose. But it would be a waste of brain-power as well as of public money to employ scientific men to do mere clerks' work. Let us have under the Department of the Interior an office for mineral statistics, and leave the Geological Survey free to do proper geological investigation."

There is another part of Mr. King's letter which to an impartial spectator of the discussion cannot but appear ominous of possible evil. He states that it will be among the duties of his Survey "to actually and directly aid in the development of the mineral industry, and promote the wise and guarded influx of foreign capital." Our irrepressible Congressman would no doubt exhaust his eloquence on this topic. "What!" he might exclaim, "are the geologists of the Survey not only to collect statistics, but to be a kind of superior share-brokers and mining speculators? I wonder how much time they are likely to find for really geological work. I hope that they are men far above the love of filthy lucre, anxious only for their country's good, incapable of taking a fee, utterly unbribable. Certainly their virtue will be put to the proof. A mining company stamped with the approval of the Geological Survey will no doubt be more easily floated into the market. On the other hand, a company whose claim is condemned as worthless by the official authorities need not expect its shares to rise in value. Such approval or condemnation will no doubt be naturally regarded by mining men as a purchasable commodity. Even should every member of the Survey keep himself wholly apart from transactions of this kind, it is a misfortune that he should ever be exposed to temptation and to the suspicion which the public knowledge of that temptation so often and so unjustly arouses." No one who knows anything of Mr. King and his associates will for a moment entertain such suspicions, but may resent the mere mention of them. Nevertheless the Survey would do wisely to avoid having anything to do with capital either foreign or domestic. It cannot too jealously guard its scientific reputation. So long as its labours are strictly geological it will be regarded with respect as an impartial tribunal. The moment it begins to meddle with the monetary aspects of mining it will occupy a lower place in public estimation. What is more, it will make enemies. Disappointed speculators will find ample opportunity of revenge; and Mr. King may have a yearly struggle to get his appropriation.

With the most cordial interest in the welfare of the newly-organised Survey and every desire to see it enter upon a long, brilliant, and useful career, we would earnestly urge upon the authorities the desirability, nay, even the necessity, of concentrating as large a part of the force as possible upon the unsurveyed and only partially explored western regions. While this great work is in progress Mr. King will doubtless find ample opportunity of keeping before Congress and the public the industrial aspects of the Survey, and of showing that, even in a pecuniary point of view, the annual expenditure of money is well bestowed. He may be able to make use of the active geological talent of the Eastern States to aid him in collating geological sections and in working out special problems of general interest and importance. In the midst of these labours we do most sincerely trust he will see his way towards collecting material for a first general geological map of the United States. Nothing worthy of the name yet exists, and though many years must elapse before a detailed and accurate map can be issued, a very great boon would meanwhile be conferred, not only on geologists, but on the general public, by the preparation of a map (such as that published by the Lands Office) giving in condensed form the general results of geological investigation all over the Republic. ARCH. GEIKIE

STONE ARROW HEADS

MANY surmises have been offered as to how our prehistoric ancestors could have manufactured stone arrow heads before the uses of bronze or iron were known. Sir John Lubbock, Mr. John Evans, and other writers have suggested that the observations of travellers as to the mode pursued by savage nations in similar work might possibly lead to some correct conclusions. Acting on this hint Mr. B. B. Redding had published an account of the manufacture as practised by the Cloud River Indians. Prior to the close of the Modoc war the Wintoons or Cloud River Indians were without firearms. Up to that time the few settlers who resided about the base of Mount Shasta made it a rule to permit no Wintoon to carry a gun. As there are no agricultural lands and no mines on the Cloud River the Wintoons were left in almost undisputed possession of their prolific hunting-grounds and to the inexhaustible supplies of salmon and trout with which that river abounds. They had but little contact with the Americans until a station was established on their river by the United States Government for the taking of salmon eggs for distribution. Even to this day very few of them have guns, and their principal reliance in the chase is upon their primitive but powerful bow and arrows with stone heads. The stone arrow head maker is still a man of great importance in the tribe, and one of the best of these undertook to make, in Mr. Redding's presence, a stone arrow head, using only such tools and implements for this purpose as were in use by the Indians before their contact with the white man. Promptly at the time appointed the old man, Consolulu, appeared, grey-haired, and though between sixty-eight and seventy-two he was still erect and vigorous. He brought, tied upon a deer's skin, a piece of obsidian weighing about a pound, a fragment of a deer's horn, split from a prong lengthwise, about four inches in length and half an inch in diameter and ground off squarely at the ends; this left each end a semicircle, besides two deer prongs with the points ground down into the shape of a square sharp-pointed file, one of these being much smaller than the other. He had also with him some pieces of iron wire tied to wooden handles and ground into the same shapes. These, he said, he used nowadays in preference to the deer prongs, simply because they did not require such constant sharpening. Holding the piece of obsidian in the hollow of his left hand, he placed between the first and second fingers of the same hand the split piece of deer's horn first described, the straight edge of the split horn resting against one-fourth of an inch of the edge of the obsidian, this being about the thickness of the flake he desired to split off, then with a small round water-worn stone which he had picked up, and which weighed perhaps a pound, he with his right hand struck the other end of the split deer's horn a sharp blow. The first attempt resulted in failure; a flake was split off, but it was at the same time shattered to fragments. The next blow was successful, a perfect flake was obtained, and a third was equally so. Now squatting on the ground, sitting on his left foot, his right leg extended in tailor-like fashion, he placed in the palm of his left hand a piece of thick, well tanned buckskin; it was thick but soft and pliable; on this he laid the obsidian flake, holding it firmly in its place by the first three fingers of the same hand; the elbow was steadied on the left knee. In his right hand he took the larger of the two deer prongs and commenced to reduce one edge of the circular form of the flake to a straight line with the thumb of the right hand resting on the edge of the left hand as a fulcrum. The point of the deer prong would be made to rest on about an eighth of an inch or less of the edge of the flake, then with a firm pressure of the point a conchoidal fragment would be broken out, almost always of the size desired. This operation was repeated until in a few moments the flake was reduced to a straight line on one edge; by rubbing this on the side of the deer horn the sharp edge was worn down. Next, the flake was turned end for end and the chipping renewed; when completed care was taken that the cutting edge was left in the centre. It was now plain that the straight edge thus made was to be one side of the long isosceles triangle, the form of the arrowheads which is used by the tribe. The other side was formed in the same manner and next the base. The chipping out of the slot by which the arrow head is firmly bound by deer tendon to the shaft was the simplest and most rapid portion of the work. It had taken forty minutes to split the two flakes from the obsidian mass and to form one of them into the arrow head. The detailed account of this most interesting process will be found, with illustrations, in the November number of the *American Naturalist*.

REV. JAMES CLIFTON WARD, F.G.S.

OUR geological readers will learn with sincere regret that one of the most earnest of the band of "workers" in this country passed away on April 15, aged 37. Early adducing a taste for science, Mr. Ward was sent to the Royal School of Mines in 1861, studying in the Geological Division, and obtaining the Associateship in 1864. In the following year he joined the staff of the Government Geological Survey, and was sent down to the Yorkshire coalfield, in the survey of which he took an active part. Under the superintendence of Prof. Green he contributed to the elucidation of the geology of seven ordnance quarter sheets, including at least twenty-three maps of Yorkshire, on the scale of 6 inches to the mile, to many Horizontal and Vertical Sections explaining the structure of the coal-field, and furnished information included in the Survey *Memoirs* on the Dewsbury and Huddersfield district, 88, N.E., in 1871, the Burnly Coalfields in 1875, and the "Geology of the Yorkshire Coalfield" in 1878, and was called before the Royal Coal Commission to give to them the results of his labours in that coalfield. In 1869 Mr. Ward was transferred to the Survey of the English Lake District, then commencing under the superintendence of Mr. Aveline, and we henceforth see Mr. Ward in a new light. Hitherto conscientious work and indefatigable industry had alone characterised him; but so soon as he was surrounded by the scenery of the Lakes, and breathed its exhilarating atmosphere, he developed, in addition to these qualities, a rare appreciation of its beauties, alike present in sunshine and in storm, not far removed from that "being one with nature" that is so marked a characteristic of the little band of poets which, in the time that has just gone by, have rendered this district, classic ground for the student of English literature. Keenly enjoying the impressions received from moor and mountain, the search after their origin, the elucidation of their past, and the restoration of their physical geology were ever present in his mind, pursued with a zest and an industry that only can be realised by those who have witnessed it. To pick up a line or clear up a doubtful point he would retrace his steps up the roughest and steepest ground, after a long day's tramp, at a speed that proved the curiosity and interest that he felt in its solution, and after the longest and hardest day in the field we have seen him working at his microscope into the small hours of the night, whilst early the next morning he was ever ready for fresh expeditions, in which no fatigue could check his interest and no discomfort try his good nature. The results of his labours in the Lake District are embodied in the "Keswick Quarter-Sheet" of the Geological Survey and the accompanying memoir on "The Geology of the Northern Part of the English Lake District," published in 1876, and in various official maps and sections, as well as in papers in the *Journal* of the Geological Society, the *Geological Magazine*, *Popular Science Review*, *Science Gossip*, and NATURE. To more fully understand the history of the volcanic rocks of his favourite Borrowdale, he undertook a journey to Italy to study Vesuvius and other volcanoes in that region. He spared neither time, cost, nor labour in microscopic sections of rocks and their chemical analyses, to aid his results in the field, and though some German petrographers have questioned some of his results worked out in the laboratory, we doubt whether any future observer will be able to suggest any improvement or change in the elaborate network of boundary lines covering the maps of the northern Lake District.

In his papers on the Lake District he pointed out the *radiate* arrangement of the ice from the higher grounds during the Glacial Epoch, and the fact that though the rock-basins were scooped out by ice, the amount denuded is an exceedingly small proportion of the entire valley, which was the product of a long period of denudation, and that the district afforded no evidence of a universal ice-cap moving across it in one direction. In his petrographical papers he deduces from "the liquid cavities in quartz-bearing rocks" that the granitoid rocks of the Lake District were consolidated at a depth not greater than 30,000 feet. Comparing the modern volcanic rocks of Vesuvius and Naples with the old lavas of the Lake District and North Wales, he refers the latter to the felstone group, and those of Cumberland to a group midway between the felstone and the basaltic; in both

Wales and Cumberland felspathic ashes being metamorphosed into felstone-like rocks.

Mr. Ward had always a strong bent towards educational work, and lectures of his first given to a school audience, and afterwards before the Keswick Literary Society, were expanded and published as text-books ("Elementary Natural Philosophy" and "Elementary Geology," 1872). Like the late Canon Kingsley with the Chester Society of Natural Science, Mr. Ward exerted an immense influence in attracting people to the pursuit of natural science, and in breaking down those trammels which prevent people of different ranks meeting for a common useful object; and not only increased the number of members of the Keswick Society and put its museum in scientific order, enriching it with his own collections, but united the society with the other societies of the county, and formed them into the Cumberland Association —a society publishing a useful journal. In 1878 he left the Geological Survey and entered the Church, holding successively two cures under the Bishop of Carlisle: the first, a curacy at Keswick; the second, the vicarage of Rydal. Thus in the shadow of Wordsworth's home, surrounded by the mountains he loved so well, he closed his useful, respected, and sadly too short life. C. E. R.

THE INSTITUTION OF MECHANICAL ENGINEERS

AT the recent meeting of the Institution of Mechanical Engineers four papers were read on subjects of practical interest to engineers and men of science, viz., on Electric Lighting, by Dr. John Hopkinson, F.R.S. Remarks on Chernoff's papers on Steel, by Mr. W. Anderson of Erith. On Permanent Way for Street Tramways, with special reference to Steam Traction, by Mr. J. D. Larsen; and on Water Pressure Engines for mining purposes, by Mr. H. Davey of Leeds.

Dr. Hopkinson's paper is divided into three principal parts. The first is a continuation of a paper read by the author in April, 1879, in which he exhibited by means of a curve the interconnection between the current passing through a dynamo-electric machine, the speed of revolution, and the electromotive force. Since the date of the author's earlier paper other electricians have made experiments in the same direction; notably Auerbach and Meyer in Germany, and Dr. Siemens, F.R.S., in this country. The results arrived at by these experiments are now given in a similar form to that adopted by the author for illustrating his own experiences.

