THURSDAY, APRIL 22, 1875

THE ANCIENT MONUMENTS BILL

IT is so far gratifying that Sir John Lubbock's bill for the preservation of the few remains of our ancient monuments that time and the ignorant or sacrilegious hand of the spoiler have left, passed the second reading by a respectable majority on Wednesday week. The Committee was fixed for yesterday, and we hope the bill will pass through the ordeal with its main principle and provisions intact. As our readers are doubtless familiar with the purpose and main details of the bill, which has been before the public for three years, it is unnecessary to expound them here, especially as we have already done so in a previous article (NATURE, vol. vii., p. 297).

The objections urged against the bill, both in the House of Commons and in the *Times* article of Monday, seem to us either frivolous or inapplicable. They may be all summed up in the statements that the bill interferes with the sacred right of private property, and that it is unnecessary, as private owners and the public generally are fully aware of the value of our historic and prehistoric relics, and that no special provision is required for their preservation.

As to the objection that the bill will interfere with the individual rights of property, we can hardly believe that even those who most strongly urged it really believe that this objection will hold water. Were the bill as it stands passed into law, landowners on whose estates any ancient monuments are situated that the Commissioners thought came under the operation of the Act, would be in exactly the same position to the relics as before, with the exception that they would not be allowed to do anything tending to their injury or destruction. And we hardly think that even any of the honourable objectors to the bill would openly declare that they held the right of destruction of a national monument to be one of the rights of private property. Nearly all the objectors expressed their respect for the remains left behind by the previous populations of this country, and their anxiety that no harm should come to them; and this the bill proposes to accomplish in a way that cannot possibly be done so long as these monuments are the absolute property of private individuals.

For the opponents of the bill in Parliament, as well as the *Times*, may talk as they will of the public spirit of the country being a sufficient safeguard against the ruthless destruction of these relics which all but the lowest class of philistians must regard as precious; but there is no doubt whatever that for want of a provision such as that contained in the bill, many of the most valuable of our ancient monuments have suffered grievous and irreparable harm. No more forcible instance could be adduced than that of "Cæsar's Camp" at Wimbledon, which, under the eyes of the public, and by members of that public whose "spirit" is so much lauded, is being rapidly obliterated from the land. No one can at present prevent it. And over all the country there are remains of equal value whose preservation it is nobody's business to see to, and which therefore, by destructive time, by philistian tourists and owners, or ignorant farmers and peasants, are gradually being made to share the fate of Cæsar's Camp. Had such a bill been passed a century or even half a century ago, how much valuable material might have been saved to the student of history and antiquities, to the investigator into the progress of civilisation and of the human race!

The *Times*, for some inscrutable reason, has seen meet to oppose the bill to a great extent on practical grounds, as if its purpose were to preserve every relic of the past that might come to light, no matter at what expense to the public welfare and convenience. But the writer of the article either ignorantly or wilfully mistakes the purpose of the bill altogether; we believe that all the monuments enumerated are so situated, are at such a distance from the "busy haunts of men," that their preservation neither now nor at any future time is likely to interfere with the convenience and welfare of the existing population. It is simply stupid to speak in this connection of fragments of old walls and tesselated pavements unearthed in London; Sir John Lubbock himself, we believe, and those who support the bill, would have no hesitation in sweeping away any ancient monument whatever, if it could be really shown that it stood in the way of the progress of the country and the race. But in the *Times* article there is an unmistakable inclination to doubt the "utility" of taking any care at all to preserve the monuments left by our predecessors; the writer evidently cannot see that it serves any "practical" purpose. Not even any of the opponents of the bill objected to it on this score. The objection is similar to that which the same paper urged against the Arctic Expedition, and might with equal force be urged against every undertaking and every pursuit that had not some unmistakable so-called "practical" end immediately in view. Were such a principle to have sway, then all science might be "thrown to the dogs;" but it is too late in the day to bring it forward: and with regard to our ancient monuments, we feel sure that all the intelligent portion of the nation would revolt were it proposed to take no further care of them, but allow them either to crumble or be carted away. There is no security against such a fate for them unless by some such enactment as that which the bill proposes. And, after all, we believe that the *Times* itself would advocate the preservation of even a fragment of tile, if it could be shown that it would in any way conduce to the highest good of the race.

Sir John Lubbock's reply to the objections urged in the House of Commons is so admirable and so much to the point, that we shall conclude by giving it almost entire. There is a certain touch of well-deserved scorn in his remarks upon some of the trivial objections which were brought forward.

"It would not be denied by anyone," he said, "that our ancient monuments were gradually disappearing, victims of the increased value of land and the demand for road material and building stones. Now, he asked hon. members to look at the ancient monuments in their own districts mentioned in that bill, and tell him which of them they would see destroyed without regret. Was it Silbury Hill, the grandest sepulchral monument, perhaps, in Europe? Was it Avebury, the most remarkable of the so-called Druidical structures? Was it Stonehenge, enigmatical and unique? Was it Arthur's Round Table, or the Rollrich stones, Kitscoty House, or Wayland Smith's Forge, dear to all readers of Sir Walter Scott? Or, turning to Scotland, was it the curious Dun of Dornadilla? Was it the Burgh of Moussa, the only one, he believed, mentioned in the Sagas, and which is even now nearly perfect? Was it Sueno's Stone? or the Cats

Stane, with its inscription said to be in memory of Vetta, the son of Hengist? Was it the Newton Stone, with its inscription as yet altogether unread? Was it Maeshowe, with its runic records? or the Ring of Brogar? or the Stones of Stennis, with all their romantic associations? In Ireland, was it the Giant's Ring, near Belfast? Was it the curious fortification known as Staigue Fort? Was it the remarkable tumulus of Newgrange, with its curious decorations? Was it the ruins of Teltain, or the remains of the hill of Tara associated so intimately with the earliest of Irish records? He hoped that the bill would be rejected neither by Englishmen nor Scotchmen; and Irishmen surely would not grudge a slight and almost infinitesimal expense for the preservation of these fragments of early Irish history. Indeed, the expense entailed by the measure would be very trifling; the amount, moreover, would be settled by the Treasury and controlled by the House of Commons. Those monuments had passed through great dangers. They had been spared by Roman soldiers, by Britons, Saxons, Danes, and Normans; they were respected in days of comparative poverty and barbarism; in these days of enlightenment and civilisation, of wealth almost beyond the dreams of avarice, they were in danger of being broken up for a profit of a few pounds or removed because they cumbered the ground. If the House allowed them to be destroyed, they could never be replaced. It was said that the bill would interfere with the rights of property. What rights? The right of destroying interesting national monuments. That was the only right that would be interfered with. It was not incidental to the bill, it was no drawback in the bill, it was the very object of the measure. It was really, however, the rights of destruction, not the rights of possession, which it touched. It was now for the House to determine whether it would exercise on behalf of the nation the right to preserve those monuments; whether it would maintain the right of individuals to destroy, or the right of the nation to preserve. He hoped the House would agree to the second reading of the bill, for it would surely be a shame and a disgrace to allow those ancient monuments to perish."

We are sure Parliament, if it passes the bill in its entirety, will have not only the approval of the nation, but the admiration of educated men all the world over.

PRACTICAL PHYSICS

Introduction to Experimental Physics. By A. F. Weinhold, Professor in the Royal Technical School at Chemnitz. Translated and edited by B. Loewy, F.R.A.S. With a Preface by Prof. G. C. Foster, F.R.S. (London: Longmans, 1875.)

IN English schools of the present day the teaching of Experimental Physics is, with few exceptions, either neglected or abused. Yet there can be little doubt that this subject ought to be an integral part of the secondary education of every boy and girl. Its usefulness merely as knowledge that touches us at every point in daily life, and that finds its development intimately associated with many modern trades and professions, is a tangible argument in its favour. But it is as a means of *education*, rather than as a vehicle of *instruction*, that physics should be taught in schools. And this because of its high power—when properly taught—of educating individual judgment, by training the senses to habits of accurate observation and the mind to clear and precise modes of thought. Added to all this, practical physics confers the benefit, by no means to be lightly regarded, of giving to the hands the power of useful skill.

Prof. Foster well remarks, in his excellent preface to the work before us: "In the study of physics we are obliged not only to learn a large number of new facts, but also to adopt new habits of learning; while we have at the same time to accustom ourselves to attach accurately defined meanings to the terms employed in discussing physical phenomena, and to reason about them with mathematical strictness, and often by the help of technical mathematical methods. These characteristics of the study of physics give to it a value, as a means of training in habits of exact thinking, which probably no other study possesses in the same degree; but at the same time they make this study more than usually difficult, especially to beginners."

It is this felt difficulty, no doubt, that largely contributes to the exclusion of physics from the general curriculum of our schools and colleges. And where physics is introduced, it is, we fear, too often badly taught, for its method of teaching is misunderstood. It generally proceeds upon the old lines of the black board and text-book. Nor is this to be wondered at. For if a schoolmaster be really anxious to teach experimental physics thoroughly, he is staggered at the multiplicity and cost of the apparatus involved, and out of this difficulty our text-books have hitherto shown him no way of escape.

Where experimental science is honestly attempted, chemistry is found to be less formidable; it also abounds in useful practical class-books, and so this subject is far more widely taught than physics. To many parents and schoolmasters chemistry has become the embodiment of all their thoughts of science. Fumes, explosions, and mess, are, to a large section of the public, inevitably associated with their idea of natural knowledge in general, and experimental knowledge in particular. The replacement of physics by chemistry in schools is much to be regretted on educational grounds; for, so far as the present writer's experience goes, it is decidedly adverse to making chemistry the first or chief part of the scientific training of youth. Nor is there much likelihood of seeing experimental physics generally taught in schools until there are good text-books on practical physics that will enable the student to construct his own apparatus as he proceeds.

On these grounds chiefly we are glad to welcome the present translation of Prof. Weinhold's "Vorschule der Experimental Physik." By following the full and excellent directions given by Prof. Weinhold, any intelligent lad can be his own instrument maker; and besides the pleasure of construction, he will acquire a sound and extensive acquaintance with the elements of physics by the time he has carefully gone through the book.

Knowledge thus obtained will be ineffaceably written on the memory, and its worth will be far greater than a corresponding expenditure of time spent in merely reading several of the ordinary class-books. Nor can there be any doubt, as Prof. Foster says, that "whenever this or some similar work comes to be commonly adopted in schools, physics will be in a fair way of becoming one of the most popular as well as most useful parts of school-work, instead of being, as it too often now is, less liked and worse taught than almost any other subject."

One great merit of Prof. Weinhold's hand-book is its great detail. Nothing is more provoking than the vague generalities and assumptions found in the general run of physical treatises, so that the student is left in the lurch just at the critical moment when he most needs help. It is quite refreshing to notice the minute care with which Prof. Weinhold describes the construction of each piece of apparatus. As illustrations of this take the instructions for cutting glass on p. 14, for soldering on pp. 27 and 28, for cutting screws on pp. 93 and 94; and especially valuable are the directions for making various simple forms of binding screws given on pp. 656-660. Every woodcut is drawn to scale, every bit of apparatus employed has its dimensions given, every difficulty is pointed out, and failure thus made almost impossible.

Nor is this work only useful for science students. We venture to say any intelligent boy of twelve to fourteen years old might begin this book by himself, and, steadily working at it out of school hours and during the vacation, would in twelve months' time have not only mastered its contents, but have made for himself a very respectable and thoroughly useful collection of physical apparatus, the history and meaning of every fragment of which will be known and loved as part of his nature.

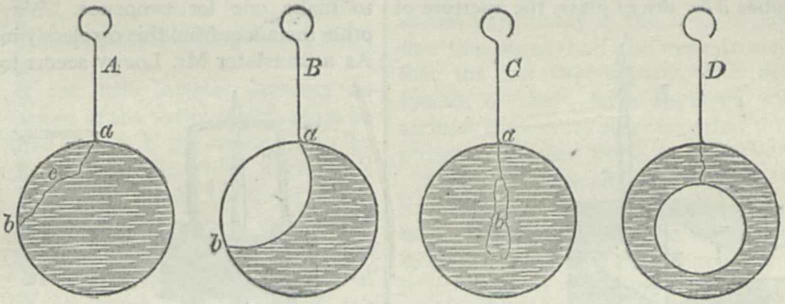


FIG. 1.—Experiments in liquid films.

But we shall be doing Prof. Weinhold more justice if we give our readers a few extracts from his hand-book. Here, for example, is a simple and elegant method of demonstrating the tension of liquid films. A ring is dipped in soap solution contained in a flat saucer, and then withdrawn; a film is thus formed after the manner of Plateau's experiments:—"If a very fine silk thread, wound from a cocoon, is tied to two points of the ring *a* and *b* (Fig. 1, A, B), and the film which is formed be broken within the portion *c*, by the finger or a rolled piece of blotting-paper, the unbroken portion of the film will contract and stretch the thread into a beautiful curve. If the thread be fixed only at *a* and held by the finger at *b*, its length may be altered at will, but the contraction of the film will always stretch it so as to form an arc of a circle. If a small loop is made at the end of the thread, (Fig. 1, C, D), the latter fixed at *a*, and the film broken at *b*, the thread of the loop will form a complete circle within the ring."

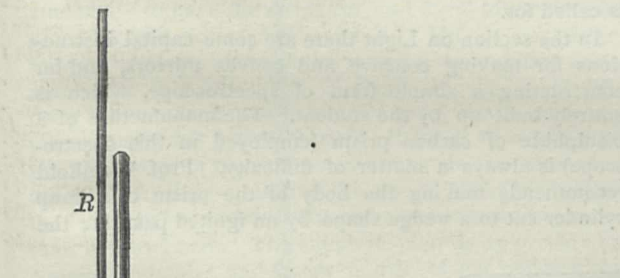


FIG. 2.—Weights raised by liquid pressure.

In speaking of hydrostatic pressure, the following simple arrangement is described:—"A pig's bladder, or, better still, that of an ox, is cut down near its mouth so far that the end of a glass tube of about the thickness of a finger, and ten centimetres in length, may be passed through the aperture and firmly tied (if necessary with the help of a cork). A longer glass tube is connected with the shorter by a piece of tight-fitting indiarubber tube, and held in a vertical position by the fork of the retort stand. The bladder is moistened, placed upon the table, flattened out as much as possible, and a piece of board, such as the lid of a box or a drawing-board, laid upon it, so that the bladder is not in the middle, but close to the edge of the board. At each end of the bladder small blocks of wood about two or three centimetres high are placed, in order to protect the glass tube, which reaches under the board, from being broken by the pressure of the board and the weights to be afterwards placed upon it. By pouring water from a bottle or through a funnel into the tube, the bladder is filled until the board begins to rise above the blocks and is in contact with the table only along one edge."

There is a neat illustration of the work done by falling bodies on p. 74, but the author is evidently unacquainted with Prof. Ball's admirable manual on experimental mechanics, wherein the student will find mechanical problems more rigidly and amply put to the test of experiment.

The section on Sound, we observe, omits all reference to the beautiful demonstrations which can be given of the reflection and refraction of sound, nor is there a single reference to the subject of sensitive flames, the value of which as phonoscopes should, in our opinion, hardly have been overlooked. The following simple method of making Kœnig's gas-flame manometer is given on p. 395. For the ordinary wooden capsule a large cork is substituted. "It is cut across the middle, the necessary holes are bored in it for the tubes, and a conical cavity is cut into each half with a sharp penknife, as shown in Fig. 3. Large corks are never quite air-tight; the whole of the outside should therefore be covered with a layer of sealing-wax one or two millimetres thick; this is done after the two halves have been glued together and the whole is perfectly dry." Before being glued together, a piece of goldbeater's skin is stretched between the two halves at *h*. The tubes *a b c* are of glass, the aperture of

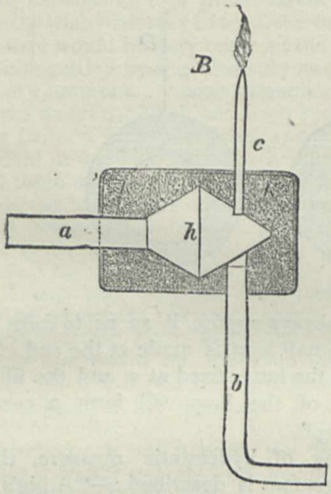


FIG. 3.—The Flame Manometer.

c being about 0·4 mm. Here we may observe that, instead of goldbeater's skin or collodion film, which students in general will find difficult to procure, a portion of one of those children's toy balloons made of thin india-rubber may be substituted with great advantage. It should be attached as follows: the edge of the capsule is first glued, and the inflated balloon then pressed on it; when the glue is dry, the portion that remains attached to the capsule is cut round with a knife; by this means a tense thin film is strained across the instrument. These toy balloons will be found of frequent service in acoustics.

The useful little instrument just described will therefore cost little beyond the slight trouble of making it. Nevertheless, the English editor has permitted a firm of instrument makers to advertise it for half a guinea at the end of the volume as "an indispensable piece of apparatus required by the student of this work." In like manner it is "indispensable" to buy a Barker's mill, the price charged being a guinea, when on p. 201 the student is shown how to make one for twopence. We might quote several other instances from this carelessly inserted advertisement. As a translator Mr. Loewy seems to have done his duty

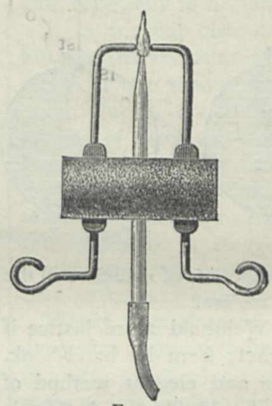


FIG. 4.

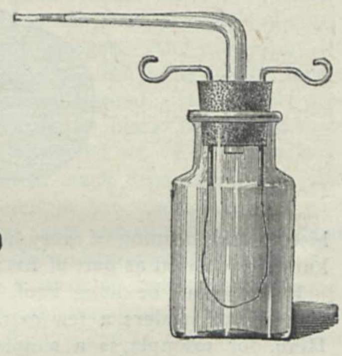


FIG. 5.

Heating effects of the discharge in Leyden jar.

well, but we would suggest the necessity of his exercising a little more editorial care if a second edition of this work is called for.

In the section on Light there are some capital instructions for making concave and convex mirrors, and for constructing a simple form of spectroscope, which is entirely built up by the student. The manufacture of a bisulphide of carbon prism (employed in this spectroscope) is always a matter of difficulty. Prof. Weinhold recommends making the body of the prism of a lamp cylinder cut to a wedge shape by an ignited pastille; the

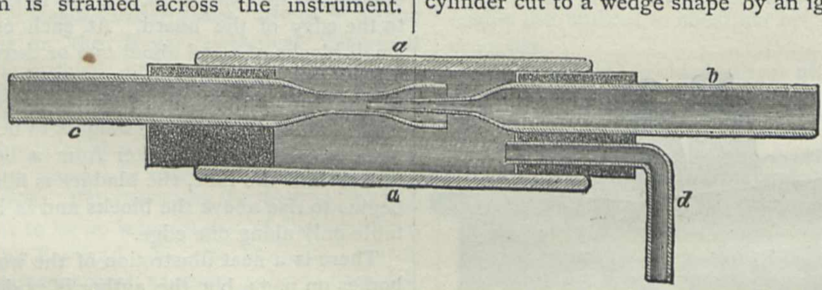


FIG. 6.

edges are then ground with emery powder, a hole bored for filling the prism, and the sides of plate-glass (French plate should have been stated) cemented on by a mixture of glue and treacle.

The accompanying woodcuts indicate two simple arrangements for showing the heating power of the electric discharge. In the one case (Fig. 4) wires, bent as shown in the figure, are insulated by sealing-wax and passed through a cork, in the centre of which is a glass tube allowing a gas jet to issue between the wires, the gas being ignited on the discharge from an electrophorus between the points. The other apparatus (Fig. 5) shows that even good conductors are heated by the electric discharge. "A small wide-necked glass bottle is closed by a cork, through which two wires pass and also a glass tube, which is drawn to a point about 1·5 mm. wide, and bent horizontally. The wires are connected by a long, very narrow strip of tinfoil. The glass being very slightly warmed by holding it in the hand for a moment, a drop of water is brought upon the point of the tube.

The heat produced by the passage of the spark through the strip of tinfoil is sufficient to expand the air in the bottle again, and the drop of water is pushed outwards by the expanding air through a space of one or several millimetres."

Fig. 6 is a simple form of the so-called "injector" or steam-jet pipe for feeding the boilers of steam-engines. A glass tube, *a a*, has corks fitted at each end into which pass the tubes *c c d*. Steam issues from the small aperture in *b*, and expanding passes out into the air through *c*. The air within *a a* becomes rarefied, and the water into which the tube *d* dips is thus driven by atmospheric pressure into, and finally ejected from, *c*.

"The construction of the little injector presents no difficulty, but the dimensions of the various parts must be exactly those shown in the figure, if the action is to be depended upon. Each side of the right angle into which the jet tube is to be bent should be about 3 cm. long, and the tube as wide as *c*; the pointed end should be like that of *b*, or very little narrower. An india-rubber suction-tube, 10 or 15 cm. long, may be attached to *d*. The india-rubber tube employed for connecting the apparatus with the vessel in which the steam is generated should fit very tight; it must not be tied with thread, so that in case the pressure of the steam becomes too great, the india-rubber may be forced off the glass tube, instead of its being torn or the glass broken by the pressure."

Before closing the volume, we notice one or two places, besides those previously alluded to, in which a little improvement might be made. For example, in describing the construction of the gold-leaf electroscope, the mode of cutting gold leaf is omitted. The author recommends students "to have the strips cut and fixed to the flat end of a wire by a skilled mechanician." This is unsatisfactory, for students cannot have recourse to a skilled workman when they like. Nor is there any very great difficulty about cutting and fixing the gold leaves when the proper method is patiently tried. Here, as throughout all practical work in physics, perseverance is the essence of success. Again, we observe that useful little instrument the "carrier," or proof-plane, might be more readily made than is stated here. The simplest plan is to procure an ebonite penholder, and fasten a disc of gilt paper at the end intended for the pen. These penholders are most useful adjuncts to a physical laboratory.

Further on, radiant heat receives rather meagre treatment. There is no description of any form of air-thermometer, an instrument which in a modified shape is capable of doing most useful work through the whole subject of heat. Nor is the subject of magnetism so fully treated as we should have expected; and in current electricity some description should have been given of the measurements of resistance and electromotive force: a simple form of Wheatstone's bridge—such, for example, as that suggested by Prof. Foster—can readily be made, and is indispensable for the proper study of this subject.