The second part of the paper deals with the brightness of the electric arc. It is common to speak of the brightness of an electric light in terms of so many candles. The colour of the electric light is however different to that of a candle. Hence "the statement without qualification, that a certain electric lamp and machine give a light of a certain number of candles," "is wanting in definite meaning." "Captain Abney (*Proceedings* of the Royal Society, March 1878) has given the results of the measurements of the red, blue, and actinic light of electric arcs in terms of the red, blue, and actinic light of a standard candle." It has also been ascertained that the electric light under certain circumstances gives very different intensities of brightness in different directions. These two facts, together with certain practical difficulties, have rendered the measurement of the light emitted by the electric arc somewhat difficult. In the second part of his paper Dr. Hopkinson describes the methods which he has adopted for overcoming these difficulties.

In the third section the author considers the efficiency of the electric arc, and concludes by giving a rule for the "measurement of the efficiency of any system of electric lighting in which the electric arc is used, the arc being neither exceptionally long nor exceptionally short."

Mr. Anderson's remarks on Chernoff's papers on Steel are chiefly interesting as tending to direct attention to an almost unknown series of papers by a distinguished Russian metallurgist. Few men have had better opportunities for becoming acquainted with the nature of steel than M. Chernoff. He has been for some years assistant manager of the celebrated Abouchoff Steel Works, close to St. Petersburg. At these works five different processes of manufacturing steel, viz., the old crucible, the Siemens crucible, the Bessemer, the Siemens-Martin, and the Whitworth fluid compressed steel systems, may all be seen in operation. Visitors to the Vienna Exhibition in 1873 will remember the splendid specimens of artillery, including a breech-loading forty-ton gun, which were turned out by this factory. The establishment is provided with an admirable laboratory, with one of Kirkaldy's testing machines, and with every appliance necessary for investigating the nature and properties of the metal. Under these circumstances any contribution to our knowledge of steel coming from the pen of M. Chernoff would probably well deserve the attention of English metallurgists. The first of the papers referred to was published in 1868, but was not translated into English till 1876. It deals with the chemical composition of steel, the effects of introducing extraneous subjects into its composition, and the effect upon its properties and molecular structure of heating the metal up to various temperatures as high as the melting point, and then cooling it again from the melting point.

In 1876 M. Chernoff published a paper on the Bessemer Process, "which gives a number of interesting analyses made at the Abouchoff works and elsewhere, and institutes a comparison as to the dimensions of apparatus, quantity of air required, and other details, in different countries and for various qualities of iron."

In 1878 he produced a paper on the Structure of Cast-Steel Ingots, which deals with the nature and origin of the defects to be met with in ingots, and the proper method of obviating them. This paper also goes into the very important question of whether steel-castings do or do not require subsequent treatment under the hammer, and the author gives tables of experiments to show that by proper annealing steel-castings can be rendered "fully as tough, tenacious, and ductile as the forged metal."

Mr. Anderson has done good service by translating these papers for the benefit of English readers. He notices at the beginning of his own paper that the Russian language is so little understood that it is only by accident that the labours of many very distinguished Russians became known in Western Europe. We commend this remark to the attention of the editorial committee of the Institution of Civil Engineers. The *Transactions* of the Institution have for some time been remarkable for the admirable series of abstracts of papers published in foreign periodicals. No English engineer can now complain that the scientific publications of other countries are inaccessible to him, therefore it seems the greater pity that any little difficulty about the language should cause the labours of Russian savants to have been overlooked.

The latter portion of Mr. Anderson's paper has nothing to do with M. Chernoff. It deals principally with the effect which occluded gases seem to play in the hardening and tempering of steel, and also considers the molecular changes, and the variations in the specific gravity of steel brought about by tempering. On this point we should like to draw the author's attention to a most interesting series of experiments by Dr. Schott, a German, on the effect of tempering glass in oil; a *résumé* of which is to be found in the foreign abstracts of the last volume of "Transactions of the Institution of Civil Engineers."

A study of this paper may perhaps throw some light on the corresponding problems in the manufacture of steel.

Mr. Larsen's paper on the Permanent Way of Street Tramways is an eminently technical production, and deals with the forms of rails and nature of sleepers and cross-ties necessary to secure not only a good and permanent road for the present system of traffic, but also one which can be readily adapted to steam traction, whenever sufficiently perfect steam traction shall have been introduced to take the place of horses.

Tramways have not hitherto succeeded in earning the sympathy of those sections of the public who travel in cabs and carriages. Owing to the peculiar kind of rail used, and the imperfect manner in which the tramway proper has been combined with the paving of the ordinary road, street vehicles have experienced a very nasty and injurious species of wrench and jolt, when crossing the rails, which, besides being very uncomfortable to the occupier of the carriage, is also extremely injurious to his wheels. In addition to this drawback the earlier tramways were laid on a very bad system. They rapidly got out of order. Owing to the spikes which fastened down the rails having been driven down from the upper side, the rain used to percolate downwards between the spike and its holding in the sleeper, so that the wood of the latter became soft, and spike and rail consequently worked loose. In fact, in the older tramways it was the exception to find a rail in good order. The difficulty of setting the paving stones properly in the neighbourhood of the longitudinal timber sleepers was so great that the surface of the roadway almost invariably settled down thereabouts into a continuous longitudinal depression, which in wet weather became a stagnant ditch, not only unsightly, but extremely inconvenient to foot passengers and ordinary traffic. Mr. Larsen in his paper describes the various inventions and contrivances brought out by himself and other engineers for the purpose of remedying these drawbacks, and of making the permanent way so secure and rigid that it can be used at any time for steam traction.

The author does not refer to one of the greatest novelties in permanent-way construction, viz., the glass sleepers brought out by Mr. Lindsay Buckill and Mr. W. Siemens of Dresden. These sleepers have been laid down for some time past on a section of one of the Metropolitan tramway lines, and appear to have answered their purpose most successfully. The fact that glass, proverbially the most brittle of substances, could be used for such a purpose, might strike most people with surprise; but readers of Dr. Schott's paper, referred to above, will have learned that by suitable tempering glass may be made, mass for mass, stronger than steel, and practically unbreakable. We understand that the success attained in the construction of glass sleepers has recently been so great that it is now proposed to make broad longitudinal sleepers with a groove in the upper surface which shall combine in themselves the functions of rail and sleeper, and do away with the necessity for separate iron rails with their fastenings, joints, and other concomitant complications.

Mr. Henry Davey's paper on water-pressure engines for mining purposes would scarcely be understood without reference to the diagrams and illustrations made use of by the author. Its character is moreover so essentially technical as to render it unsuited for reproduction in this journal.

NOTES

We take the following from the *Times*:—The following are the names of the fifteen candidates for the Fellowship of the Royal Society selected by the Council and recommended for election (Thursday, June 3, is the day appointed for the election):—Dr. Clifford Allbutt, Prof. J. Attfield, Mr. H. E. Blanford, the Rev. W. H. Dallinger, Mr. Thiselton Dyer, Lieut.-Col. Godwin-Austen, the Bishop of Limerick, Prof. D. E. Hughes, Mr. H. M. Jeffery, Prof. F. M'Coy, Mr. J. F. Moulton, Prof. C. Niven, Dr. J. Rae, Prof. J. E. Reynolds, Dr. W. A. Tilden.

Prof. Bayley Balfour returned last week from Socotra, with considerable botanical and zoological collections made during his necessarily very brief visit. He obtained dried specimens of 500 species of flowering plants, and four cases of living specimens, besides a large plant of the *Dracæna*, which yields the dragon's blood of Socotra, and which, till recently, was quite unknown to science. He attempted to convey with him through Italy a small case of succulent plants of special interest, but it was stopped at the Custom House at Brindisi, and unless it finds its way to England by the sea route, its contents are of course lost.

We regret to learn of the death, after a short illness, of Mr. W. H. Holloway, F.G.S., of the Geological Survey of England and Wales.

The Portuguese Naturalist Anchietta has recently sent from Africa 2,000 specimens of birds and 1,000 reptiles, fishes, insects, and other animals, besides numerous specimens of plants and rare minerals. They are intended for the Polytechnic Museum of Lisbon.

The *Newcastle Chronicle* announces the death, at Gosport, of Mr. Thomas Atthey, a naturalist of considerable reputation. Although living in comparative obscurity and quiet, he was well known and highly esteemed in learned circles for his researches in and contributions to that branch of science to which he was so much attached, his position being very much akin to that of Thomas Edwards.

The *Irish Farmers' Gazette* understands that Prof. Baldwin is about to retire on a well-earned pension from the appointment he has so ably filled for many years as Superintendent of the Agricultural Department of the National Board, Dublin.

The Dharwar correspondent of the *Bombay Gazette* gives a graphic account of a thunderstorm which occurred on March 24 last, and was accompanied by a fall of some very heavy hailstones. "The storm," the correspondent states, "was ushered in by the fall of some extremely heavy hail, several of the largest stones, which were *spherical* in shape, measuring no less than *nine or ten inches in circumference*. He did not himself see these monster hailstones, but he vouches for the accuracy of this statement. He picked up several hailstones, however, himself, which were the size of Tangier oranges. Accompanying this storm of hail were thunder and lightning, both on a grand scale, the latter at times being very vivid. After the hail came a heavy downpour of rain, and the whole affair was over by about 8 p.m. One piece of ice was picked up about five inches long and pointed at one end." The correspondent who sends us this writes: "It is a pity that these remarkable hailstones were not more closely examined and measured. Of course there are cases on record of still larger stones having fallen, especially in tropical countries."

The programme of the annual meeting of the Iron and Steel Institute, to be held on May 5, 6, and 7, has just been issued. The Bessemer medal for 1880 is to be presented to Sir Joseph Whitworth, and among the papers to be read and discussed are the following:—"On Hardening Steel, its Causes and Effects;" "Physical Changes occurring in Iron and Steel at High Temperatures;" "Manufacture of Bessemer Steel and Ingot Iron from Phosphoric Pig;" "Dephosphorisation of Iron at the Hördeworks, Germany;" "Reactions in the Open-hearth Process;" "Improved Method of Utilising By-products in the

Manufacture of Cake;" and "Improved Apparatus for Analysing Blast Furnace and other Gases."

PROF. HUMPHRY, F.R.S., has been appointed Rede Lecturer for this year.

A RUMOUR has been spread in all the French papers and in some of our English contemporaries, that a war balloon had exploded at Meudon, and an officer with some privates severely wounded. We are happy to be able to state on official authority that this statement has no ground whatever, in spite of its precision.

M. BISCHOFFSHEIM, the well-known Paris banker, a native of Amsterdam, is to be naturalised, without being subjected to the usual formalities, as a compliment for his munificence towards scientific and other objects.

THE elections for the Superior Council of Public Instruction in France took place last week. The Institute sent five delegates, one from each class, the College de France two professors, the Museum of Natural History one, the Polytechnic School one, the Normal School two, the Conservatoire des Arts et Métiers one. The other delegates were selected all over France by the several delegations of private teachers voting by categories. The counting of these votes took place at the Ministry of Public Instruction. Amongst the delegates are M. Jules Simon, the former Minister of Public Instruction, M. Bertrand, the Perpetual Secretary of the Academy of Sciences, M. Fremy, the former President of the Academy of Sciences, M. St. Claire Deville, M. Berthelot, M. Hervé-Mangon the Director of the Conservatoire of Arts, and M. Laussedat, the former Director of the Meudon Aëronautical School.

THE *Daily News* states that we have to thank the heliograph again for an important message received from General Stewart, and announcing the result of an attack on our troops, in which the enemy seems to have suffered severely. The message is dated Camp Ghuzni, April 22, and was received at the India Office the following day. It is very probable that the news could not have been brought so speedily by electric telegraph. The heliograph does not require the route to be kept open. The line of communication cannot be cut, for the simple reason that the signalling takes place over the heads of the enemy, and the stations required are but few and far between. A 10-inch mirror, and this is the diameter of the ordinary field heliograph, is capable of reflecting the sun's rays in the form of a bright spot, or flare, to a distance of fifty miles, the signal at this interval being recognisable without the aid of a glass. That is to say, two trained sappers, each provided with a mirror, can readily speak to one another, supposing the sun is shining, with an interval of fifty miles between them, provided their stations are sufficiently high and no rising ground intervenes to stop the rays. The adjustment of the military heliograph is a very simple matter. An army leaves its base where a heliograph station is located, and after travelling some miles desires to communicate with the stay-at-homes. A hill in the locality is chosen, and a sapper ascends with his heliograph, which is simply a stand bearing a mirror swung like the ordinary toilet looking-glass, except that besides swinging horizontally it is also pivoted so as to move vertically as well. Behind the mirror, in the very centre, a little of the quicksilver has been removed, so that the sapper can go behind his instrument and look through a tiny hole in it towards the station he desires to signal. Having sighted the station by adjusting the mirror, he next proceeds to set up in front of the heliograph a rod, and upon this rod is a movable stud. This stud is manipulated like the foresight of a rifle, and the sapper again, standing behind his instrument, directs the adjustment of this stud until the hole in the mirror, the stud, and the distant station are in a line. The heliograph is then ready to work, and in order to flash signals so that they may be seen at a distance, the sapper has only to take care that his mirror reflects the sunshine on the stud just in front of him.