But the work is intended as an introduction to the study of physics, and, as such, it is altogether the best we have yet met with among English hand-books. The volume unfortunately is of an unwieldy size, and might have been made far more convenient for the constant reference it requires if a better arrangement of type had been adopted. W. F. B.

DRESSER'S "BIRDS OF EUROPE"

A History of the Birds of Europe, including all the Species inhabiting the Western Palæarctic Region. By H. E. Dresser, F.Z.S., &c. (Published by the Author, by special permission, at the Office of the Zoological Society of London.)

THE issue of Parts 35 and 36, completing the third volume, affords us the occasion of again noticing the progress of this beautiful and important work.

The energy with which the author has laboured to ensure punctuality in the issue is beyond all praise; and now that about half the work is completed, and we find that the last twelve parts, with figures of nearly 120 species of birds, have appeared within the year, subscribers have every assurance that they will, in due course, possess a finished work.

And this punctuality of issue is not effected by any haste or carelessness of workmanship either in the plates or the letterpress. In the last double number we find some pictures which are triumphs of artistic skill. Such in particular is the figure of the Night-jar (*Caprimulgus europæus*), in which the downy softness of the plumage, the exquisite mottling of the feathers, the roundness and repose of the whole bird, the half-closed sleepy eye, and the well-contrasted background, are exquisitely rendered. The Wryneck (*Yunx torquilla*) is almost equally good, and the tail of this bird in particular is rendered with a delicacy and skill which cannot be surpassed. Another charming picture is that of the Smew (*Mergus albellus*), surrounded by half a dozen young, whose various attitudes and the grouping of the whole, with the quiet river scene, are in admirable taste. The two Sand-martins (*Cotyle riparia*) perched on bending reeds form another beautiful bit of nature. An important feature of this work is the care taken to figure the birds in all their different states of plumage, and more especially that of the young or nestling birds. In this part we have four species in which the young are figured—the Black-winged Kite, the Pied Flycatcher, the Dottrell, and the Smew—and in every case the plumage of these infants is remarkably different from that of their parents. The introduction of these young birds adds greatly to the variety and interest of the plates as mere pictures; but they also have a high scientific value, since they are with good reason believed to indicate what was probably the plumage of the ancestral form of the group to which they belong. From this point of view, the young are really very old birds indeed, and may, when thoroughly studied, enable future ornithologists not only to reconstruct the forms, but also to reproduce the colouring of the birds of past ages. They thus, to some extent, make up for the deficiency of fossil remains of birds; and this work, when completed and the plates arranged in systematic order, will be invaluable to the philosophic naturalist.

It is difficult to choose an extract which shall give any adequate idea of the valuable scientific matter to be found in the letterpress. The following passage (somewhat condensed), taken from the account of the Night-jar, touches on a difficult question which the observations of some of the readers of NATURE may help to clear up:—

"The Night-jar feeds on moths, beetles, and insects of various kinds, most frequently capturing its prey on the wing, its capacious gape forming an excellent moth or beetle trap. That it eats caterpillars is also certain: but it feeds more especially on the larger insects, such as may-bugs, dung-beetles, large night-flying moths, especially the Sphinx Moth, and various species of nocturnal insects. It is a very greedy feeder, and in the autumn is often very fat. The indigestible portions of the insects it devours (which it swallows entire) it throws up in long pellets, which may frequently be found in the places where it reposes during the day. As it feeds more especially on those insects which are to be met with amongst the dung in places where cattle have been feeding, or where they are stalled, the Night-jar is often to be met with in these pastures or in the immediate vicinity of outlying folds; and hence the popular delusion that it sucks the goats hanging on to their udders; and from this belief has arisen the common appellation of Goat-sucker.

"This species has the claw of the middle toe furnished on the side with pectinations forming a sort of close-toothed comb; and the use made of this peculiar appendage has puzzled naturalists not a little. Some observers contend that it is used to clean the bristles at the base of the bill from the fragments of wings of insects which may adhere to them; but this cannot well be the case, as these vibrissæ or bristles are large, strong, and placed at some distance apart, whereas the teeth of the claw are thin and very close. Others think that as the bird invariably perches along a branch in a direction parellel with it, and never across the bough like almost all other birds, this pectinated claw may assist it in keeping its perch more firmly than it otherwise would do. Other naturalists, again, contend that it is used to hold large insects with greater security; but it appears that the Night-jar almost invariably takes its prey with the mouth and not with the foot; and consequently this supposition falls to the ground. An anonymous writer suggests that the comb-like structure of the claw may be used for disengaging the hooked feet of beetles from the bill, to enable the bird to swallow them; and this may possibly be the case, as the serrations are well calculated to catch the polished limbs of beetles. Anyone who has attempted to confine *Dytisci* or *Scarabæi* in a collecting-box, must be aware of the difficulty in getting their feet free from the edge, to which they hold with the greatest pertinacity, one foot being no sooner pushed in than another is protruded."

This last explanation seems the most probable one, and it agrees with the observation of Gilbert White (of Selborne), who states that he has distinctly seen the Night-jar raise its foot to its mouth while hawking for insects on the wing.

The passage above quoted is a portion of seven quarto pages devoted to an account of the habits and distribution of the Night-jar. A work like the present, so beautifully and artistically illustrated, and of which only a limited number of copies is printed, is sure to become scarce and to rise considerably in value. Lovers of nature and of art may therefore be reminded, that in becoming subscribers they are not only obtaining a valuable and most interesting book, but are at the same time making a profitable investment.

A. R. W.

OUR BOOK SHELF

The Monthly Journal of Education and Scholastic Advertiser. A medium of intercommunication for Masters, Mistresses, and others interested in Education. Nos. 1 to 16. (W. P. Nimmo, 1874, 1875.)

THE original *Quarterly* form of this journal had been for some years "slowly but steadily increasing in circulation." The journal is now issued as a *monthly* publication "by a number of teachers who are anxious to be of service to their fellow-workers, and to all persons interested in education." The editor and principal contributors to the two forms of the journal being the same, as might be expected there is no great difference in the earlier and later volumes, but yet there is, we believe, an improvement on the side of the present series. The advantage of such a frequent issue is pretty obvious, but the meeting the subscription for twelve numbers instead of four, is to some a serious consideration. The number of subscribers, we find, is fairly satisfactory, but to make it more than a barely paying matter a much larger number of subscribers, the editor states, is required.

Glancing rapidly over the articles in the numbers before us, we just indicate a few which strike us as most generally interesting. The first we light upon is a letter from Mr. Wilson, of Rugby, to Dr. Temple, on Successive *v.* Simultaneous Instruction: it was written in January 1869, and in considering the problem of education advocates the "stratification of studies." The question is naturally discussed with an eye to Rugby, but the paper is, as might be supposed, deserving of careful study by outsiders. Another Rugby master, Mr. Kitchener, gives his views on teaching botany to junior classes; and Mr. J. Clifton Ward on natural science teaching in schools. A paper on trifle blindness advocates Dr. Liebrich's views. Besides, we note a reprint of a paper by Dr. Hodgson, on exaggerated estimates of reading and writing; one on French accent; and one, by Dr. Jones, on Mr. Todhunter's essay on Elementary Geometry. These two should be read by all who may wish to see what can be said for and against Euclid as a school text-book of geometry. A portion of each number is devoted to correspondence, and a new feature in this new issue of the journal is a Mathematical Column. What the journal wants is the support and contributions of more of our foremost educationalists, and then it would take a higher position than it does at present.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressea 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.*]

On the Dynamical Evidence of Molecular Constitution

I BEG to offer the following remarks upon the extremely valuable and instructive lecture by Prof. Clerk-Maxwell which appeared in NATURE, vol. xi. pp. 357, 374, in the hope that they may tend to the further elucidation of this interesting subject.

If two bodies are attracted towards each other by a force which varies inversely as the square of the distance, and R, r, be the force and distance at any instant, Rr will represent the sum of that portion of the energy of the two bodies which is due to their mutual attraction (the mean being $\frac{1}{2}Rr$); that is, the amount which would be converted from potential to actual energy while they approached each other to this point from an infinite distance.

The sum of the virials $\Sigma\Sigma(\frac{1}{2}Rr)$, or $\Sigma(Rr)$, will therefore represent, for a gas whose molecules are so attracted, the total amount of the energy due to attraction.

According, therefore, to the formula of Clausius, the elasticity of such a gas would be the same as if those forces and a portion of the kinetic energy of translation of every particle equal to the energy which is due to them had no existence.

And as the distances between the particles vary inversely as the cube root of the density, if the attractive forces vary inversely as the square of the distances, $\Sigma\Sigma(\frac{1}{2}Rr)$ will vary directly as the cube root of the density. The deduction from the element of pV represented by $\frac{2}{3}T$ will therefore vary as the cube root of the density, and the value of pV will diminish as the density increases.

If the attractive forces vary in a higher inverse ratio, this effect will be further increased.

And if this ratio be the nth power, the sum of the virials wi be the energy due to the attraction of those forces multiplied by $n - 1$, and for a given quantity of gas will vary as the density raised to the power of $\frac{n-1}{3}$.

The sum of the virials due to gravitation does not appear sufficient to account for the observed effects, and moreover would vary with the quantity of gas in a compound ratio. We must conclude, then, that the ratio of the force to the distance is a higher one than that of the inverse squares.

Upon that law, as already stated, the sum of the virials would increase, for equal quantities of gas, in the ratio of the cube root of the density. Prof. Maxwell has shown that for equal volumes the increase must be as the square of the density, that is, for equal quantities as the density. In order to obtain the same result directly, supposing the density to vary, the quantity remaining constant, it is necessary to assume the forces to vary inversely with the fourth power of the distances. On this supposition the sum of the virials will vary for a given density, as the facts appear to indicate, directly with the volume.

The formula of Clausius does not elucidate the phenomenon of the increase of $p\,V$ at low densities with increase of density, experimentally demonstrated in the case of hydrogen gas only, but probably true, as conjectured by Regnault, of other gases also at sufficiently high temperatures.

The *rationale* of this I believe I have discovered, but will not now attempt to enter upon this point.

Prof. Maxwell mentions that Clausius had long ago pointed out that the ratio of the increment of the whole energy to that of the energy of translation may be determined if we know by experiment the ratio of the specific heat at constant pressure to that at constant volume.

The same result is obtained by comparing the specific heat at constant volume with the difference in the kinetic energy of translation on increase of temperature indicated by the increase of pressure; a method by which a small error arising from the variation in the value of $p\,V$ at different densities is eliminated, the sum of the virials remaining constant.

Taking c_1 to represent the specific heat at constant volume, J the mechanical equivalent of heat, p and V the initial pressure in pounds per square foot and volume in feet of a pound weight of the gas, T_0 and T_1 the energy exclusive of that of translation at zero and 1° Centigrade respectively, a the coefficient of expansion for constant volume,* we shall have—

$$c_1 J - \tfrac{3}{2}\, a p V = T_1 - T_0.$$

For atmospheric air $c_1 J$ may be taken at 233·41, and $p\,V$ at 26215, and a, by Regnault's experiments, is ·003665, so that—

$$T_1 - T_0 = 233{\cdot}41 - 144{\cdot}12 = 89{\cdot}29.$$

This gives the increment of energy due to other motions than that of translation not quite two-thirds of that due to the motion of translation. The exact ratio is 1·859 to 3.

The experiments of Regnault prove that neither $p\,V$ nor a are absolutely constant at all densities. He found a at ·1444 atmosphere to be ·0036482 and 4·81 atmosphere ·0037091. His experiments do not indicate an appreciable difference in the value of $p\,V$ between ·1444 and 1 atmosphere, but between 1 and 4·81 atmosphere it appears to be diminished about ·004 of its amount. The value of $\frac{3}{2}\,a p V$ in the former case will therefore be about 143·46, and in the latter 145·27.

Supposing the specific heat to be independent of density, this would indicate that the ratio of the increment of the energy of translation to that of the remaining energy, and therefore probably that of the energies themselves, increases with the density. It is, however, not improbable that c_1 may likewise vary, and that the ratio of the two elements may be constant.

M. Regnault's experiments to determine the specific heat of air were all made at somewhat high pressures, varying at the commencement of the experiments from 4 to 6000 mm., and at the termination from 800 to 3000 mm. They more nearly correspond, therefore, to a pressure of 4·81 atmosphere than to 1 atmosphere. And if $\frac{3}{2}\,a p V = 145{\cdot}27$, $T_1 - T_0 = 88{\cdot}14$, a ratio between the elements of the energy of 3 to 1·82.

It is also probable that c_1 varies to some extent at different temperatures, but I am not aware that any experiments have been made to ascertain this. Regnault throughout assumes the specific heat to be constant for all temperatures.

Prof. Maxwell states that a consequence of Dr. Boltzmann's theorem is that the temperature tends to become equal throughout a vertical column of gas at rest. He also confirms this doctrine as an independent conclusion of his own.

It is with great diffidence that I advance a different view from that which has the sanction of such high authority.

It seems obvious, however, that the mean energy of the molecules moving downwards must be increased, and that of those moving upwards diminished, by the amount of the work of gravitation. And there is nothing to counteract this tendency unless there is repulsion between the particles; attraction would increase it. At all parts of the system there is exchange of energy between the particles; but, supposing equilibrium to have been attained, the mean amounts of energy transmitted in opposite directions at any given point must be equal. Equilibrium, therefore, can only exist when the difference of the actual energy at different distances from the centre of attraction is the same as the difference due to the transfer of particles from one distance to the other.

I think that the equality of temperature must be involved, either explicitly or implicitly, in the data from which the theorem of Boltzmann is deduced.

If this reasoning is correct (supposing the gas at rest), the following equation will represent the relation of the temperatures at different elevations:—

$$t_1 = t_2 - \frac{x_1 - x_2}{c_1 J}$$

where $x_1\ x_2$ are the heights, $t_1\ t_2$ the corresponding temperatures.

The difference of temperature which would exist in the atmosphere at different heights in consequence of this law (one degree Centigrade for every 233 feet) is partly counteracted by the action of the currents; the rate of cooling by expansion being less for the same difference of height. But in a long-continued calm the increase of heat in the lower region of the atmosphere is well known to be intense.

If the condition of equal temperature at all heights were one of atmospheric equilibrium, it would be one of stable equilibrium. It would sooner or later be attained, and would be subject to little disturbance. But the equilibrium which the law above stated tends to induce in still air is extremely unstable, inasmuch as a body of air which has risen in consequence of being warmer and lighter than the surrounding portions of the same stratum has a still greater difference of temperature from the higher strata, having suffered less refrigeration from expansion than that due to the difference of elevation in still air. Slight affections of temperature are therefore capable of causing great atmospheric disturbances, and the tropical calms before alluded to are commonly followed by the most violent tempests.

Prof. Maxwell observes that a molecular æther would be neither more nor less than a gas. This statement requires one qualification, as the theory does not necessarily imply the existence of either attraction or repulsion between the particles, and from the universal diffusion of the æther it must be inferred that no such forces exist. This constitutes a difference of some importance from the condition of a gas. It is true that an equilibrium of temperature would *tend* to establish itself between the agitation of the ordinary molecules and those of the æther. But the establishment of such an equilibrium would be constantly counteracted by the rapid transmission of the energy communicated to them, through space, by the molecules of the æther; in other words, by *radiation*. There are doubtless difficulties in this hypothesis, but its rejection involves the conception of the transmission of energy by other means than the motion of material particles, and we have no sufficient ground for supposing any other mode of transmission to be possible.

It has been suggested that the alternative to the conception of a molecular æther is a continuous material substance, not made up of parts, and that such a substance might be capable of motion and of transmitting energy. But a continuous material substance, not made up of separate parts, capable of internal motion, and permeable throughout by ordinary matter, can hardly be called material in an ordinary sense. I find it as difficult to conceive such a substance as an immaterial substance capable of transmitting energy. But I am profoundly conscious of the difference between the limits of our powers of conception and the limits of possibility.

Athenæum Club, April 9 R. C. NICHOLS

* The coefficient of the increase of pressure, the volume remaining constant, as well as the coefficient of expansion properly so called, is termed the coefficient of expansion by Regnault. In view, however, of the variation which exists from the law of Boyle and Marriotte, it is necessary to observe the distinction.

On the "Law of Fatigue" regulating Muscular Exertion *

II.

WITH regard to Mr. Nipher's new series of experiments published in NATURE (vol. xi., p. 276), in Table II., I shall make only two observations :—

1. That they appear to me to be subjected to too much of reduction and discussion, a process which does not always improve experiments, and that the intervention of an assistant who lifts the weight from the experimenter appears to introduce new sources of error, both as regards the work done and the punctual observance of time of lift.

2. That the formula (cubical hyperbola) objected to by Mr. Nipher, which is derived from the "Law of Fatigue," represents his new series of experiments quite as well as the complicated empirical formula which he has employed, and which has no theoretical meaning.

I simply give the following table, taken from Mr. Nipher's Table II., and calculated from the formula—

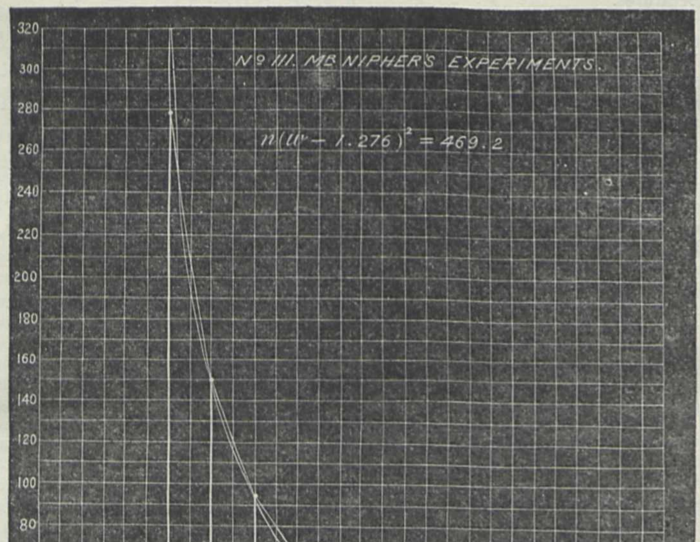
$$n\,(w + a)^2 = A$$

where $A = 469{\cdot}2$, $a = -1{\cdot}276$.

Comparison of Nipher and Haughton's Calculations with Nipher's Observations.

w	n (obs.)	n (calc.) Nipher.	n (calc.) Haughton.	Diff. Nipher.	Diff. Haughton.
2½	283	242	313	+ 41	− 30
3	152·5	150·3	157	+ 2·2	− 4·5
3½	95·8	99·4	94·7	− 3·6	+ 1·1
4	67·2	69·2	63·3	− 2·0	+ 3·9
4½	51·2	50·1	41·5	+ 1·1	+ 6·1
5	36·9	37·4	33·8	− 0·5	+ 3·1
5½	28·6	28·7	26·2	− 0·1	+ 2·4
6	22·7	22·5	21·0	+ 0·2	+ 1·7
6½	18·1	18·0	17·2	+ 0·1	+ 0·9
7	14·5	14·6	14·3	− 0·1	+ 0·2
7½	10·4	11·9	12·1	− 1·5	− 1·7
8	7·7	9·9	10·4	− 2·2	− 2·7

I also give a diagram (No. 3), showing to the eye the agreement between the shape of the cubical hyperbola and Mr. Nipher's observations.



In fact it is plain, either from the table or the diagram, that my formula, derived from the "Law of Fatigue," represents his observations fully as well as his own empirical formula.

In Mr. Nipher's former experiments already given, the value of a comes out to be $+ 1{\cdot}094$, and in the present experiments it is a negative quantity and equal to $- 1{\cdot}276$; whereas, according to direct observation, it ought to be $+ 1{\cdot}50$. According to the Law of Fatigue, the value of a should be half the weight of the arm, and a negative value of a is absurd.

The absurdity, however, is easily explained, and is not in the "Law of Fatigue." The "Law of Fatigue" asserts that the total work done by a group of muscles tired fairly out is inversely proportional to the rate at which they are condemned to act; but it tacitly supposes that the group of muscles in question is not aided by other muscles in any way. This is very difficult to prevent, and it can only be accomplished by a careful study of the muscles used, and by devising a rigorous posture and movement during the experiments, such as shall compel the group of muscles to do their work and prevent other groups from helping them, which they endeavour to do, from the strong animal instinct of avoiding pain. In the experiments made by myself, Dr. Macalister, and Mr. Gilbert Haughton, the muscles used were two—

1. Supraspinatus
2. Deltoideus Acromialis :

and the palms were supinated, and the plane of motion was the transverse plane.

In Mr. Nipher's experiments (if I understand his description correctly) the plane of motion was 45° in advance of the transverse plane, and the hand was probably pronated. These circumstances would allow the muscles already named to be aided in an irregular manner by the following muscles :—

3. Deltoideus clavicularis
4. Trapezius scapularis (anterior fibres)
5. Pectoralis major (superior fibres).

The assistance supposed given to the group of muscles which are tired out is not sufficient to fatigue the muscular fibres called into

* Continued from p. 466.

play irregularly, and the Law of Fatigue will not apply to them; and the statement of that law leading to the cubical hyperbola must be modified as follows:—

Let there be m fibres tired out,

And n fibres worked but not tired out;

And let x be the mean weight held in the hand lifted by the fibres n; then the weight really lifted by the fibres m will be $(w + a - x)$. And it is to this quantity only that the Law of Fatigue applies, giving us the formula

$$n\,(w + a - x)^2 = A. \quad (4)$$

In Mr. Nipher's first set of experiments at fixed rate we found—

$$a - x = + 1{\cdot}094.$$

And in his experiments now published we have—

$$a - x = - 1{\cdot}276.$$

From this (supposing the experiments not damaged in their reduction) I should infer that the supraspinatus and acromial deltoid were aided, irregularly, in the two cases by muscular fibres (not tired out), which lifted respectively 0·41 and 2·77 kilos.

Trinity College, Dublin, March 13 SAMUEL HAUGHTON

P.S.—I have received a letter from Prof. Gustavus Hinrichs, of Iowa State University, in whose laboratory Mr. Nipher was assistant, and who gave Mr. Nipher all possible aid in his experiments. In this letter Prof. Hinrichs states that Mr. Nipher's former experiments were in fact as good as those he last made. I myself believe that, in some respects, they were better.

Denudation

MANY students of geology find a difficulty in realising that the effects of denudation are due to the simple action of water set in motion only in ways familiar to us. To them, and indeed to many others, it may be of some interest to observe a working model which, though made without any such design, shows with curious fidelity, on a small scale, the effects which have been produced in the lapse of ages on the great features of our globe.