AN open competition for one situation of Junior Second Assistant in the Herbarium, Royal Gardens, Kew, will be held in London, under the following regulations, on Tuesday, May 25, 1880, and following days. No person will be admitted to the examination from whom the Secretary, Civil Service Commission, has not received, on or before May 15, an application on the prescribed form. The examination will be in the following subjects, viz:—(1) Handwriting, (2) Orthography, (3) Arithmetic (elementary), (4) Elements of Systematic and Structural Botany, (5) the naming of plants by the British Flora. Candidates will be required to show what preliminary training or technical education they have undergone to qualify themselves for a situation of this nature, and they must satisfy the Civil Service Commissioners that they possess the special qualifications necessary for the office. The salary of the Junior Second Assistant in the Herbarium is 100*l*. per annum, rising by annual increments of 10*l*. to 150*l*. per annum.

SHOCKS of earthquake were felt at Nice at 2 p.m. on Sunday.

THE Municipal Council of Paris have visited the peninsula of Gennevilliers, to ascertain the results of irrigation with the discharge from the sewers. These have been found splendid, and the agricultural population of the district is very well satisfied with them. Other lands are to be found for utilising the remaining part of the sewage of Paris. The city engineers proposed to irrigate land in the vicinity of the forest of St. Germain, but the inhabitants have sent petitions against the project, and deputations have met the Municipal Council. At all events, it is supposed the opposition will be overruled by the city authorities, unless Parliament vetoes the further extension of sewage irrigation.

NEWS has just reached Shanghai respecting the progress of the scheme for establishing a woollen manufactory at Lanchow-fu, in the extreme north-west of China Proper, to which we alluded about a year ago. Mr. Hagge, one of the foreigners employed at it by the Chinese Government, has just returned to Hankow and Shanghai; he states that no difficulty is experienced by the natives in working the machinery, and that the sheep's wool supplied is of the finest quality, a great deal of camels' wool also being used. It is perhaps worthy of note that the Chinese in that region live almost entirely on meat and wheat flour. Mr. Hagge's journey from Lanchow-fu to Hankow occupied fifty-two days.

FROM the *Japan Herald* we gather some particulars respecting the earthquake at Yokohama on February 22, the most serious one which has occurred in Japan since 1855. The Government some years ago, established the necessary apparatus at Tokio for registering the duration, force, &c., of earthquakes, by which it appeared that the first shock took place at 0h. 49m. 22s. a.m., and lasted fourteen seconds; the second was at 0h. 50m 19s., and lasted only six seconds, but it was far more severe than the first, and did much damage. There was a third and less violent shock thirty seconds later, but no record is given of its duration. The index of the stenograph showed that the second shock was from N.N.W. to S.S.E., and the force of the shock was registered at 79 degrees.

THE *Report* of the Geological Association for 1879 complains, like the recent reports of other societies, of the few additions to its membership during the past year, no doubt mainly owing to the general depression. The Society now numbers 415 members.

FROM Tokio, Japan, we have received a little pamphlet on "Japanese, Metric, and English Weights and Measures," by Mr. Edward Kinch, compiled for the use of the students of the

Imperial Agricultural College of Tokio. The tables inclnde mensuration and mechanical formulæ, and physical, chemical, and physiological memoranda and constants.

"NOTES on the Alluvial and Drift Deposits of the Trent Valley near Nottingham," is the title of a lecture to the Nottingham Naturalists' Society by Mr. James Shipman, published by Norris and Cokaigne, of Nottingham.

No. 1 of the *Transactions* of the Cremation Society of England has been issued by Smith, Elder, and Co.; it contains a short history of the subject of cremation at home and abroad, up to the date of the sixth anniversary of the Society, on January 13 of this year.

As proof that fat is formed from albumen, the affirmation of Blondeau (*inter alia*) is sometimes cited, that in the cellars at Roquefort the albumen of the cheese kept there is changed to fat by action of the fungus present. This has been often doubted, and recently Herr Sieber has given (*Journal für praktische Chemie*, Bd. xxi. p. 203) experimental evidence of its falsity. He analysed fresh cheese, cheese that had remained one month in the cellar, and quite old cheese. His figures prove that the most marked change which cheese undergoes in ripening is the loss of water. The proportion of fat remains unaltered, if only the dry substance be considered. (The apparent increase of fat represented in the three percentage figures 27·41, 31·23, and 40·13 is due to drying.) The second essential change of cheese in ripening consists in the decomposition of albumen; the casein passes into a series of decomposition-products, which are pretty similar to products of putrefaction in the first stages of putrefactive fermentation. But these analyses show no transformation of albumen into fat.

FROM a circular which has been sent us we learn that the "Studies from the Biological Laboratory of the Johns Hopkins University," will appear in parts from time to time as sufficient material accumulates; and will contain original papers upon Physiology, Animal and Vegetable Morphology, and Embryology, published by members of the University in different scientific journals, and other papers which are not printed elsewhere. The publication will be based upon the investigations made by members of the University in the biological laboratory, and in the marine zoological station of the University. Each part will contain about 100 pages, and four parts will make a volume. The first volume is now complete, and contains 519 pages, and 40 plates, besides illustrations in the text: with the following table of contents. Vol. I., part 1, contains:—The normal respiratory movements of the frog and the influence upon its respiratory centre of stimulation of the optic lobes, by H. Newell Martin. The development and regeneration of the gastric glandular epithelium during fœtal life and after birth, by H. Sewall. The influence of stimulation of the midbrain upon the respiratory rhythm of the mammal, by H. Newell Martin and W. D. Booker. The botanical relations of *Trichophyton tonsurans*, by I. E. Atkinson. Preliminary observations upon the development of the marine prosobranchiate mollusca, by W. K. Brooks. With four plates and three illustrations in the text; price 1 dollar. Vol. I. part 2, contains:—On the respiratory function of the internal intercostal muscles, by H. Newell Martin and Edward Mussey Hartwell. Observations on the physiology of the spinal cord, by Isaac Ott. On the effect of two succeeding stimuli upon muscular contraction, by Henry Sewall. On the so-called heat dyspnœa, by Christian Sihler. A self-feeding chronograph pen, by H. Newell Martin. Observations upon the early stages in the development of the freshwater pulmonates, by W. K. Brooks. The development of *Amblystoma punctatum*, by S. F. Clarke. With twelve plates; price 1 dollar. Vol. I. part 3 (Chesapeake Zoological Laboratory; scientific results of the session of 1878), contains:—Introductory, by W. K. Brooks. Land Plants found at Fort Wool, by N. B. Webster. List of animals found at Fort Wool, by P. R. Uhler. The development of Lingula, by W. K. Brooks. Lucifer typus, by Walter Faxon. The development of Gasteropods, by W. K. Brooks. The development of Squilla, by W. K. Brooks. With thirteen plates; price 1 dollar. Vol. I. part 4 contains:—The development of the American oyster, by W. K. Brooks. The acquisition and loss of a food-yolk in molluscan eggs, by W. K. Brooks. With eleven plates; price 1 dollar. The editors wish to exchange this publication with the publications of scientific societies and scientific journals. The publishers are J. Murphy and Co., Baltimore, Md., U.S.A.

THE *Revue Scientifique* for April 24 has a long essay by M. J. Thoulet, on the Mineralogy of Homer.

MR. MOSELEY asks us to state that in the report of his lecture on Deep-Sea Dredging and Life in the Deep Sea (NATURE, vol. xxi. p. 543), "Four-elevenths, or nearly three-fourths," should stand "eleven-fifteenths," κ.τ.λ.

THE additions to the Zoological Society's Gardens during the past week include a Cape Hunting-Dog (*Lycaon pictus*) from South Africa, presented by Mr. C. Ernest Pope; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Capt. Fife; a Green-Winged Trumpeter (*Psophia viridis*) from Maranham, presented by Mr. R. M. Hyde; a Blue-fronted Amazon (*Chrysotis æstiva*) from South America, presented by Miss E. Bentley; a Black Scoter (*Ædemia nigra*), European, presented by Mr. J. E. Harting, F.Z.S.; a Long-Eared Owl (*Asio otus*), European, presented by Capt. C. A. Lumsden; a Stump-Tailed Lizard (*Trachydosaurus rugosus*) from Australia, presented by Capt. J. Thomas; a Common Adder (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a Drill Baboon (*Cynocephalus leucophæus* from West Africa, deposited; two Common Seals (*Phoca vitulina*), British Seas, purchased; two Jameson's Gulls (*Larus jamesoni*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE GREAT COMET OF 1843.—Now that the identity of the southern comet of the present year with that which excited such unusual attention in almost all parts of the globe in March, 1843, is pretty well established, it is not without interest to recall the circumstances under which the comet then made its appearance.

There were vague reports that the tail had been remarked before the perihelion passage (February 27) at Bermuda, Philadelphia, and Porto Rico on February 19, 23, and 26, and, according to Encke, the German newspapers had a notification from New York, that the comet was seen as early as February 5, and six days later was observed near β Ceti. These statements did not receive confirmation. The first definite observation of the head of the comet, and the only one previous to perihelion passage, was claimed to have been made by a Capt. Ray, and is described in a letter from Mr. Mitchell, of Nantucket, published by Prof. Peirce, the well-known American geometer. Capt. Ray is said to have been "a man of sound judgment, a very accurate observer, and correct man." He says he saw the comet nearly at midday at Concepcion, S.A.; at 11 a.m. its bearing from the sun was almost precisely east, with very little perceptible southing; "he did not measure the angle, his instruments being on board of the ship, some distance below the city; but he took great pains to estimate the apparent distance, and, being so near the sun, thinks he has done it very nearly," as Mr. Mitchell reported. The comet's "distance from the sun was only five minutes, or one-sixth of the sun's apparent diameter." It is not easy to understand how an object could have been detected without instruments, at a distance of only five minutes from the sun's limb, and it is certain that the elements which represent the observations after perihelion very closely, place the comet at 11 a.m. at Coucepcion on February 27, much further distant; according to Hubbard's parabolic orbit, the comet was then 1° 55′ from the sun's limb, and its hourly motion at the time was − 15″·4 in right ascension and + 4″·5 in declination; Prof. Peirce remarked, "the Concepcion observation, if it was made with anything of the accuracy which might be expected from Capt. Ray, exhibits a decided anomaly in the nature of the forces to which the comet was subjected during its perihelion passage," and it is only in this connection that the observation requires to be noted; there still remains the difficulty of explaining how Capt. Ray's attention could have been called to an object distant only 5′ from the sun's limb.

On February 28 the head, with a tail several degrees in length, was observed at noonday in various parts of Italy, off the Cape of Good Hope, and at different points in the United States, and in Mexico. Bianchi, writing from Modena, states that on this day, the sky having been perfectly clear up to noon, great numbers of persons at Bologna, Parma, at the Villa de Colorno, and at Genoa, from 10h. 45m. to 11h. 45m., saw "a kind of star," a little distance from the sun to the east, which shone very vividly—"malgré la proximité apparente du soleil dont il fallait seulement se mettre à l'abris de la vue directe par l'interposition d'une mureille"—from which a bright tail extended towards the east for four or five degrees. The passengers and others on board a vessel, then off the Cape of Good Hope, remarked the comet distinctly about the same hours, and rather later, as we have mentioned, it was discovered at different places in the United States. The only observations of position made there which have any pretensions to accuracy were obtained by Mr. Clarke of Portland, Maine, who measured the distance of the nucleus from the sun's limb soon after 3 p.m. Mr. Bowring, at Chihuahua in Mexico, took with a sextant double-altitudes of comet and sun on the same afternoon. Unfortunately, notwithstanding the comet was so widely observed in Italy, its place was nowhere accurately fixed, but motion was detected, as appears from a letter of Amici to Arago, communicated by the latter to the Paris Academy. Amici wrote that his son, traversing the Place Calderini at Bologna, remarked a group of persons whose attention was directed to a comet. He saw it as a luminous mass, distant from the sun eastward more than two solar diameters. When viewed with an opera-glass it resembled a small flame, with ill-defined contours, three times as long as broad, very luminous on the side next the sun, and a little smoky to the east. At 1 p.m. its position was south of the sun's lower limb; "at 3 p.m. its motion towards the east had already produced a decided displacement."

The tail was remarked on the evening of March 1 in southern latitudes, and on March 5 precise observations of the nucleus were commenced after sunset at the Royal Observatory, Cape of Good Hope; the nucleus had been seen at Buenos Ayres two days earlier. The tail was detected at Lisbon on March 8, and the nucleus on March 12. At Montpellier M. Legrand saw the comet on March 11 at 7h. 15m., and described its light as of a "couleur rouge, très-prononcée;" this redness, he states, was equally noticeable on March 13, but on the following evening the train was white. The ruddy colour was disputed by other observers.

In those pre-telegraphic days we were without intimation of the comet's appearance before March 17, on the evening of which day in this country, as in most parts of Europe, the tail attracted general attention. It was considered at the time that the only certain glimpse of the nucleus obtained in England was by Sir John Herschel, at Hawkhurst, Kent.

THE COMET 1880 *b* (SCHAEBERLE, APRIL 6).—Admiral Mouchez, Director of the Observatory of Paris, has communicated to the Academy of Sciences observations of the comet detected at Ann Arbor, Michigan, made by MM. Henry and Bigourdan on April 8, 12, 16, and 18. The comet has a nucleus as bright as a star of about 11m., and a fan-shaped tail of 3′ or 4′. From the observations of April 8, 12, and 18, Mr. Hind has deduced the following rough approximation to the elements of the comet's orbit:—

Perihelion passage 1880, July 17·8675 G.M.T.

Longitude of perihelion	° ′ 100 44
,, ascending node	260 11
Inclination	57 28
Logarithm of perihelion distance	0·21371

Motion—retrograde.

A calculation by MM. Holetschek and Zelbr of Vienna, founded on observations of April 10, 11, and 13, give the date of perihelion passage, June 11, and the longitude of perihelion 122° 43′, but it is a case where these elements are not likely to be accurately fixed by the earlier computations.

The following positions are derived from the above orbit:—

12h. G.M.T.	R.A. h. m.	N.P.D. ° ′	Log. Distance from Earth.	Log. Distance from Sun.
April 30	6 14·9	22 49	0·3374	0·2872
May 2	6 15·3	24 5		
4	6 15·8	25 18	0·3453	0·2810
6	6 16·4	26 30		
8	6 17·2	27 40	0·3531	0·2750

GEOGRAPHICAL NOTES

THE medals annually given by the Royal Geographical Society for competition among the principal public schools have been awarded as follows:—Physical Geography (Examiner, Commander V. L. Cameron), Gold Medal, David Bowie, Dulwich College; Silver Medal, A. L. Humphries, Liverpool College. This medal was awarded by the Examiner to F. Taylor Sharpe, of Liverpool College, who had gained it in 1879, and was, therefore disqualified. Political Geography (Examiner, Admiral Sir Erasmus Ommanney), Gold Medal, Frederick Jas. Naylor, Dulwich College; Silver Medal, Theodore Brooks, London International College.

AT the meeting of the Geographical Society on Monday evening, the Rev. C. T. Wilson, of the Church Missionary Society's Nyanza Expedition, who has just returned to England from Lake Victoria, read a paper on Uganda and its people. The three Waganda chiefs who had accompanied him and Mr. Felkin were present at the meeting. After recording his movements since 1876, Mr. Wilson gave a general description of the physical aspect, climate and products of Uganda, adding some remarks on the people, their constitutional arrangements, the tenure of land, &c. Since Capt. Speke's time there had been a considerable improvement among the Waganda, who had taken to wearing cloth, and had become very teachable, some learning to speak Arabic and read Swahili in the Roman character, at the mission station. The folk-lore and traditions of the country afford a very promising field for research, and Mr. Wilson gave an amusing instance in the reputed adventures of one Kinto with the gods. The language belongs to the Bantu group, and is an agglutinative one. It has, of course, to be reduced to writing by the missionaries, who have found twenty-four Roman letters sufficient for the purpose. Mr. Wilson stated that he had made a collection of 5,000 words, as well as of fables, stories, and songs. Reverting to the subject of geography, Mr. Wilson averred that German and other writers had given erroneous names to the lake, and that its true and only name was Nyanza or Nyanja—a term which rightly belonged only to it. In the course of a general outline of the configuration of the lake coast, Mr. Wilson dwelt on the peculiar and large group of islands—the natives say 400 in number—at the north-west corner of the lake, which are very beautiful as to scenery, but separated by difficult and intricate channels. The characteristics of the shore are at present but little known, a remark which particularly applies to the north-east corner, and generally the lake is very imperfectly mapped. As is the case with Lake Nyassa, squalls are the great danger of the Nyanza, and there are also some peculiar currents which require investigation. Mr. Felkin, who had formed one of the expedition sent up the Nile at the end of 1878, and had spent some three months at the lake, afterwards read some desultory notes relating chiefly to the homeward journey, in which he drew a terrible picture of the condition of the Egyptian equatorial provinces since the suppression of the slave-traders' rebellion.

AS might have been expected, the reception of Prof. Nordenskjöld and his fellow-voyagers at Stockholm was of the most enthusiastic kind. The *Vega*, escorted by about 200 steamers, arrived at half-past ten o'clock on Saturday night. The adjacent coasts were lit up for a distance of many miles, and the city itself was splendidly illuminated. Near the landing-place a special platform was erected, where Prof. Nordenskjöld and his companions were received and congratulated by the municipal authorities. They proceeded immediately afterwards to the Royal Castle, where they were welcomed by the Kings Prof. Nordenskjöld subsequently drove through the city to hi.

residence in the Academy of Sciences, being vociferously cheered on the way by the dense crowds assembled to witness his return. Prof. Nordenskjöld has been created a Baron, and Lieut. Palander and Mr. Oscar Dickson (who so largely contributed to the expense of the expedition) have received patents of nobility. The latter has, in addition, received the Grand Cross of the Order of the North Star. M. Sibiriakoff, another liberal supporter of the expedition, has been appointed Commander of the same Order.

THE long-expected map of Palestine, drawn in twenty-six sheets, on a scale of 1 inch to the mile, after the surveys of Lieutenants Conder and Kitchener, R.E., is now reported as complete and ready for publication. It has been photozincographed, under the superintendence of Col. Cooke, R.E., the Director-General of the Ordnance Survey, for the committee of the Palestine Exploration Fund. The first issue will be to the 250 holders of the special edition of the memoirs and map, as a first instalment of that work. It will afterwards be forwarded to the general subscribers of this fund, and will then be issued to the public. The survey of the country was accomplished between January, 1872, and September, 1877, since which time the maps have been laid down, the memoirs written, the observations calculated, the hills drawn, and the sheets lithographed. The whole of the work, except the colouring, has been executed by officers and men of the Royal Engineers. The general editors of the maps and memoirs are Major Anderson, C.M.G., R.E., and Prof. E. H. Palmer, of Cambridge.

MR. WHYMPER has succeeded in carrying out part of his South American programme by ascending to the summit of Mount Chimborazo. Dr. Nachtigal, in reference to this, states at a recent meeting of the Berlin Geographical Society, that a Frenchman, Jules Remy, professed to have accomplished the feat in 1856, but it is very doubtful if he actually did. He gave the height as 7,328 metres, whereas it is 1,000 m. less. Humboldt observed the height trigonometrically to be 6,530 m., and Reiss, as the result of three measurements, found the highest of the two peaks to be 6,310 m., and the other 6,269 m. Humboldt in 1802 attempted the ascent, but only reached a height of 5,878 m., while Boussingault with Hall, in 1831, reached a height of 6,004 m.; these attempted it from the south side, while Dr. Stübel, from the north side, reached a height of 5,810 m. After an inspection of ten days Mr. Whymper made three attempts, and on the third succeeded in mounting both peaks. The night before the final ascent he spent at a height of 5,227 m.

THE *Voix* has received a letter from the Russian Consul at Sydney, M. S. Paul, dated February 4 (16), in which he states that he had received a letter from Dr. Miclucho-Maclay, of date November 28 (December 10). The explorer was then at Simbonn, one of the Solomon Islands, and proposed to visit the Louisiade and Solomon Archipelagos, which would occupy him about six months, when he would return to Sydney.

THE Russian Geographical Society will receive from the Government a subsidy of 14,000 roubles yearly, to found and maintain meteorological stations at the mouth of the Lena and on the islands of New Siberia.

L'Exploration states that early in March Mount Argaeus (Ardjieh Dagh), in the Anti-Taurus chain, Asia Minor, 12 kilometres from the town of Kaisarieh, broke out in eruption. Its height is estimated at 3,991 metres above the sea. M. A. Synnet, of the Imperial Lycée of Galata-Serai, writing to the *Stamboul* on the eruption, states that Mount Argaeus had its origin in volcanic eruptions which have taken place from the lower tertiary to the fourth century A.D. The surface occupied by the lava is greater than that of the Island of Corsica. The mountain is composed exclusively of dolerite, trachyte, and basalt. Claudius and Strabo speak of the mountain as then active.

WE hear from Washington that the Government printer has been authorised by Congress to put to press a second edition of the "Narrative of the North Polar Expedition of the U.S. Ship *Polaris*" (noticed in NATURE, vol. xvi. p. 225), under the command of Capt. C. F. Hall, as soon as orders for a thousand copies have been received.

THE new *Bulletin* of the Belgian Geographical Society contains M. Cambier's report to the International African Association on his journey from Tabora to Karema on Lake Tanganyika, accompanied by a sketch map of his route. There is also a report of the recent annual meeting of the Association.

THE chief paper in the last part of the *Transactions* of the Asiatic Society of Japan is one by Mr. R. W. Atkinson descriptive of a journey through the provinces of Shinshiu, Hida, and Etchiu, during which he visited the mountains known as Yatsuga-take, Haku-san, and Tate-Yama. There is also a proposal by Mr. W. G. Aston for the arrangement of the Corean alphabet.

PHYSICAL NOTES

PROF. MARANGONI has lately experimented (*Riv. Sci. Ind.*, March 15) on the diathermanous power of films of soapy water. A series of equidistant films (eight to ten) were produced in a wide vertical glass tube, and horizontal heat-rays from a smoked plate having a temperature of about 400° were directed down the tube by means of a metallic mirror, a second mirror below directing them to a thermopile communicating with a Weber magnetometer. The conclusions arrived at from the tabulated numbers are these: 1. The first of the films, notwithstanding its great tenuity, absorbs more than half the incident heat, reducing it (as expressed in the magnetometer deflections) from 38 to 18. 2. The successive films produce decrements, as theory indicates; the differences of their logarithms are sensibly constant (on an average 7·5), and the logarithms themselves, after the second film, decrease proportionally to the number of the films. 3. The diminution of intensity observed must depend very little on reflection, but be due almost wholly to absorption. Indeed the first two films act like a sieve, intercepting, probably, the less refrangible rays in very large proportion, such as would hardly have been expected. 4. A given film becomes more diathermanous the thinner it becomes. 5. When various salts are mixed with the soap solution the diathermanous power is not sensibly affected. All these conclusions are in full agreement with the results of Melloni and with the theory of the phenomenon.

IN a recent paper to the Vienna Academy on the photochemistry of silver bromide, Dr. Eder gives the result of a large number of experiments relating to latent actions of light connected with the chemical development. It is first proved that silver bromide behaves differently, as it is brought to an emulsion in an indifferent material (*e.g.*, collodion) or an easily oxidable organic substance (*e.g.*, gelatine); also the influence of this circumstance and of the presence of variable quantities of silver nitrate or of soluble bromide on the sensitiveness to light is carefully studied, special regard being had to the passage of silver bromide into its different modifications and the consequent different photo-chemical behaviour. Oxidising acids are especially prejudicial to the light-sensitiveness, other acids less so, and still less alkaline chlorides and bromides. Alkalies increase the light-sensitiveness considerably. For a highly sensitive silver-bromide preparation the addition of ammonia to the finely-divided granular bromide of silver modification, in the form of a gelatine emulsion, is recommended. Temperature and moisture have no marked influence on the sensitiveness to light, but the quality of the developer has. The view is expressed that in chemical development of the latent image, electro-chemical processes must have a part. Mechanical pressure (which especially modifies the behaviour of silver iodide to physical developers), is without action on the behaviour of silver bromide to chemical developers. Dr. Eder cites some other decompositions of silver bromide, which resemble the "latent action" of light, and may be induced by prolonged treatment with *weak* means of reduction. Lastly, it is pointed out that silver bromide *with chemical development* is greatly superior to silver iodide, which *with physical development* exceeds all other silver haloid salts in sensitiveness, and herein it is nearly equalled by silver chloride.