Londoners will remember that the Serpentine was emptied, cleaned out, and finally refilled about five years ago. Coping-stones of hewn granite were laid along the margin of the foot-path, and from this, slanting down for about two feet, was a layer of concrete laid about the level of the water line. Possibly this concrete was not of the most durable quality, still it was certainly harder than most of the rocks which bound our coasts. But in the short space of about five years the tiny wavelets of this litttle lake have worked this *smooth sloping hill* into a bold and rugged line. In some places, indeed, all the concrete has been washed away, and there is a sandy beach right up to the granite. Two or three years ago the water was at a somewhat lower level than it is now. The traces of the change are recorded, especially on the north side, a little to the east of the boat-houses. There, a double range of "cliffs," one over the other, is to be seen extending for some considerable distance.

This "*model*" is indeed of so much interest that I ask you to insert this notice of it, for I am sure that many of the readers of NATURE would share the pleasure I have felt in watching the very striking similarity in effects produced by the same agents working on scales so vastly different. R. H.

OUR ASTRONOMICAL COLUMN

THE SUN'S PARALLAX.—In *Astron. Nach.*, No. 2,033, Prof. Galle, Director of the Observatory of Breslau, gives his final deductions with reference to the value of solar parallax from corresponding observations of the minor planet Flora, about the opposition of 1873, which took place while the planet was near perihelion. Observations with this special object in view were made at the Observatories of Bothkamp (Herr von Bulow), Cape of Good Hope, Clinton (N.Y.), Cordoba, Dublin, Leipsic, Lund, Melbourne, Moscow, Parsonstown (the Earl of Rosse), Washington, and Upsala; by 37 N. and 36 S. stars, the sun's parallax is inferred to be 8″·879 (± 0″·0396), which, singularly enough, is the exact figure lately communicated by M. d'Abbadie to the Astronomer Royal, as a first result obtained by M. Puiseux, from observations of the recent Transit of Venus at the French stations at Pekin and St. Paul Island.

TUTTLE'S VARIABLE NEBULA IN DRACO, &C.—This object well deserves regular observation, the evidence in favour of its variability being apparently beyond question. It was first seen by Tuttle in September 1859, and occurs in Argelander's Durchmusterung. On the 24th of September, 1862, D'Arrest, observing with the Copenhagen refractor, describes it as a large bright nebula, 2′ long and 80″ broad, and he adds: "bene conspicienda tubo quæstore." On the 22nd of August, 1863, after re-examination, he has the note: "I think this nebula was far brighter in the year 1862," and on the 12th of the following month he remarks: "tubo quæstore non amplius discernitur." In a letter to Sir John Herschel, he expresses his conviction that the nebula could not have been so bright as it was in September 1862, in the time of Sir W. Herschel and Messier. Auwers, in Königsberg Observations, xxxiv. p. 227, says he found the nebula pretty bright, 2½′ long, 1½′ broad, the direction of the longer diameter being 50°. If we take the mean of D'Arrest's observations for position (*Siderum Nebulosorum*, &c., p. 333), and bring up to the commencement of 1875, the following place results:—

R.A. ... 18h. 23m. 16s. N.P.D. ... 15° 29′·5

This nebula is No. 4,415 of Sir John Herschel's general Catalogue. We are able to state that there is some suspicion of variability about No. 4,369 of the same Catalogue (Hind, 1852, April 26), and possibly in the small hazy-looking star preceding the brightest part of the nebula. In April 1852 it was very small and rather faint, perhaps 1′ in diameter; it followed Lalande, 33076, 50·1s., and was 9′·4 north of the star. Auwers (Königsberg Observations, xxxiv. p. 227) found it pretty faint, 2′ diameter, gradually a little brighter towards the middle; a star 12th magnitude situate on the border of the nebula on an angle of about 230° from its centre. Later observations have afforded indication of fluctuating brightness, but are not decisive. Auwers thought he found signs of variability in the nebula No. 4,473 (Hind, 1845, March 30). In a 6-feet Fraunhofer it was pretty bright, round, and from two to three minutes in diameter; and once, 1860, Aug. 16, with the Königsberg heliometer it was "surprisingly faint and of the second class at the highest." Schönfeld has several observations in *Astronomische Beob. zu Manheim*, 1862; the diameter is variously recorded between 45″ and 2′, and once it is remarked that the nebula showed strong scintillation and appeared resolvable. D'Arrest, who independently discovered this nebula in the spring of 1852 (*Astron. Nach.*, No. 809) has given his earlier observations in *Resultate aus Beob. der Nebelflecken, Erste Reihe*; in September 1855 he suspected it might prove a cluster of very minute stars. His later observations with the Copenhagen refractor are published in *Siderum Nebulosorum*, &c., where he states that he had not, during sixteen years, noticed any change either of brightness or position; and he mentions further that in April 1866 he detected a number of luminous points. Variability in the case of this object appears hardly to rest upon sufficient proof, considering the effect of indifferent nights upon such observations, but it is suggested in Sir John Herschel's last Catalogue, and on that account is referred to here.

COMET 1766 (II.)—If Burckhardt's elliptical elements of the second comet of 1766, discovered at Paris on April 8, are approximately correct, it is not improbable that the comet was observed on its first perihelion passage with that form of orbit. Burckhardt succeeded in representing the rough observations of La Nux at the Isle of Bourbon, extending to May 13, by an ellipse with a period of only five years, Pingré having failed in bringing them into satisfactory agreement with the few obser, vations taken by Messier and Cassini de Thury, at Paris-from the 8th to the 12th of April, in a parabolic orbit. With the period assigned by Burckhardt, the comet would have passed its aphelion in October or November 1763, at which time the planet Jupiter was near the same heliocentric longitude, and his distance from the comet might have been less than 0·4; indeed, a period very slightly shorter than Burckhardt's, and quite within the probable error of his determination, might have occasioned an extremely close approach of the two bodies, producing, in all probability, a great alteration of elements, and resulting in the ellipse of short period indicated by the observations of 1766. This comet was suspected by Clausen to have been identical with the comet of July 1819, or the comet of Winnecke, which has been observed during the present year; and the very possible close approach to the planet Jupiter in the autumn of 1763 may have been the cause of the introduction of this body amongst the quickly revolving comets of the system. It is also to be remarked that Burckhardt's orbit for 1766 points to a close approximation to the orbit of Mercury; in about heliocentric longitude 290°, the distance is less than 0·025.

THE SOLAR ECLIPSE

IN continuation of our articles on this subject, we print the following telegrams which have since been received, detailing the results of the observations; together with some remarks which have appeared in the *Times* concerning them.

First, with regard to the Siam party we have, from Singapore, April 15, the following Reuter's telegram with respect to the results obtained:—

"Valuable results were obtained by the English observers of the solar eclipse in Siam. Although the sky was hazy, the results by the prismatic camera were good. The spectroscopic cameras failed. Eight good photographs of the corona were taken."

Next, a *Times* telegram from Dr. Schuster, at Bangkok, as follows:—

"The English observers of the solar eclipse in Siam are remaining a few days at their station to take copies of photographs obtained. Unavoidable accidents prevented them being on the spot until five days before the eclipse. Owing to the untiring energy of Capt. Loftus, the arrangements were nearly complete, and thus partial success of the expedition secured."

Next, a *Daily News* telegram from the special correspondent of that journal with the expedition at Bangkok:—

"The results of the English Eclipse Expedition must be considered merely preliminary, this being the first time spectrum photography has been tried. The prismatic camera shows the rings with protuberances at the edge of the sun, and at least one more ring towards the ultra-violet without protuberances. Eight good photographs of the corona were taken, the exposure varying from two to sixteen seconds."

It will be observed that in none of these telegrams was Dr. Janssen mentioned. It is possible, therefore, that he left Singapore before the arrival of the English Expedition. Be this as it may, he observed the eclipse in Siam, and on Monday last, at the Paris Academy of Sciences, a telegram was read from him to the effect that though the sky was not clear, he obtained results, and that these were confirmatory of those obtained in 1871, so far as they related to the coronal atmosphere.

The news received from the Camorta party is a sad contrast to the above. The following Reuter's telegram, dated "Calcutta, April 18," will no doubt cause universal regret:—

"The Indian astronomical party at Camorta were successful in observing the external contacts during the solar eclipse. They failed, however, to obtain photographic results, owing to the sky being completely overcast during totality."

The *Times'* comments on the results obtained at Siam are as follows:—

"Reading the above telegram from Dr. Schuster in connection with that which we published in our second edition on Wednesday last (NATURE, April 15, p. 474), we see that two-thirds of the work which the Siam expedition went out to do have been successfully accomplished. Photographs giving us the actual shape and many of the conditions of the coronal atmosphere at the present epoch of minimum sun-spots have been secured, and these photographs we shall be able to compare with those taken in India and Java in 1871 at the time of maximum sun-spots. It is not too much to hope that this comparison may teach us much as to the changes in the solar atmosphere which accompany or are brought about by the changes in the spots—changes which require eleven years or thereabout to run through their cycle. But this, after all, is a trifle compared with another part of the work. Not only was photography *pure et simple* employed to tell us the shape and other conditions of the solar atmosphere, but photography *plus* spectroscopy has been utilised to tell us the chemical constitution of the various readings of the sun's surroundings; and it is in this branch of the work that the most valuable of the announced results have been obtained. The Committee of the Royal Society laid so much stress upon this part of the attack that no less than three instruments were devoted to it by the Siam party alone, the work of each being so arranged that it would supplement that accomplished by any of the others.

"A few simple considerations will serve to indicate not only the nature of this part of the work, but how carefully it had been prepared throughout by those upon whom the responsibility of organising the expeditions fell. The brilliancy of the corona has varied enormously—one, indeed, might almost say impossibly—in various eclipses. The celebrated Otto Struve, for instance, has placed on record the fact that in one of the eclipses which he observed its brilliancy was almost insupportable to the naked eye; other astronomers have made use of expressions equally strong, while it is known that, if those who are fortunate enough to have the opportunity of observing eclipses take the precaution of guarding the eye from the direct light of the sun before its disappearance, there is not only light enough from the corona to read by with comfort, but a light surpassing in brilliancy the brightest moonlight we are familiar with in these latitudes. This is so far as the eye is concerned. When we deal with the photographic plate instead of the retina, the brilliancy of the corona becomes yet more certain. A camera of, say, four inches aperture will impress an image of the corona on a prepared plate in far less time than it will impress an image of the moon at its brightest. This is one indication of the photographic brilliancy of the coronal light, and in a former article we took occasion to refer to others of an equally striking kind which were rendered very obvious during the eclipse of 1871. The evidence as to the brightness of the spectrum of the lower layers of the sun's atmosphere is equally strong."

"The Royal Society Committee, therefore, would have been justified in reckoning upon a bright corona. They did so, but at the same time they provided for a very feeble one. Long before the expedition sailed, the members of both parties made some very interesting researches on the possibility of securing photographs of gaseous spectra—that is, precisely such spectra as those which it is natural to expect will be furnished to us by the corona. They found that, with a time of exposure only slightly in excess of that allowed by the eclipse itself, they were enabled to photograph the spectra of chlorine, nitrogen, and other similar bodies under somewhat complicated instrumental conditions, and when those spectra were dimmer than the spectrum of the corona is known to be."