FROM recent experiments by a new method on heat-conduction in liquids (a subject on which very conflicting results have been recorded), Herr F. H. Weber concludes that the heat-conducting power stands (without exception) in closest connection with the specific heat of unit volume. Comparing the conduction of heat in a metallic liquid (mercury) with that in transparent non-metallic liquids, he considers it depends on essentially different "moments" in the two cases. In the non-metallic liquids it seems to consist in a simple transference of the kinetic energy of the moved ponderable molecules from layer to layer, whereas in metallic liquids it would appear that the *internal* radiation from layer to layer is the essential element, the other being here of only secondary importance. This, in Herr Weber's opinion, throws quite a new light on the analogy between the heat conductivity and the electric conductivity of metals. These researches are described in the *Vierteljahrschrift* of the Zurich *Naturforschende Gesellschaft*, 1879, Bd. xxiv. p. 252.

THE INDIA MUSEUM ZOOLOGICAL COLLECTIONS

THE following letter on this subject has been sent us for publication:—

British Museum, March 17, 1880

MY LORD,—I am directed by the Trustees of the British Museum to acquaint your Lordship that Dr. Günther, the Keeper of the Department of Zoology in this Museum, has reported to them that he has completed the work of selecting from the zoological collections of the India Museum the specimens required for the British Museum, and of distributing the remainder among other institutions.

The accompanying extract from Dr. Günther's report shows in detail what has been done with those specimens which formed part of the India Museum, and what is proposed with reference to certain other specimens not included in the general transfer to the Trustees. I have, &c.,

(Signed) EDW. A. BOND

The Right Honourable the Secretary of State for India, &c., &c.

ZOOLOGICAL COLLECTIONS FROM THE INDIA MUSEUM

Extract from Report to the Trustees of the British Museum, by Dr. Günther, Keeper of the Department of Zoology. Dated March 8, 1880

1. For the British Museum have been selected and retained:—

672 Mammalia (mounted, or in skins, skeletons or skulls).
6,409 Birds.
125 Fishes.
28 Tortoises.
217 Mollusca.
83 Crustacea.
1,813 Insecta.
52 Radiata.
60 Jars and preparation of Economic Animal Products (besides some objects of manufacture transferred to the Ethnographical Department).

The Documents relating to the Zoological collections:—

2. A selection of the remainder was offered in succession to the Indian Museum, Calcutta; the Indian Institute, Oxford; the South Kensington Museum; the Dublin Museum; the Museum of Scarborough; and the Museum of Maidstone; the three first having been specially mentioned by the India Office as deserving precedence of other institutions.

a. The Agent of the Calcutta Museum selected:—

53 Mammalia and 3 Skulls of Mammals.
A series of named shells.
3,140 Named Insects.
A box of miscellaneous Insects. (The number of bird skins to be sent is not yet determined.)

b. Prof. Monier Williams, on behalf of the Indian Institute, Oxford, took the bulk of the remaining specimens, entering at the same time into an engagement to return them to the Trustees in case the project of the Institute were not carried out; he received:—

118 Mammalia.
37 Skulls and heads of Mammalia.
49 Horns of Mammalia.
2 Boxes containing various bones.
1 Narwhal's tusk.
1 Picture of a Flying Fox.
426 Stuffed Birds.
3 Boxes of Bird-skins.
5 Birds'-nests.
125 Bottles containing Reptiles and Fishes.
44 Stuffed Reptiles.
2 Models of Snakes.
1 Case of Stuffed Snakes.
94 Stuffed Fishes.
4 Models of Fishes.
1 Cabinet with Mollusks.
1 Box with Shells and Corals.
2 Boxes with Pearl Oysters, &c.
2 Boxes with Gorgonia.
2 Cases with Crustaceans.
5 Cabinets with named Insects.
10 Old Store boxes with various Insects.
2 Echinoderms.
1 Neptune's Cup.
1 Cabinet with Miscellaneous Specimens; Eggs, Nest, Crustaceans, Shells, &c.
1 Box of Sterna of Hodgson's Birds.

c. The South Kensington Museum took the whole of the collection of Economic Animal Products left after the selections for the British Museum and Kew had been made; the latter establishment receiving, by a special arrangement with the India Office, all products of silk and lac.

d. The Agent of the Science and Art Museum, Dublin, selected:—

7 Stuffed Mammals.
8 Skulls of Mammals.
1 Horn of *Cervus duvaucelii.*
5 Tortoises.
4 Bottles containing Reptiles.

e. The Agent of the Philosophical Society of Scarborough selected:—

10 Mammalia.

f. The Agent of the Museum of Maidstone took the whole of the remaining specimens, viz.:—

103 Stuffed Mammals.
10 Skulls.

Before commencing the work of distribution Dr. Günther received intimation from Dr. Birdwood that certain specimens were not included in the general transfer to the Trustees, viz.:—

1. Four small cases of stuffed Birds from Kashgar and an Ibex, belonging to Dr. Bellew, and lent by him to the Indian Museum for exhibition. These specimens would be a valuable acquisition to the British Museum, and therefore Dr. Günther has written to Dr. Bellew, who is at present in Afghanistan, that he would propose to the Trustees to continue the custody of them until instructions shall have been received from him as to their disposal.

2. A case of Wild Dogs, lent for exhibition by Mr. T. Webber, whose address is unknown at present. Dr. Günther would propose to undertake the temporary custody of this case until it is claimed by the owner.

METEOR SHOWERS[1]

SEVERAL of the meteor streams observed at Bristol within the last two years appear to be of such marked intensity as to merit special description, and the following notes in connection with five of these may possess some interest to observers.

No.	Epoch.	Radiant. α	Radiant. δ	Date of Maximum.
		°	°	
I.	July 30–Aug. 1	32	+ 53	July 31, 1878.
II.	July 27–30	341	− 13	July 27, 28, 1878–9.
III.	August 21–25	291	+ 60	August 21–23, 1879.
IV.	October 14–20	31	+ 9	October 15, 1879.
V.	August 8–11	44	+ 25	August 8–11.

I. At the middle of July, 1877, a few meteors were traced from a radiant point at 36° + 47°, and on projecting a large number of meteor tracks registered in foreign catalogues for the period July 25–31, I found the same shower amply manifested from 25 paths, though the radiant was 5° higher in declination. A succession of clear nights occurred from July 26 to August 2 in 1878, and I obtained some lengthy observations. In about twenty-two hours of watching more than 400 shooting stars were seen in the eastern sky, chiefly amongst the constellations of Perseus, Cassiopeia, and Andromeda. I saw many swift meteors leaving short streaks and otherwise exhibiting much uniformity in their appearances and directions. The radiant point was not reconcilable with that of the well-known annual shower of Perseids. It was sharply defined about 3° S. of the group χ Persei, and the maximum of the shower was witnessed on July 31, when 21 meteors were noted diverging from the point described. In all I saw 63 meteors conforming to this stream; they were short and quick, always with streaks of 3° or 4° in the latter portion of their flights. I looked for the shower again in 1879, and

[1] Extract from a paper in the *Monthly Notices* of the Royal Astronomical Society, vol. xl., No. 3 (January, 1880).

recovered it both on July 28 and 29. It appears to be identical with a radiant given by Schmidt at $31^\circ + 55^\circ$, August 3-12. The diagram shows the observed paths of 86 ♃ s (in the region of the radiant point) recorded at Bristol in the years 1877-8, and includes some tracks in the catalogues of foreign observers.

II. Contemporary with these, χ Perseïds, or Perseïds II, my observations in July, 1878, led me to recognise a large number of slow meteors with long paths (averaging 17°) and occasionally leaving faint trails of sparks, ascending amongst the stars of Pegasus, Andromeda, &c., which, by their parallelism of motion, obviously proceeded from a common radiant point south of Pegasus. I watched them narrowly, and determined the position with fair precision as near δ Aquarii. The best display of this fine shower was on July 27, when 22 of its meteors were recorded, and in the ¾h. preceding midnight on July 30, eight of

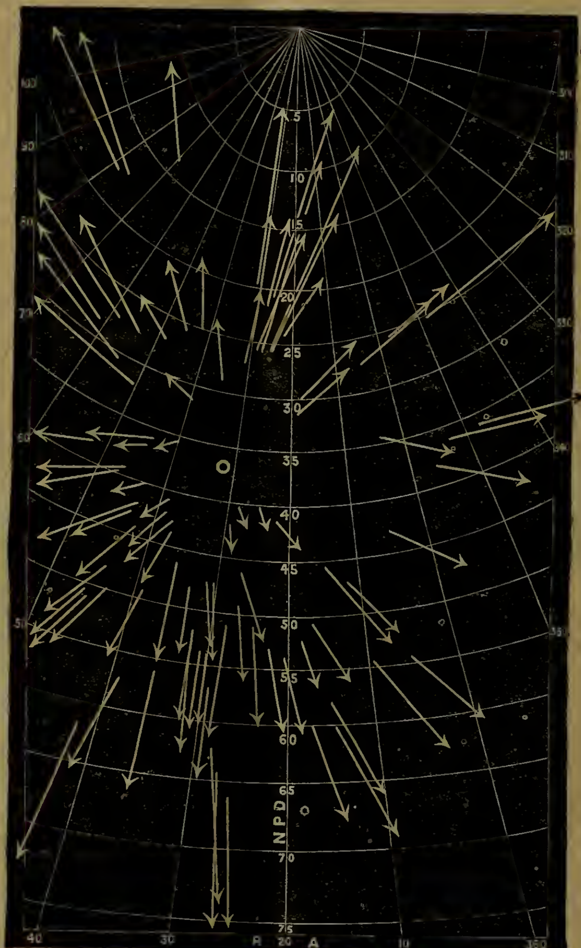

FIG. 1.—Shower of χ Perseïds, or Perseïds II, near the radiant point $32^\circ + 53^\circ$, max. July 28—August 1.

these Aquariads were visible, though the radiant was close to the horizon; but on the following night the shower appeared to have become extinct. In 1879, July 28, it reappeared, giving very long gradual meteors similar to those seen the year before. The continuation of this radiant in August is rendered extremely probable by my observations in 1877, when I detected a good centre at $342^\circ - 12^\circ$ from 12 meteors, August 3-16, and by a bright stationary meteor, also recorded at Bristol, on August 9, 1879, at $342^\circ - 16^\circ$. Major Tupman had obtained the best previous observations of this shower. On July 27, 1870, and several ensuing nights, he saw many meteors from an accurate radiant at $340^\circ - 14^\circ$, and the position and epoch of the shower, as he determined it, agree perfectly with its apparition in 1878-79 recorded at Bristol. Prof. Herschel had also, as early as July 28, 1865, traced a few of its meteors. There are later showers (of very slow meteors) from the same region of Aquarius. The diagram shows 41 tracks registered at the end of July, chiefly in 1878, at Bristol.

III. Beginning to observe at about 9h. 30m. on August 21, 1879, I immediately found a very active shower of slow, trained meteors proceeding from a point in Draco. I noted 9 of them in the ¾h. before 10h. 15m., though afterwards the display became less decided, and of the 68 meteors which I counted up to 13h. 30m. (when clouds overspread the sky) 21 belonged to this system. The two ensuing nights were clear, and I saw 143 shooting stars, including 31 additional paths conforming to the special shower in Draco, the exact position of which I determined at 291° + 60° (near *o* Draconis). The total number directed from this stream

Fig. 3.—Shower of Draconids (291° + 60°), max. August 21–23.

Fig. 5.—Shower of Muscids (44° + 25°), max. August 8–11.

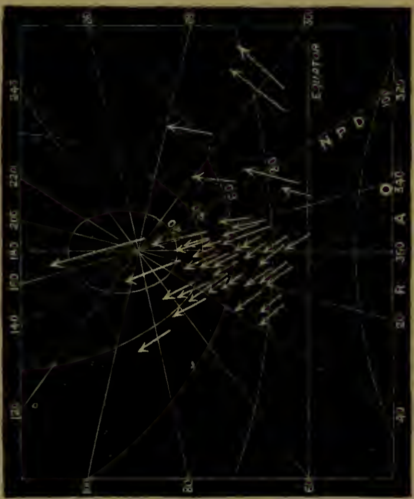

Fig. 2.—Shower of Aquariads (341° − 13°), max. July 27–30.