The extreme importance which attaches to the determination of the particular class of spectrum under which that of the corona may be classed was pointed out in NATURE, vol. xi. p. 201, and on this point the *Times* article says :—

"The most perfect determination would have been accomplished when the peculiarities of the spectrum, of whatever class it might be, with its bright lines or its 'channelled spaces,' had been recorded over a long range. For this purpose the Siam party was provided with a siderostat, a short focus reflector, and a spectroscopic camera of long focus—that is, a spectroscope in which the ordinary observing telescope had been replaced by a lens of long focus and a photographic camera. If everything had been in order, the air perfectly clear, and the corona very bright, this instrument would have given us the most valuable record of all, as we should have obtained a detailed spectrum of the coronal atmosphere and chromosphere from the Fraunhofer line G to far beyond H, the ordinary limit of visibility. This was the most crucial experiment ; while it was the one least likely to be realised, its success would have been of the highest importance, as the chemical as well as the physical constitution might have been more or less fully revealed. Next in delicacy to this came a similar arrangement in which the same principles were depended on, but in which, as all the parts were not of quartz and as the focal length of the camera was not so great, equally good results over so large a range were not to be dreamt of. The nature of the spectrum and of some of the constituent gases of the solar atmosphere might have been determined in this way, but the information, though equal in quality to that obtained by the instrument to which we have before referred, would have been deficient in quantity. Still, this information might have been obtained with a less clear air and by less brilliancy in the corona than were necessary for perfect success in the former case.

"In the prismatic camera, an instrument described at some length in our last article (reprinted in NATURE, vol. xi. p. 452), we have an instrument which may be held to be certain to give us a valuable result, even if the air be not very clear and if the corona be not very bright. We may say that this was the gross attack upon the chemical nature of the corona, as the siderostat and its accompanying long-focus spectroscope represented the most delicate one. Now this has perfectly succeeded, and in this lies the extreme importance of the observations made in Siam. For some reason which is not yet clear to us, the more delicate ones have failed. On receipt of the first telegram we attributed this failure to the hazy sky, which would as certainly have cut off all the violet rays which alone were to be impressed on the photographic plate as the blue rays are cut off at sunrise, giving us, as the result of the absorption of all the blue light, first the rosy-fingered dawn and then the red sun himself. But from Dr. Schuster's later telegram which we have now received it would appear that some accident had delayed the colonial steamer between Singapore and Siam, and, further, that the observatories which it was hoped would have been built at Chulai Point before the expedition arrived at Singapore had never been built at all ; so that the expedition had to proceed direct to Bangkok, and, as an inevitable consequence, spent in royal receptions the time which was absolutely required for the erection and adjustment of the instruments, with or without observatories over them.

"Where and how the delay of four days occurred will, of course, be known hereafter, and it is needless to speculate too closely upon it ; but it is clear that Dr. Schuster is inclined to attribute the incompleteness of the results which his party has attained more to this delay than even to the haze. We can well imagine his disappointment in not having the whole story to tell ; but the measure of success his party has achieved is greater than might fairly have been expected from any one expedition, and there is little doubt that the photographs his party has secured will do more to advance solar physics than any permanent records obtained by any former expedition. They are well worth all the time, labour, and thought which have been lavished on the whole attempt.

"Evidence of the highest value bearing on the general nature of the spectrum of the coronal atmosphere in the blue region has been obtained. It was clear that the minimum of success must enable us to compare the coronal atmosphere as a whole with that part of it which is composed mainly of hydrogen, and if there happened to be a remainder, the chemical nature of that remainder would be demonstrated. Let us explain the sense in which we have used the term 'remainder.' Evidence was collected during the eclipse of 1871 which went to show that above the hydrogen region and that occupied by the brighter layers of that unknown substance which lies outside it, there was matter, at the sun, the light of which was powerful in its action upon a photographic plate, while it was comparatively powerless to act upon the eye. The corona depicted on the photographic plate was vastly different from the corona seen by the eye, but from a very different cause—one depending upon the condition of our air, or, at all events, of something between us and the moon.

"Now, if we assume that there is something at the sun enveloping the hydrogen, this something will be cooler, and we have now an abundance of laboratory experiments to show that the molecular constitution of the vapours of the same chemical element at different temperatures is vastly different ; and, further, that the spectra of these variously constituted molecules are very definite, and, for the same degree of molecular complexity, have a strange family likeness to each other.

"So far as we have gone already, we have never been able to attack those parts of the sun's surroundings where, in consequence of the reduction of temperature, the various affinities of the molecules have begun to come into play, and combinations of molecules with similar or dissimilar molecules must occur.

"As a consequence of the perfect action of dissociation in the lower layers which has apparently reduced the vapours of all the chemical substances present in the sun's atmosphere to their simplest molecular condition, each vapour in this condition thins out, so to speak, in such a manner that everything represented high up in the atmosphere is more strongly represented low down. But though this is true for a state of things where the molecular constitution is of the simplest, it is quite clear that if we assume an exterior cooler region filled with molecules of greater complexity in consequence of a reduced temperature, if we can get at this region observationally we shall find that the spectrum which it gives will be confined to the higher levels, *and will not be represented lower down because the compound molecules which produce it will be broken up by the higher temperature of the subjacent regions.*

"Now, it looks as if this important and anticipated result has been established. In a telegram addressed to the *Daily News* it is stated that 'the prismatic camera shows the rings with protuberances at the edge of the sun, *and at least one more ring towards the ultra-violet without protuberances.*' In other words, the molecules which existed higher up, and built up the stratum the spectrum of which consisted of a ring towards the ultraviolet above the prominence-region, were unrepresented below among the simpler molecules the spectra of which consist of rings extending down to, and actually including, the prominences.

"We have said this much by way of pointing out one among the many questions on which light may be thrown by the photographs which have been secured in Siam, and which it was hoped would have been duplicated in the Bay of Bengal. As the prismatic camera was the instrument requiring least time for adjustment, so it was the one which could be employed for the longest period during the eclipse. Before and after totality it may have done good service by recording the constitution of the lower part of the sun's atmosphere in a manner which it will not be very difficult to interpret, though certainly the characters will be of the strangest."

ARCTIC GEOLOGY *

III.

Coast of Arctic America.—Melville Peninsula.—Amongst the rock specimens brought home by Dr. Rae, Prof. Tennant recognised gneiss, hornblende slate, and similar metamorphic rocks, a portion probably of the granitic and crystalline rocks described by Sir John Richardson as occupying the central and eastern countries of the Hudson's Bay territory, believed by Sir R. Murchison to belong to the Laurentian system. The latter points out that from the prevalence of a profusion of Upper Silurian corals characteristic of the Niagara and Onondaga limestones (Wenlock or Dudley), the trilobite *Encrinurus punctatus*, and the shell *Pentamerus oblongus*, in the rocks lying on the Laurentian, in the north of the Hudson's Bay territory, and the absence of any traces of Lower Silurian rocks or fossils in the whole of the known polar region, that it is in the highest degree probable that the whole of the country north of the Laurentian Mountains was dry land during the deposition of the Lower Silurian. In the area to the south, and in Europe, and even in the Upper Silurian times, the sea, as evidenced by the presence of *Pentamerus*, was not a deep one, which is borne out by Sir W. Logan's discovery that the Silurian limestones at the head of Lake Temiscamang include enormous blocks of the sandstone on which they rest.†

Boothia.—Chalky limestones occur, but do not contain fossils, as at Prince of Wales Island, where the Esquimaux obtain large quantities of native copper on the shore.

Sir James Ross ‡ describes the River Saumarez, lat. 70, long. 92 W., as never frozen, and gives a sketch showing the gorge 80 feet in depth, excavated in hard trap, in which it runs. In the month of July he found several butterflies living near the coast, including an *Hipparchia*, two species of *Colias*, one being near *C. edusa*, and a *Polyommatus*. In Agnew River he found copper ore.

West Coast of Baffin Sea.—Crystalline rocks extend from Lancaster Sound to Cape Walter Bathurst and Cumberland Sound, with the exception of Cape Durban, where coal has been found by the whalers, a continuation probably of that of Disco; it also occurs at Kingaiti, two degrees south of Durban, as well as pure graphite.§

Arctic Archipelago.—Dr. Haughton, from an examination of the rocks and fossils collected by Sir Leopold M'Clintock from 1849 to 1859, now deposited in the museum of the Royal Dublin Society, was enabled to draw up a geological map of the Arctic Archipelago,‖ in which Silurian limestone is shown to occupy nearly all the islands south of Lancaster and Melville Sounds, including the south side of Banks Land, Prince Albert Land, Prince of Wales Land, King William's Island, and Boothia Felix, the central and western area of North Devon, and the whole of Cornwallis Island, &c.; granitoid rocks occurred on either side of Peel Sound, and at Ponds Bay, and near the mouth of the Fish River; also the eastern coast of North Devon and the opposite side of Baffin Bay, to 77° north latitude.

The lower carboniferous close-grained white sandstone ("Ursa stage" of Heer), with beds of coal, strikes S.W. and N.E. from Baring or Banks Land, where it rests on the Silurian, through Melville Island to Bathurst Island, where it disappears under the carboniferous limestone between Penny Strait and Queen's Channel.

The carboniferous limestone appears to strike nearly east and west; the whole of Prince Patrick Island is composed of it, and the northward portion of Parry Islands and the whole of Grinnell Land;* scattered over the limestone on several points are patches of lias, in which fossils have been found, notably at Intrepid Inlet, Arnott Bay, Bathurst Island, and on Exmouth Island north of Grinnell Land.

North Devon.—From Cape Osborne to Cape Warrender graphic granite occurs, passing into laminated gneiss consisting of black mica and transparent felspar, interstratified with garnetiferous mica-slate, traversed by epidote hornstone overlaid by red sandstone, similar to that of Wolstenholme Sound.

Dr. Sutherland describes the crevasses of the glaciers of Petowak, on the south coast of Jones Sound, as often being filled with mud, which becomes frozen in, and the whole mass breaks off in bergs.

North Somerset.—Granite of grey quartz, red felspar, and green chloritic mica occurs on the west coast. Eastward, the island consists of the Upper Silurian sandstones and limestones, the junction of which occurs in Transition Valley. In Bellot Straits granite and syenite rise to a height of 1,600 feet. The base of the Silurian consists of red sandstone and coarse grit, resembling those of Cape Warrender and Wolstenholme Sound, overlaid by ferruginous limestones with quartz grains, earthy limestones, occasionally cream-coloured, dipping from 0° to 5° to the N.N.W.; a few high cliffs occur, but the country is generally low and terraced, the limestone standing out as steps and buttresses, particularly at Port Leopold, where the alternation of hard limestone and soft shales, so well known in European limestone districts, is well shown in Beechey's sketch, at p. 35 of Parry's First Voyage. Amongst the fossils from Port Leopold Dr. Haughton records *Loxonema M'Clintockii*, and specimens of carnelian and selenite.

Prince of Wales Island.—Eruptive syenite occurs at Cape M'Clure. The western coast consists of Silurian limestone with fossils, overlaid by bright red ferruginous limestones, and a few beds of bright red sandstones, like the Transition Valley sandstone.

Banks Land.—Upper Silurian rocks are succeeded by close-grained sandstone, striking N.E. to E.N.E., of Lower Carboniferous age, and containing thin coal seams, discovered first in Parry Islands by Parry, and afterwards by Austin and Belcher in Melville Island and Bathurst Island. The fossils from this series are similar to those from the Irish Calp series, and from the Eifel. Silicified stems of plants were discovered by M'Clure on the coast of Banks Land, and on those of Wellington Channel by Belcher. The southern entrance to this channel was discovered by Sir Edward Parry in 1819. The lamented Sir John Franklin sailed up it 150 miles in 1845, before being beset with ice at Beechey Island in September 1846.