Fig. 4.—Shower of meteors from a radiant point at 31° + 9°, October 14–20 (max. October 15).

was 56 out of an aggregate of 225 meteors seen on August 21, 22, 23, and 25. The Draconids were generally brilliant, with short paths and spark-trails; motions rather slow. Ten exceeded or equalled the 1st mag. and 15 were estimated = 2nd mag. The shower is evidently identical with the Draconids II. (No. 78) of Greg's "Catalogue of Meteor Showers" (1876), in which the position is averaged at 282° + 60° and the whole duration extends from June 28 to August 25 (?) from 12 observations. There are other conspicuous showers directed from the same region in Draco at many other periods of the year. The diagram gives 41 paths, nearly all of which were traced on August 21–23, 1879.

IV. On October 15, 1879, the sky was watched for eleven hours (6h. 30m. to 17h. 30m.), and of the 127 shooting-stars seen during that lengthy observation, 21 were slow meteors from a radiant point at 31° + 9°, but the position was not well defined. I had seen several meteors from the same region on the previous night, and on the 20th, when the sky was again favourable, I recorded 10 others, making 37 in all from this shower in the south of Aries. They were generally faint, with rather short paths, and decidedly slow. The same radiant was seen by Major Tupman in 1869, October 13, at 28° + 10°, and Mr. Corder has distinguished a series of October positions in Aries and Pisces. The diagram (IV.) includes 42 paths observed by me in the years 1876–79, but chiefly in 1879.

V. At about the middle of August, 1877, a few rapid meteors were traced from a radiant in Musca at 40° + 28°, and in the following year, while noting the progress of the Perseids, I recorded several fine meteors, leaving streaks, and with paths averaging 40°. The radiant was evidently on the horizon, and the directions of the meteors, which in several instances were very exactly observed and mapped, indicated the point 44° + 25° as the diverging focus of the shower. With the object of further investigating it, I examined the observations made at the epoch of the Perseids, by the Italians in 1872 and by Zezioli in 1867–70, and found many meteors conforming to this shower of Muscids, which had already been detected by Weiss in 1869, August 11, 46½° + 23½°, and August 12, 41½° + 24°. In this region, between Musca and the east extremity of Aries, there are many successive showers during the four months from August to November. Early in August, when the first display is perceptible, the meteors are very swift, with unusually long paths, and seldom without streaks; but in October and November the motions are generally slow, and the phosphorescent streaks, forming so persistent a feature of the earlier displays, have given way to occasional trains of ashy sparks. The August shower above referred to merits description, as supplying some fine long meteors in the mornings of August. Thirty-eight paths are shown in the diagram, several of which are notable on account of inordinate length.

The several showers here mentioned, being apparently of little less importance than the Orionids, Geminids, Taurids, &c., will no doubt be frequently seen in future years; and it seems desirable to select them from the mass of feeble systems now ascertained, as affording displays of more than ordinary richness.

W. F. DENNING

CHEMICAL SOCIETY—ANNIVERSARY MEETING

WE take the following extract from the address, at the Anniversary Meeting, of the Chemical Society on March 30, by the president, Dr. De la Rue:—

Although since my last term of office I have not been precisely in a sleepy hollow, like that described by Washington Irving, nevertheless my thoughts have been mainly absorbed by other branches of science, and I found myself, on returning to this chair, very much in the same perplexity as Rip Van Winkle when he awoke in the Kaatskill Mountains after his long sleep.

So rapid has been the progress of our science, that much of the aspect of chemical thought has altered in the interval; old and once familiar bodies have not only changed their nomenclature, but new and unfamiliar individuals and families have crowded into the greatly extended domain of chemistry. The very elements which are looked upon as most stable are now considered to be in a critical position, and liable at any moment to dissociation; for it is only a few months ago that the minds of chemists were disturbed by the announcement that spectroscopic evidence afforded by the sun and stars tended to show that the so-called elements were in reality compound bodies. Even if we reserve our judgment on this point, we can no longer assert that the light emitted from the so-called elements, when incandescent or vaporised, is characterised by certain definite wave-lengths. Moreover, we learn that a well-known German chemist, Professor V. Meyer, has actually succeeded in dissociating the halogens, chlorine, bromine, and iodine. The results which he and his coadjutors have obtained appear to leave little doubt that such is actually the case, and we must await the outcome of their continued labours with intense interest.

As regards the spectrum itself, we can no longer attribute certain specific functions and properties to different parts of it; for Captain Abney has shown that every part of the spectrum acts actinically, and he even goes so far as to hold out a prospect of Becquerel's beautiful discovery being further extended, so as to produce permanent photographs of the spectrum in its natural colours. In his Bakerian lecture to the Royal Society, Captain Abney has made known his method of preparing a form of silver bromide, sensitive not only to the ultra-violet and the whole visible spectrum, but also to the infra-red rays, and has presented to that Society his magnificent map of the infra-red spectrum. It is difficult to overrate the value of this discovery, and it may be expected that important results will accrue from the investigation of the infra-red absorption spectra of various substances. Indeed, Captain Abney has already informed me of his progress in this direction. The importance of photography, not only as affording a means of investigation, but as a method of permanently recording observations which may be dealt with at leisure, thus affording the means of accurate measurement, in such hands as those of Dewar, Liveing, and Abney, cannot be too highly prized.

A problem which had long baffled all efforts, the artificial production of the diamond, is said to have been solved. Mr. Hannay's communication on the subject is so vague, however, that it is impossible to pronounce any opinion on it. The observations on the solubility of solids in gases, which led Mr. Hannay to attempt to crystallise carbon, and which are described in a recent communication to the Royal Society by Messrs. Hannay and Hogarth, are of great interest, and most important results will doubtless be obtained by an extension of these experiments.

The necessity for further information on the subject of the behaviour of various substances, and especially of mixtures under great pressure, is well shown by the recent remarkable observations of Cailletet, that on compressing a mixture of five volumes of carbon dioxide and one volume of air, the former at first liquefies; but that as the pressure is increased to 150–200 atmospheres, the meniscus of the liquid carbon dioxide becomes plane, and is gradually effaced, until finally the liquid wholly disappears, apparently dissolving in the gas.

Mr. Ansdell's papers on the "Physical Constants of Liquid Acetylene and Liquid Hydrogen Chloride," as determined with the aid of the Cailletet apparatus in the laboratory of the Royal Institution, are valuable contributions to our knowledge of chemical physics, and appear to furnish the interesting result, that the volume of the fluid and gas are equal at the critical point in the case of the latter substance.

Another investigation in chemical physics of great interest is that recently published by Brühl, who has considerably extended the observations of Gladstone, Landolt, and others, on the refractive indices of carbon-compounds. The introduction of a new method of calculating the results by which the influence of dispersion is eliminated, has led him to the discovery of an apparently very simple relation between chemical constitution and refractive power.

The extraordinary diligence of chemists who apply themselves to the investigation of carbon-compounds has also reaped a rich harvest of results. It would be impossible for me to consider the progress of this branch of chemistry in detail, but I cannot help noticing how rapidly the more complex bodies, such as the alkaloïds and the carbo-hydrates, are being forced to yield up the secret of their constitution, which has so long been withheld. The synthesis of *Isatin* by Claisen and Shadwell, and the researches of Baeyer in the indigo-group, must, it would seem, ere long result in the discovery of a method for the artificial manufacture of this colouring matter.

Ladenburg's success in preparing the alkaloïd atropine from *Tropine* and *Tropic* acid, the two substances which it furnishes when decomposed by hydration, is no doubt the first step towards the synthesis of an alkaloïd. Great advances have been made in unravelling the constitution of the bases of the Pyridine and Picoline series, and much light has been thrown thereby on the constitution of nicotine and the Cinchona alkaloïds. Moreover, important additions have been made to our knowledge of starch. It is remarkable, also, that a number of new facts have been brought to light tending to prove that the symbolic system at present employed to represent the constitution of carbon-compounds is insufficient.

The year has not passed by without announcements of new members of the family of Elements. One of the most interesting and best authenticated is that of Scandium, which has been separated from Norwegian Gadolinite and Yttrotitanite by Nelson and Clive. I had the advantage, when last year in the University of Upsala, of being shown the spectrum of this metal by Professor Thalén, and of making the personal acquaintance of its distinguished discoverers, who showed me the enormous amount of material they worked upon in order to obtain the specimen I saw. Scandium, according to Clive, has the atomic weight 45, and the properties of its compounds are almost exactly those predicted by Mendelejeff of the hypothetical element *Ekaboron*, to which the atomic weight 44 was assigned. We have thus apparently, for the second time, a remarkable verification of Mendelejeff's sagacity and the importance of his so-called Periodic Law. I may here refer to the service Mr. Crookes has rendered by publishing a translation of a revise of Mendelejeff's celebrated paper in *Liebig's Annalen*.

The Report of the Research Fund will be found in the Appendix, and it is not necessary for me to enter upon its details. There is much work always to be done of the highest importance to the advancement of chemistry, but which does not offer sufficient attraction to induce the devotion of the time, perseverance, and money necessary for its accomplishment; here the Research Fund steps in and removes one of the obstacles. In other cases, where the necessary zeal and talent exist to commence a valuable research, the chemist may not be in a position to devote time and money for the undertaking; but with funds at its disposal our Society can prevent the opportunity from being lost. I trust that those whose position of fortune permits of their doing it will contribute largely to the Research Fund, and thus promote the advancement of a science which may have contributed greatly to their own prosperity.

The Drapers' Company for the last three years contributed 105*l*. per annum to the Research Fund, and the Goldsmiths' Company at the commencement gave a munificent donation of 1,000*l*.; the City Companies cannot devote a portion of their vast revenues more usefully than in promoting scientific researches, for with the advance of knowledge will the prosperity of our country develop. The past year has been one of peaceful prosperity in our Society, and we have had a large accession to our members, and the alteration of the bye-law relating to the election of candidates has, on the whole, worked well; but as it has been frequently necessary to postpone the ballot for want of sufficient attendance, it has therefore been thought desirable to make a change in it.

APPENDIX.

Third Report of the Research Fund Committee.—During the past session the following sums have been granted from the Research Fund by the Council on the recommendation of the Research Fund Committee:—

30*l*. to Mr. M. Whitley Williams, for the elaboration of an improved method of Organic Analysis.

25*l*. to Mr. M. M. P. Muir, for the study of the Chemical Habitudes and Physical Constants of Bismuth Compounds.

15*l*. to Mr. J. M. Thomson, for experiments on the action of Isomorphous Bodies in exciting the Crystalisation of Supersaturated Solutions.

50*l*. to Dr. Wright, for the continuation of his investigations of certain points in Chemical Dynamics.

25*l* to Mr. F. D. Brown, for the continuation of his investigation of the theory of Fractional Distillation.

30*l*. to Mr. Bolas, for the preparation and investigation of Alloys and Compounds of Chromium.

20*l*. to Dr. Japp, for the investigation of the action of the Organo-zinc Compounds on Quinones.

100*l*. to Dr. Armstrong, for the determination of certain physical properties, especially the Refractive Indices of Typical Chemical Compounds.

100*l*. to Dr. Wright, for the determination of Chemical Affinity in terms of Electrical Magnitudes.

100*l*. to Mr. F. D. Brown, for the determination of the Vapour Tension of Pure Compounds and of Mixtures.

The two last-mentioned grants were made in February of this year, the others in June, 1879.

A donation of 105*l*. from the Worshipful Company of Drapers, and one of 100*l*. for which the Society is indebted to the generosity of its president, Mr. De la Rue, are important items in the income of the fund for the year. The Committee desire to point out to the Council and to the Fellows at large the desirability of obtaining further additions to the fund, for without such contributions as these the income arising from investments would have been quite inadequate to meet the legitimate demands upon the fund. It is to be expected, and indeed we hope, that these demands will increase rather than diminish, and it is therefore especially necessary that efforts should be made to increase the income of the fund.

During the session the result of several investigations, in aid of which grants have been made from the Research Fund, have been communicated to the Society.

Dr. Tilden, in a paper on terpene and terpinol (*Trans.*, 1879, 286–290), after describing several properties of these bodies, adduces evidence to prove that the latter is a constituent of some essential oils, as oil of lemon and cajuput.

Prof. Thorp has described (*Trans.*, 1879, 296–309) the results of his examination of so-called abietene, the exudation from the Californian nut or Digger pine (*Pinus sabiniana*). He finds it to consist of the almost pure paraffin, normal heptane, C_7H_{16}, and having thus obtained a considerable quantity of this hydrocarbon, he has availed himself of the opportunity to make a series of most valuable determinations of several of its physical constants.