In Drift on the Coxcomb Range, Banks Land, M'Clure found fine specimens of *Cyprina Islandica*, 500 feet above the sea. In 78° N., Belcher found whale bones on high ground; and marine shells are described by Parry as occurring in clay in the ravines of Byam Martin's Island.

From the coast of Princess Royal Island the Esquimaux procure native copper in large masses. The rocks consist of greyish-yellow sandstone, with *Terebratula aspersa*.

* Continued from p. 469.

† Narrative of Expedition to Shores of Arctic Sea. By John Rae. London, 1852. "Siluria," 5th edit. London, 1872.

‡ Narrative of Second Voyage in search of a N.W. Passage, by Sir James Ross. 1835.

§ Quar. Jour. Geol. Soc., vol. ix.

‖ "Voyage of the *Fox*." Appendix IV. (London, 1850.)

* The north-west corner of *North Devon*, not the large tract west of Kennedy Channel.

Melville Island.—Several coal seams occur in the sandstones beneath the carboniferous limestone, striking about E.N.E. The coal burns with a bright flame, with much smoke, and resembles some of the gas coals of Scotland.

In Eglinton Island, between Melville Island and Prince Patrick's, carboniferous limestone with siliceous and ferruginous grits occur, capped by a patch of lias; and highly crystalline gypsum was found N.W. of Melville Island.

Byam Martin Island.—Two sandstones occur, one soft streaky, passing into purple sandstone like that of Wolstenholme Sound, the other fine grained, greyish-yellow, with coal seams, like that of Cape Hamilton, Baring Island, containing *Terebratula primipilaris*, Von Buch, and several Eifel forms, and of therefore Upper Silurian or Devonian species. The coal seams occur at a height of 350 feet above the sea, and are described as lignites by Salter.

Exmouth, Table, and Princess Islands, between North Cornwall and North Devon, with Depot Point on the north coast of the latter, form a remarkably fossiliferous area, from which a large number of fossils were collected by Sir Edward Belcher in 1855, and described by the late Mr. Salter.* Exmouth Island (77° N. lat. and 95° W. long.) rises to a height of 570 feet; the base is soft sandstone abruptly terminating except to the west, overlaid by limestone dipping to the west at 7°, containing *Zaphrentis*, *Spirifer Keilhavii*, and other species of carboniferous limestone type; at the top a patch of lias occurs, from which the vertebræ and ribs were collected by Belcher, determined by Prof. Owen to belong to an *Ichthyosaurus* near to *I. acutus* of the Whitby Lias.

Lias fossils had previously been discovered by Lieut. Anjou, of the Russian Navy, and described by Wrangel, from New Siberia in Asia, in 74° N. lat., but the presence of lias in these high latitudes remained unnoticed until Belcher's discovery at Exmouth Island, after which several fossils were brought home by Sir Leopold M'Clintock and Admiral Sherard Osborne, amongst them *Ammonite M'Clintockii* of Haughton.† A remarkably fossiliferous patch of lias also occurs at Point Wilkie, in Prince Patrick's Island, resting on carboniferous limestones, &c.

Rhynchonella of Silurian species were found by the Rev. Longmuir in the ballast of a ship from the coast of Prince Albert's Land; it is worthy of note that one species of *Rhynchonella*, *R. psittacea*, still lives on in these Arctic Seas, and, according to Mr. Gwyn Jeffreys, as far south as Drontheim.

Cornwallis Islands consist of Silurian rocks with *Syringopora geniculata*. On its coast and on that of Beechey Island Dr. Sutherland describes marine glacial drift, with Arctic shells, as occurring up to a height of 1,000 feet above the sea, and the presence of blocks of granite and anthracite on the shores of Lancaster Sound, brought by coast-ice.

At Dundas Island, in lat. 76° 15′, one of Capt. Penny's crew found a Silurian trilobite, and preserved it, tied in his shirt, when the boat had to be abandoned and a retreat effected. The presence of Silurian rocks at a point so far north, and of sandstones at Wolstenholme Sound, appears to render it probable that the E.N.E. strike of the Carboniferous strata, with their overlying Liassic patches, is cut off eastward, and the Silurian rocks surround them in a basin-like form, an E.N.E. synclinal running through Prince Patrick Island towards Hayes Sound. Detailed examination of the west coast of Smith Sound and Kennedy Channel will have great geological interest, as it will prove whether such a synclinal exists, and if so, whether the Carboniferous rocks are brought in by it, and whether the lower coal-bearing measures are present on both sides of it, and in what manner they rest on the Silurians of Grinnell Land.

Grinnell Land.—From the cliffs of Lady Franklin Bay and from Cape Frazer, in lat. 81° 35′ N., long. 70° W., Dr. Hayes found thirteen species of fossils, which were identified by Prof. Meek as Upper Silurian species, belonging to the fauna found in the New York Catskill Shaley Limestone of the Lower Helderberg group. Some of the species, as *Zaphrentis Haysii*, Meek, and *Loxonema Kanei*, Meek, are new to science.* One of the most northern promontories of Grinnell Land is named after the late Sir Roderick Murchison, who, commenting on the collections brought from the Arctic Archipelago by Parry, Franklin, Ross, Back, Austin, Ommaney, and the private expeditions of Lady Franklin, particularly those of Penny and Inglefield, and by the expedition under Sir E. Belcher, endorses the results arrived at by Mr. Salter, that the larger number of fossils obtained belong to Upper Silurian species of rather an American than a European facies, though many species were identical with those of Wenlock, Dudley, and Gothland.† Dr. Conybeare had, in his Report on Geology to the British Association in 1832, already noticed the similarity of the fossils from the Arctic regions to those of the English Upper Silurian series.

Dr. Emil Bessels, the naturalist of the American *Polaris* Expedition under the late Capt. Hall, who had previously taken part in the Prussian Polar Expedition, reports the most northern known land on the east side of the channel, including that portion of Hall's Land examined, to consist of Upper Silurian rocks, with a few fossils.‡

The Esquimaux inhabitants of the coasts of Arctic America, from Behring's Straits to Greenland, speak the same language, and use similar implements. There is no more interesting passage in Prof. Dawkins' recent work § than that in which he compares the identity of type of these implements with those from Dordogne and other parts of France and Belgium, both as regards fowling and fishing spears, darts, and arrows; this likeness extends to the actual shape of the base of insertion into the haft, the haft being formed of mammoth ivory derived from the frozen cliffs, of the very species that was hunted by palæolithic man in the South of France.

These two peoples, separated so widely in time and space, were alike in their artistic feelings and methods of incising, on tusks, antlers, and bones, representations of familiar objects; alike also in their habit of splitting bones for marrow and accumulating them around their dwellings, in their disregard for the sepulchre of their dead, in their preparation of skins for clothing, and in the pattern of the needles used in sewing them together; alike also in their feeding on the musk sheep and the reindeer, and in countless other characteristics. It is well-nigh impossible to resist Prof. Dawkins' conclusion that the Esquimaux is the descendant of palæolithic man, who retreated northwards with the Arctic fauna with which he lived in Europe: though before the close of the glacial epoch it is probable that a continuous land connection existed between France and North America by way of Siberia, remains of the true horse having been discovered associated with *Bison priscus* and the mammoth in Arctic America, and representations of the horse, by a palæolithic artist, occurring on an antler from La Madelaine, and the entire skeleton of a horse from a palæolithic station being preserved in the Lyons Museum.

Sir John Richardson ‖ speaks of the Kuskutchchewak people who inhabit the banks of a river flowing

* "Last of the Arctic Voyages by Sir E. Belcher." (London, 1855.)
† Appendix to "Voyage of the *Fox*."

* *American Journal of Science and Arts*, second series, vol. xl., No. 118, 1865.
† "Open Polar Sea" (London, 1867), pp. 440, *et seq.* "Siluria," 1872. 5th edition, p. 441.
‡ Bull. Soc. Geog. Paris, March 1875. I have to thank Captain Feilden, R.A., naturalist to the Arctic Expedition, for calling my attention to this letter of Dr. Bessels.
§ "Cave Hunting." (London: Macmillan, 1874.)
‖ "Arctic Search Expedition." (London, 1851.)

into Kuskokvim Bay, Behring Sea, as believing that the mammoth, whose tusks they constantly find came from the east, and were destroyed by the spells of their *shaman*.

In the kitchen-middens of the deserted Esquimaux villages of Jacobshafn, West Greenland, Dr. Oberg discovered bones of the Walrus and *Cystophora cristata*, which no longer ventures into this ice-blockaded fjord; and also of the bear *Ursus maritimus*, which is now rarely seen south of the Waigat, associated with arrowheads, stone flakes, and scrapers, of clear quartz crystals and green jasper (*angmak* of the Greenlanders), found in the basalt of Disco.

CHARLES E. DE RANCE

(*To be continued.*)

ON ATTRACTION AND REPULSION RESULTING FROM RADIATION

AT the Royal Society *conversazione* the other evening the most interesting object exhibited was, beyond all doubt, the radiometer of Mr. Crookes. Mr. Crookes' discovery is of so much importance that our readers will be glad to have an abstract of a paper on the subject, recently read by Mr. Crookes at the Royal Society. It was the second part of a paper which the author sent to that Society in August 1873.

Mr. Crookes commences by describing improvements which he has made in the Sprengel pump, and in various accessories which are necessary when working at the highest rarefactions. He describes different new forms which enable the phenomena of repulsion by radiation to be observed and illustrated. A bulb three inches diameter is blown at the end of a glass tube eighteen inches long. In this bulb a fine glass stem with a sphere or disc of pith, &c., at each end is suspended by means of a cocoon fibre. The whole is attached to the Sprengel pump in such a way that it can be perfectly exhausted, and then hermetically sealed. Besides pith, the terminals may be made of cork, ivory, metal, or other substance. During exhaustion several precautions have to be taken, and to get the greatest delicacy in an apparatus of this kind, there is required large surface with a minimum of weight. An apparatus constructed with the proper precautions is so sensitive to heat that a touch with the finger on a part of the globe near one extremity of the pith will drive the index round over 90°, whilst it follows a piece of ice as a needle follows a magnet. With a large bulb very well exhausted and containing a suspended bar of pith, a somewhat striking effect is produced when a lighted candle is placed about two inches from the globe. The pith-bar commences to oscillate to and fro, the swing gradually increasing in amplitude until the dead centre is passed over, when several complete revolutions are made. The torsion of the suspending fibre now offers resistance to the revolutions, and the bar commences to turn in the opposite direction. This movement is kept up with great energy and regularity as long as the candle burns.

Mr. Crookes discusses the action of ice, or a cold substance, on the suspended index. Cold being simply negative heat, it is not at first sight obvious how it can produce the opposite effect to heat. The author, however, explains this by the law of exchanges, and shows that attraction by a cold body is really repulsion by radiation falling on the opposite side. According to the same law, it is not difficult to foresee what will be the action of two bodies, each free to move, if they are brought near to each other in space, and if they differ in temperature either from each other or from the limiting walls of the space. The author gives four typical cases, with experiments, which prove his reasoning to be correct.