Dr. Wright, in conjunction with Messrs. Luff and Rennie (*Trans.* 1879, 475–524), has presented a voluminous third report on his researches on some points of chemical dynamics, describing at length the result of experiments on the relation between the rate of the reduction of cupric oxide by hydrogen or carbon monoxides, time, and temperature.

Mr. F. D. Brown has described the behaviour of mixtures of benzene and carbon bisulphide when distilled under various conditions as a contribution to the theory of fractional distillation (*Trans.*, 1879, 547–562). In a second communication (*Trans.*, 1880, 49–60) he has embodied the results of the comparison of the value of the different methods of fractional distillation.

Drs. Armstrong and Tilden have presented an account (*Trans.*, 1879, 733–760) of their examination of the action of sulphuric acid under various conditions on the terpenes. One of the chief results of their investigation is to establish the fact that no such substance as terebene exists, the liquid hitherto described under this name being simply impure camphene.

Dr. Bedson (*Trans.*, 1880, 90–102) has carefully examined a number of derivatives of phenylacetic acid, an acid which has now become of special interest to the chemist on account of its relation to indigo.

The investigation of Messrs. Hartley and Huntington on the action of organic compounds in absorbing the ultra-violet rays of the spectrum referred to in the last report has since been published in the *Transactions* of the Royal Society. These gentlemen also have since submitted to the Royal Society an account of the results of the combination of the investigations.

Dr. Tilden has communicated the chief results of experiments on the action of hydrochloric acid upon terpenes—a portion of the subject for which he received a grant from the Society—to the Chemical Society of Berlin (*Ber.*, 12, 1131).

The experiments on the action of iodine on terpenes and on the saturated hydrocarbon, referred to by Dr. Armstrong in the last report, have been partially described in communications to the Berlin Chemical Society (*Ber.*, 12, 1756–1790). The publication of the observations on camphor has been delayed in order to render them as complete as possible.

Dr. Japp has forwarded to the Secretaries a paper which will be read at the next meeting, in which he describes the results of his investigations of the action of zinc ethyl on phenanthraquinone.

Several gentlemen who have received grants, but not yet communicated their results to the Society, viz., Messrs. Bolas, Burghardt, Dupré, Jago, Shenstone, and Williams, have favoured the Committee with preliminary reports of the progress made in their investigations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—A little more than one half of the total cost of the new hall of Newnham College has now been received or paid, and the amalgamation of Newnham Hall with the Lecture Association may be described as almost completed. To pay for the buildings and furnish them about 5,000*l*. more will be needed. The laboratory and gymnasium are excellent.

Messrs. Shaw (Emmanuel College) and Glazebrook (Trinity

College) have been appointed Demonstrators in the Cavendish Laboratory of Experimental Physics.

The University Commissioners have at last put forward a Statute by which students in "Letters" are to have a Doctorate, so that to Divinity, Law, and Medicine, two new faculties are now added, namely, Letters and Science. The University is also to have power to accept as an affiliated college any college in the British dominions, educating principally adult students, and to allow their qualified students three terms of residence towards those required to obtain a Cambridge degree.

The Woodwardian Professor gives notice that as he is prevented by illness from returning to Cambridge at present, Mr. Roberts, D.Sc. [Lond], will lecture for him during the present term.

The returns already received for the Technological Examinations of the City and Guilds Institute show that over 1,100 candidates will present themselves for examination at eighty centres. This is a very large increase on last year, when only 202 were examined. The examinations are to be held on the evening of May 12, concurrently with the examination of the Science and Art Department on that evening.

SCIENTIFIC SERIALS

The *Quarterly Journal of Microscopical Science*, April.—W. T. Thiselton Dyer, M.A., Assistant-Director, Kew, on the coffee-leaf disease of Ceylon (six plates).—J. I. Siddall, on Shepheardella, an undescribed type of marine rhizopoda (on the plates Shepheardia), with two plates. The nucleu in this form seems to be unlike anything as yet described among the rhizopods. The author also figures and describes *Lieberkuehnia wageneri* from Tenby. This rhizopod is only "a native of Berlin" in a very peculiar sense. Claparède's words are, "Nous n'avons rencontré qu'une seule fois ce rhizopode, à Berlin dans une petite bouteille qui renfermait de l'eau de provenance inconnue." The present memoir throws no new light on its probable affinity to *Pamphagus mutabilis*.—A. Sedgwick, on the development of the kidney in its relation to the wolffian body in the chick (with two plates).—F. M. Balfour, notes on the development of the Araneina (with three plates).—Dr. L. Waldstein, a contribution to the biology of bacteria.—Prof. Schäfer, some teachings of development.—Prof. T. Jeffery Parker, on the histology of *Hydra fusca*.—Prof. Giard, on the Orthonectida, a new class of the phylum of the worms (with a plate).—Notes and memoranda.

American Journal of Science, March.—On a chart of the magnetic declination in the United States, constructed by J. E. Hilgard.—The old river-beds of California, by J. Le Conte.—Age of the Green Mountains, by J. D. Dana.—On a new action of the magnet on electric currents, by E. H. Hall.—Measures of the polar and equatorial diameter of Mars, made at Princeton, New Jersey, U.S., by C. A. Young.—On the use of the sine-formula for the diurnal variation of temperature, by B. A. Gould.—On the chemical composition of the Uraninite from Branchville, Conn., by W. J. Comstock.—On the mean free path of a molecule, by N. D. C. Hodges.—On the western limits of the Taconic system, by S. W. Ford.—Principal characters of American Jurassic dinosaurs, by O. C. Marsh. Part iii.

The *American Entomologist*, No. 3, new series, March, 1880, contains a multitude of useful notes on questions concerning entomology, amongst which may be noticed trappi[illegible] the Carpet Beetle (*Anthrenus scrophulariæ*).—The Ailanthus silkworm.—Insects injuring the black locust.—The insect [illegible]mies of our small fruits, by A. S. Fuller.—The relation be[illegible] insects and plants, and the consensus in animal and vegeta[illegible], by L. F. Ward.—Birds *v.* insects, by the late E. Perris, t[illegible]d.—Two days collecting in the Mammoth Cave, with c[illegible]utions to a study of its fauna, by H. G. Hubbard, the latter especially interesting, giving a list of all the animals hithert[illegible] found in this celebrated cave, highly illustrated by excellent w[illegible] cuts, with a description of a very curious new form of p[illegible]udo-scorpion, described by Dr. Hagen as *Chthonius packardi*. It will be a great advantage if the editors of this periodic[illegible] in future a *résumé* of the contents of each number. We a[illegible] requested to notice that it is now published by the Hub Publ[illegible] Company of New York, 323 Pearl Street.

Journal of the Franklin Institute, March. The Edison [illegible]ectric light (continued), by Mr. Outerbridge.—Committee's report on the Goodwin mowing-machine.—Saws (continued), by Dr. Grimshaw.—Apparatus for illustrating the aberration of light, by Prof. Tobin.—On the acid products of combustion of coal, by M. Vincotte (translation).—Mica, by Mr. Rand.—A new lecture experiment; the cupelling of gold and silver.

SOCIETIES AND ACADEMIES

London

Royal Society, April 8.—"On the Sensitive State of Vacuum Discharges. Part II." By William Spottiswoode, D.C.L., LL.D., Pres.R.S., and J. Fletcher Moulton, late Fellow of Christ's College, Cambridge.

This paper forms a sequel to that published under the same title in the *Phil. Trans.*, 1879. It describes a continuation of the research into the nature and laws of the disruptive discharge, or electric spark. The methods of the earlier paper have been extended, and others adapted to the new circumstances have been devised, in order to carry the investigation into high vacua. In particular, independent sources of electricity have been used for effecting the discharge, whether in the sensitive or in the non-sensitive state; and the results have been confirmatory of the conclusions derived from the more limited means formerly described. Further, the effects of various tubes containing discharges in the sensitive state upon a tube containing a discharge in the non-sensitive state have been observed and compared; and the tube so used as a test has been called the standard tube, and the method of its use the standard tube method. By this means, principally, the laws of the discharge in comparatively moderate vacua have been extended to high vacua.

In the higher vacua, the phenomena of molecular streams, and the phosphorescence consequent on them, that have been studied and described by Mr. Crookes, present themselves. These derive great importance for the purposes of the present paper from the fact that in high vacua the ordinary luminous discharge becomes so feeble in appearance that it is often difficult to observe. Under these circumstances the phosphorescence, which, like the ordinary luminous effects, may exist either in a sensitive or in a non-sensitive state, forms the best index of what is going on within the tube. Much information as to the nature and procedure of the discharge may be derived from the mode of interference of one molecular stream with another, from the direction and character of shadows cast by these streams, and by a form of interference which has here been called that of virtual shadows.

The conditions of pressure and of electrical violence, under which phosphorescence is produced, have been carefully studied; and it has been found that, with a suitable adjustment of the discharge, the phenomena are not confined to high vacua, but can be obtained under pressures much exceeding those of ordinary vacuum tubes. The phenomena of these molecular streams have also been compared with those exhibited by the projection of finely divided solid conducting matter when heaped up over the negative terminal, with the view of ascertaining the nature of the phenomenon and its position in the discharge.

At the close of the paper the authors have discussed some of the general conclusions which they think may be fairly drawn from their present researches. First, as to the relative order of magnitude of the time-quantities entering into the discharge; *e.g.*, the times occupied by the discharge of positive or negative electricity, or of molecular streams, in leaving a terminal; the time occupied by the same elements in passing along the tube, &c. Secondly, as to the durational character of the negative as compared with the positive discharge, which appears to increase with the degree of exhaustion. Thirdly, as to the mode of formation of the positive column; and fourthly, as to the relation of the molecular streams to the discharge proper.

But for the details of these conclusions the reader must be referred to the paper itself.

April 15.—"Description of some Remains of the Gigantic Land-lizard (*Megalania prisca*, Owen) from Australia. Part II.," by Prof. Owen, C.B., F.R.S.—Referring to a former Part (*Phil. Trans.* 1858, p. 43), the author gives, in the present, descriptions of subsequently received fossils of *Megalania prisca*, advancing the knowledge of that species of large extinct lizard. Characters of the dorsal, sacral, and caudal vertebræ, with those of a considerable portion of the skull, are detailed. So much of the upper jaw as is preserved shows the species to have had that part sheathed with horn as in the tortoise. Upon the head were seven horns, three in pairs, and one single; they are defined as the "supraparietal," "supratemporal," and "post-orbital" pairs; the single and symmetrical horn is "nasal."

In the comparison of this character with the known genera of lizards the author finds the closest correspondence in the diminutive existing Australian species, *Moloch horridus*, Gray. He concludes with remarks on the probable habits and conditions of extinction of the subject of his two papers.

"Report on the Exploration of the Caves of Borneo," by A. Hart Everett. "Introductory Remarks," by John Evans, D.C.L., LL.D., Treas. R.S. And "Note on the Bones Collected," by G. Busk, V.P.R.S.

The general result of the exploration may be summed up as follows:—The existence of ossiferous caves in Borneo has been proved, and at the same time the existence of man in the island with the fauna, whose remains are entombed in these caves. But, both from the recent nature of this fauna, and from the fact that the race of men whose remains are associated with it had already reached an advanced stage of civilisation, the discovery has in no way aided the solution of those problems for the unravelling of which it was originally promoted. No light has been thrown on the origin of the human race—the history of the development of the fauna characterising the Indo-Malayan subregion has not been advanced—nor, virtually, has any evidence been obtained towards showing what races of men inhabited Borneo previously to the immigration of the various tribes of Malayan stock which now people the island. Furthermore, the presumption that the north-west portion of Borneo has too recently emerged above the waters of the sea to render it probable that future discoveries will be made of cave deposits of greatly higher antiquity than those already examined, has been strengthened. Under these circumstances it seems advisable that cavern-research in north-west Borneo should now be left to private enterprise, and that no further expense should be hazarded, at any rate until the higher parts of the island in the north-east may be conveniently examined.

"Note on the Collection of Bones from Caves in Borneo, referred to in Mr. Everett's Report on the 'Exploration of the Bornean Caves in 1878-9,'" by George Busk, F.R.S., V.P. Anth. Inst.

These bones present nothing of especial interest; and with respect to the race to which they may have belonged, the information they have afforded is very meagre. On this point all that can be said is that they may well have belonged to the Malay type, but there is also no apparent reason why they should not have been of Chinese origin. What tends to afford some support to this supposition is the marked fulness or bulging of the squamosal in the sphenoidal fossa, to which I have called attention, and which, upon examination of the collection of crania in the Royal College of Surgeons, I find is presented by several among the Chinese crania in a more marked degree than in the other races to which my attention was directed.

Physical Society, April 10.—Prof. Fuller in the chair.—New members:—Mr. W. O. Smith, Prof. Judd, F.R.S.—A paper on the human eye as an automatic photometer, by Mr. William Ackroyd, was read. It is difficult to get the value of a very intense light in terms of a weak one, because the relative physiological values of the similarly coloured constituents are unknown. The author's experiments were made to show that the eye itself is a fairly good light measurer. When a "spot" or star of light is looked at from a distance, it is seen to emit "rays" or spokes of light at all angles. These are due to the radiate structure of the crystalline lens and to the lachrymal fluid on the surface of the corner of the eye. The rays are of various lengths and are shorter in the 1st and 2nd quadrants, next the nose, near the blind spots, than on the 3rd and 4th quadrants—a fact probably due to the insensibility of this region. The iris expands and contracts under the stimulus of light independently of the will; and both irises act sympathetically. Now the iris lies between the seats of irregular refraction, and thus any change in the size of the pupillary aperture will be rendered evident by an alteration in the length of the longer rays of a spot or point of light. On this fact is based the use of the eye as an automatic photometer. The sensitiveness of the iris varies in different persons. The author finds that a sperm candle, burning 120 grains per hour, produces a distinct movement of his iris when 14 yards distant. In employing the eye as a photometer, the author adopts the principle that if the light from one source A falling on the eye is capable of producing movement of the iris at a distance *d*, and the light from a different source B is capable of producing the same movement at the distance *d'*, then the relative intensity is proportional to the squares of these distances. To carry this out in practice the observer is in the dark, and an artificial star is placed on a level with the eyes at a fixed distance. Below this is placed the light to be tested in the same plane. While gazing steadily at the star the other light is to be eclipsed and revealed, and the observer is to find a position where the revealing of the second light does not influence his iris, as shown by no apparent shortening of the rays of the star taking place. He then approaches gradually till a second position is reached, when the revealing of the second light *does* produce a movement of the iris. The distance between his eye and the light, *d*, is measured. A third light is now put in place of the second, and the same observations repeated, so as to get a second distance, *d'*. From these distances the relative intensities are calculated; the author's results agree pretty closely with Rumford's photometer, but he found that for some reason the two first observations have to be discarded as too inaccurate. Owing to the sympathy between the two irises these experiments were binocular. This sympathy may prove convenient in constructing an eye-photometer, since one eye can be turned to the light to be estimated while the other is looking at the artificial star. This method of photometry would be too delicate for comparing powerful electric lights, unless aided by mechanical means.—Prof. Ayrton then offered an explanation of the experiment shown by Prof. Guthrie at last meeting to the effect that while flannel rubbed with ebonite was + electrified, and ebonite rubbed with glass was +, flannel rubbed with glass was −. Prof. Ayrton accounted for this apparent anomaly on the ground that one or more of the substances was an electrolyte. Glass, for instance, is an electrolyte, and a battery had been made from it. Experiments made by Prof. Perry and himself had shown that in a "pile" made up of divers substances, one or more of which were electrolytes, though the rest were metals, the electromotive force of the pile was equivalent to the algebraical sum of the several "pairs" composing it, but it was *not* equivalent to the electromotive force of the first and final plates made into a pair. That could not be predicated from the contact-electromotive forces of the elementary "pairs." When only metals were employed it could, but not in cases where an electrolyte entered. This same result would apply to Prof. Guthrie's frictional experiments. In answer to Prof. Guthrie's question whether electrolysis did not come into play in Prof. Ayrton's experiments, Prof. Ayrton replied that it could not operate to a greater extent than in Prof. Guthrie's experiments, as he had used a quadrant electrometer.—Dr. Stone then described a new tonometer devised by Prof. Rudolf König, which he had recently seen in Paris. It consisted of a clock-work working into a tuning-fork, which produced no less than 128 escapes per second. To this clock-work, originally invented by an assistant of M. Breguet, and exhibited at the Paris Exhibition of 1856, Prof. König had added a Helmholtz vibration microscope moved by the clock and the fork, whose vibration number to be measured is placed vertically in the focus of the microscope. The tonometer is very portable, and no loading of the fork is required. Prof. Hughes observed that he had patented a vibrating regulator in 1856.—Dr. Guthrie then exhibited an electric machine formed of a collodion disk rubbed with a cat's fur, and giving negative sparks. The collodion, after a suggestion of Capt. Abney, was put on by giving a disk a coat of collodion, then a coat of india-rubber dissolved in benzol, then a coat of collodion again. Prof. Guthrie also showed that an iron cylinder revolving round its longer axis, and with a current flowing in a wire parallel to it, has power to deflect a magnetic needle. Prof. Ayrton stated that he had found the mere rotation of an iron cylinder produced the deflection in question, and therefore thought the current was not required to produce the effect shown.

PHILADELPHIA

Academy of Natural Sciences, November 11, 1879.—On a collection of crustacea from Virginia, North Carolina, and Florida, with a revision of the genera of Cragonidæ and Palæmonidæ, by J. S. Kingsley.

November 18.—On the stratigraphical evidence afforded by the Tertiary fossils of the Peninsula of Maryland, by Angelo Heilprin.

December 9.—Description of a fœtal walrus, by Dr. Harrison Allen.—Complete connection of the *Fissura centralis* (fissure of Rolando) with *Forsa sylvii*, by Dr. A. J. Parker.

December 30.—Annual meeting.—Dr. Ruschenberger, the president, gave a *résumé* of the Society's work, describing it not as an exclusive but as an inclusive Society for the acquirement, increase, simplification, and diffusion of natural knowledge. Its members have signalised themselves by doing their own printing in the Academy Hall; in fact gratuitous labour produces all the matter published by the Academy. The institution is free from debt, with a substantial building, and large collections of objects as yet little studied. During last year the card catalogue of works on anatomy and physiology has been completed, and the only departments of the library not yet possessing a special catalogue will be those of anthropology and mineralogy; these it is hoped to complete this year. In the museum work Mr. J. A. Ryder has now identified 700 species of fishes in 325 genera. The museum has had a notable acquisition in the archæological collections of the American Philosophical Society, especially consisting of the Poinsett collection of Mexican antiquities, and many Peruvian remains; while Mr. W. S. Vaux has borne the expense of adapting a room to receive the collection. The skeleton of a native of the Chatham Islands has been presented by Mr. W. H. Rau. Many fossils of great interest and value, including bones of Uintatherium, Palæosyopæ, and Crocodile, from Green River, Wyoming, have also been added. The Section of Biology and Microscopy has had two special *soirées* and seventeen meetings. In Conchology 2,750 trays, containing 11,895 specimens, have been determined, labelled, mounted, and placed in the collection. The arrangement of the Swift Collection is now completed, after three years' labour; it is especially rich in West Indian shells, and especially in terrestrial species; it comprises 7,058 trays, containing 30,384 specimens. Mr. C. F. Parker has been a very active worker in this department, and Mr. John Ford, vice-director of the section, has prepared sections of many shells to show their internal form. Donations have been very numerous and valuable. The Herbarium has received very valuable donations, and the gaps in the genera are now mostly from rare districts. Dr. Asa Gray has during the year revised many perplexing genera in the North American Compositæ, and Mr. Parker is mounting the plants, with Dr. Gray's notes affixed, as fast as elaborated. There is great and valuable voluntary work going on by many botanical workers; 2,181 species have been received during the year, especially 623 species of Florida plants, including many new and rare species collected and presented by Dr. A. P. Garber, and many hundreds of foreign plants, by Dr. Asa Gray.

PARIS

Academy of Sciences, April 19.—M. Edm. Becquerel in the chair.—The following papers were read:—On the inverse problem of motion of a material point on a surface of revolution, by M. Resal.—On the reciprocal displacements of the halogen elements, by M. Berthelot.—On the stability of oxygenated water, by M. Berthelot. The spontaneous decomposition of this compound becomes slower and slower in course of time. The rate of transformation varies remarkably with the presence of foreign substances in the liquor. The least trace of a base or free alkali causes rapid decomposition; acids retard the process; variation in amount of acid hardly affects it, but the special nature of the acid does. Temperature accelerates the process. —On the earths of samarskite, by M. Marignac. He confines himself here to those earths the nitrates of which are last decomposed. To separate these he had recourse to their difference of solubility in a saturated solution of sulphate of potash. He finds, then, yttria (the principal element), terbine, a new earth Y_a, and a small quantity of oxide of didymium, and of an earth, which, if not pure decipium, is at least in great part composed of it.—On the interoceanic canal of Panama, by M. de Lesseps. No serious difficulty is anticipated. The length of the canal will be 73 km., while the Suez Canal is 162. From the Atlantic the entrance will be by the mouth of the River Chagres (which will be deepened), and at Cruces, where this river issues from the mountains, a dam of 46m. height will be raised, making possible the storage of 1 milliard cubic metres of water. Beyond Cruces the canal traverses the mountain of Culebra by a cutting of 5km., and then the bed of the Rio Grande is utilised to the Bay of Panama.—Observations on Megapoda, by M. Oustalet. He gives results of a visit to the English and Dutch museums; thinks the number of species allowed by ornithologists too large and reducible to about twenty-five; proposes a new subdivision of the genus *Talegallus*, the sub-genus *Æpypodius*, including the *T.* of Waigiou (which he calls *T. Bruijnii*), and *T. pyrrhopygius*; he also seeks to rectify the frontiers assigned to Pteropoda by Huxley.—Theory of capillary phenomena (5th memoir), by M. Roger.—On the electromagnetic gyroscope, by M. de Fonvielle. The impossibility of getting rotation with induction-coils whose induced wire was very long, and in which therefore the difference referred to by M. Jamin was as great as possible, led him to reject M. Jamin's explanation.—Discovery of a comet by M. Schaberle (telegram from the Smithsonian Institution), communicated by Admiral Mouchez.—Observations of the same comet at Paris Observatory, by MM. Henry and Bigourdan.—On the positions of the principal planets, by Mr. Chase.—Remarks on the formulæ of quadrature of Gauss, by M. Radau. —Electric synchronism of any two motions, by M. Deprez. He transmits electrically the movement of a motor A to a receiver B, so that the angular velocity of B is always equal in amount and sign to that of A. The transmitter has two commutators for inversion of current, and the receiver two straight electromagnets which rotate between the branches of a fixed one.—Measurement of thermo-electric electromotive forces in contact of a metal and a liquid, by M. Bouty. A derivation from a circuit of known resistance, traversed by the current of one Daniell element, comprised (1) a thermoelectric apparatus, formed of two tubes containing a liquid kept at different temperatures, and two metallic plates of the same metal, the tubes being connected by a long capillary syphon; (2) a sensitive Lippmann electrometer. The results with various metals and salts of these in water-solution, where the warm metal is exteriorly the positive pole, are tabulated. The thermo-electric force is rigorously proportional to the difference of temperature of the plates, and does not sensibly vary with the degree of dilution of the salt. Salts of a given oxide give nearly the same number, and the number for copper and amalgamated zinc are nearly identical. Where the cold metal is exteriorly the positive pole, the measurements become uncertain, and the variations of electromotive force are no longer proportional to the temperature.—On an automatic mercury pump, by M. Couttolene. This is for increasing a vacuum commenced by a water-trompe.—On tropeins, artificial mydriatic alkaloids, by M. Ladenburg.—On gelose, by M. Morin.—On carbonate of ammonia, by M. Maumerle. Two samples, nearly identical, showed very different properties. —On existence of ammonia in plants and muscular flesh, by M. Pellet. *Inter alia*, the strong ammoniacal odour perceived in sugar manufacture, when the juice is treated with lime, is accounted for by the ammonia found in beet. Plants containing much of alkaline phosphates (*e.g.*, corn) have their carbonates decomposed by these. In flesh of ox M. Pellet found 0·15 gr. ammonia per cent. of the substance.—On an adulteration of silicate of soda, by M. Jean. Anhydrous soap was the substance added.—On the variability of the teats of Ovides of the Lower Cevennes, by M. Tayon.—On treatment of Arabian elephantiasis by simultaneous use of continuous and intermittent currents, by MM. Moncorvo and Aranjo. The continuous currents soften the tissues, and the intermittent promote re-absorption.

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