Experiments are described with the object of ascertaining whether the attraction by heat, which, commencing at the neutral point, increases with the density of the enclosed air, will be continued in the same ratio if the apparatus is filled with air above the atmospheric pressure. This is found to be the case. Various experiments are described with bulb-apparatus, in which the bulb is surrounded with a shell containing various adiathermous liquids, and also with a shell of vacuum. In all cases radiation passed through, producing the normal action of attraction in air and repulsion in a vacuum.

Mr. Crookes next describes a form of apparatus by which measurable results are attainable. It consists of a long glass tube, with a wider piece at the end. In it is suspended a lump of magnesium by a very fine platinum wire, the distance between the point of suspension and the centre of gravity of the magnesium bob being 39·14 inches. Near the magnesium is a platinum spiral, capable of being ignited by a voltaic battery. Observations of the movement of the pendulum were made with a telescope with micrometer eyepiece. With this apparatus a large series of experiments are described, starting from air of normal density, and working at intermediate pressures up to the best attainable vacuum.

With this apparatus it was found that a candle-flame brought within a few inches of the magnesium weight, or its image focussed on the weight, and alternately obscured and exposed by a piece of card at intervals of one second, will soon set the pendulum in vibration when the vacuum is very good. A ray of sunlight allowed to fall once on the pendulum will immediately set it swinging.

The form of apparatus is next described, which the author has finally adopted, as combining the greatest delicacy with facility of obtaining accurate observations, and therefore of getting quantitative as well as qualitative results. It consists of a glass apparatus in the shape of an inverted T, and containing a horizontal glass beam suspended by a very fine glass thread. At the extremities of the beam are attached the substances to be experimented on, and at the centre of the beam is a small mirror from which a ray of light is reflected on to a graduated scale. The advantage which a glass thread possesses over a cocoon fibre is that the index always comes accurately back to zero. In order to keep the luminous index at zero, except when experiments are being tried, extreme precautions must be taken to keep all extraneous radiation from acting on the torsion-balance. The whole apparatus is closely packed all round with a layer of cotton-wool about six inches thick, and outside this is arranged a double row of Winchester quart bottles filled with water, spaces only being left for the radiation to fall on the balance, and for the index ray of light to get to the mirror.

However much the results may vary when the vacuum is imperfect, with an apparatus of this kind they always agree amongst themselves when the residual gas is reduced to the minimum possible; and it is of no consequence what this residual gas is. Thus, starting with the apparatus full of various vapours and gases, such as air, carbonic acid, water, iodine, hydrogen, ammonia, &c., at the highest rarefaction there is not found any difference in the results which can be traced to the residual gas. A hydrogen vacuum appears the same as a water or an iodine vacuum.

With this apparatus the effect of exposing torsion-balance to a continuous radiation is described, and the results are shown graphically. The effect of a short (11·3 seconds) exposure to radiation is next described, and the results are given in the form of a Table.

In another Table are given the results of experiments in which a constant source of radiation was allowed to act upon one end of the torsion-beam at a distance of 140 or 280 millims., various substances being interposed. The sensitiveness of this apparatus to heat-rays appears to be greater than that of an ordinary thermo-multiplier. Thus the obscure heat-rays from copper at 100°, passing through glass, produce a deflection on the scale of 3·25, whilst under the same circumstances no current is detected in the thermo-pile. The following substances are used as a screen, and the deflections produced, when the source of radiation is magnesium-wire, a standard candle, copper at 400° and copper at 100°, are tabulated :—

Rock-salt, 20 millims. thick ; rock-crystal, 42 millims. thick ; dark smoky talc ; plate glass of various thicknesses, both white and green ; a glass cell containing 8 millims. of water ; a plate of alum 5 millims. thick ; calc-spar, 27 millims. thick ; ammonio-sulphate of copper, opaque to rays below E, ditto opaque to rays below G.

Mr. Crookes considers that these experiments show that the repulsion is not entirely due to the rays usually called heat, *i.e.* to the extremo- and ultra-red of the spectrum. Experiments have been tried with the electric and the solar spectrum formed with a quartz train, which prove the action to be exerted by the luminous and ultra-violet rays. Some numerical data have been obtained, but unfavourable weather has prevented many observations being made with the solar spectrum.

The barometric position of the neutral point dividing attraction from repulsion is next discussed. The position of this point varies with the density of the substance on which variation falls, the ratio of its mass to its surface, its radiating and conducting power for heat, the physical condition of its surface, the kind of gas filling the apparatus, the intensity of radiation, and the temperature of the surrounding atmosphere. The author is inclined to believe that the true action of radiation is repulsion at any pressure, and that the attraction observed when the rarefaction is below the neutral point is caused by some modifying circumstances connected with the surrounding gas, but not being of the nature of air-currents. The neutral point for a thin surface of pith being low, whilst that for a moderately thick piece of platinum being high, it follows that at a rarefaction intermediate between these two points pith would be repelled, while platinum was attracted by the same beam of radiation. This is proved experimentally ; and an apparatus showing simultaneously attraction and repulsion by the same ray of light is described and illustrated in the paper.

Mr. Crookes concludes his paper with a discussion of the various theories which have been adduced in explanation of these phenomena. The air-current and electrical theory are considered to have been abundantly disproved. The following experiment is given to show that Prof. Osborne Reynolds's hypothesis of the movements due to evaporation and condensation at the surface will not account for all the facts of the case, and that, therefore, he has not hit upon the true explanation. A thick and strong bulb was blown at the end of a piece of very difficultly fusible green glass, specially made for steam-boiler gauges. In it was supported a thin bar of aluminium at the end of a long platinum wire. The upper end of the wire was passed through the top of the tube and well sealed in, for electrical purposes. The apparatus was sealed by fusion to the Sprengel pump, and exhaustion was kept going on for two days, until an induction-spark refused to pass across the vacuum. During this time the bulb and its contents were several times raised to a dull red heat. At the end of two days' exhaustion the tube was found to behave in the same manner as, but in a stronger degree than, it would in a less perfectly exhausted apparatus, viz., it was repelled by heat of low intensity and attracted by cold. A similar experiment was next tried, only water was placed in the bulb before exhaustion. The water was then boiled away *in vacuo*, and the exhaustion continued, with frequent heating of the apparatus to dull redness, for about forty-eight hours. At the end of this time the bar of aluminium was found to behave exactly the same as the one in the former experiment, being repelled by radiation.

It is impossible to conceive that in these experiments sufficient condensable gas or vapour was present to produce the effects Prof. Osborne Reynolds ascribes to it. After the repeated heating to redness of the highest attainable exhaustion, it is impossible that sufficient vapour or gas should condense on the movable index to be instantly driven off by the warmth of the finger with recoil enough to drive backwards a heavy piece of metal.

Whilst objecting to the theories already advanced as not accounting for all the facts of the case, Mr. Crookes confesses that he is not as yet prepared with one to put in their place. He wishes to avoid giving any theory on the subject until a sufficient number of facts have been accumulated. The facts will then tell their own tale. The conditions under which they invariably occur will give the laws, and the theory will follow without much difficulty.

THE FATAL BALLOON ASCENT

THE readers of NATURE are no doubt aware of the fatal result of the recent ascent of the balloon *Zenith* ; the following authentic details at first hand will no doubt be of interest :—

CIRON (Indre), *April* 17.

The *Zenith* was sent up on the 15th of April in order to determine the quantity of carbonic acid contained in the atmosphere at an altitude of 24,000 feet. The "let go" was given at twenty-five minutes to twelve A.M. The captain was M. Sivel, and there were only two passengers, M. Gaston Tissandier and M. Crocé-Spinelli. The ascent took place gradually in a slight E.N.E. wind, the sky being blue but vaporous. The rate of ascent was calculated to be nine feet per second, but diminished gradually. Shortly after one o'clock the altitude obtained was 22,800, and the passengers were quite well, although feeling weak. The inhalation of oxygen produced good restorative effects when tried. Then a consultation took place, and the *Zenith* being in equilibrium, a quantity of ballast was thrown overboard. M. Tissandier then fainted, and is ignorant of what was felt by his friends.

At eighteen minutes past two he was awakened by M. Crocé-Spinelli warning him to throw over ballast as the balloon was fast descending. He obeyed mechanically, and at the same time Crocé-Spinelli threw overboard the aspirator, weighing eighty pounds. Tissandier then wrote in his book a few disconnected words, and again fell asleep for about an hour. When he awoke, the balloon was descending at a terrific rate ; no more ballast was left to be thrown away, and his two friends were suffocated. Their faces had turned black, and the blood was flowing from their mouth and nose. They were evidently dead. It was a terrible situation.

The only resource was to cut the grapnel rope a little before the instant when the car should strike the ground, which Tissandier did with astonishing coolness. The wind had increased in strength, and Tissandier was obliged to tear open the balloon in order to stop it. It was caught on a hedge in a commune of Indre, called Ciron, 190 miles S.S.W. from Paris.

The tragic fate of Sivel and Spinelli is to be ascribed to the fatal resolution of accomplishing, at any price, a height of 24,000 feet, but mainly, no doubt, to the throwing out of the aspirator, which will be discovered somewhere perhaps unbroken, as it had been provided with a parachute.*

The only instruments broken are the potash tubes for the absorption of carbonic acid. The experiment had been tried successfully ; two aspirators had been used, but the tubes were not lodged in their proper case.

Careful readings were taken with the thermometer, and,

* According to the *Times* correspondent, this and other things have been ound.

although diminishing, the temperature was remarkably high:—

9,600 feet	... ...	1° Centrigrade
12,000 „	... ...	0° „
13,200 „	... ...	0° „
15,420 „	... ...	−5° „
19,600 „	... ...	−8° „
22,960 „	... ...	−10° „

The temperature of the gas in the interior of the balloon was also observed by a new system. It was found to vary very little, owing to the heating power of the sun, and at 22,900 feet was found to be + 25°, showing a difference of − 35° centrigade with the temperature of the air.

This result is extremely remarkable, and was observed at several intervals, although the gas ought to suffer a diminution of temperature owing to its constant dilatation.

Although the air was clear and the sky quite blue, a number of cirrus clouds were seen on the horizon, which could not be seen from the surface of the earth.

As far as can be inferred from the ascertained facts, there was no sensible variation in the direction of the air for an immense altitude. It accounts for the unprecedented beauty of the weather and the purity of the air; it may be taken as a fair prognostic of the continuance of good weather for at least a few days.

The aëronauts had in their cars maximum barometers in a sealed box, in order to test the altitude in which they were travelling. These tubes, having been saved, will be tested in the laboratory of M. Hervé-Mangon.

M. Tissandier was slightly hurt in his fall. Great sympathy has been elicited for Sivel and Crocé-Spinelli, who may be said to have spent their lives in the battle-field of the air. Sivel was formerly a captain of the mercantile navy; his age was forty-two years. Crocé-Spinelli was a pupil of the École Centrale, and was thirty-two years of age. The former was a widower, and leaves a girl, and the second was a bachelor. A subscription is being contemplated for the fatherless child.*

The *Zenith* is in good order, and will be put in repair. Although marred by a sad tragedy, and although the composition of the air has not been ascertained, as was contemplated, the expedition cannot be said to be devoid of results. It will serve as an incitement to further investigation in the same direction, but with greater caution.

W. DE FONVIELLE

Since the date of our correspondent's letter, it would seem from the indications shown by the uninjured barometers that the height reached was actually 14,000 metres, or eight miles. On Tuesday the bodies of Sivel and Spinelli were interred with well-deserved honours in Père la Chaise, many eminent scientific men being present. Subscriptions on behalf of those who were dependent on the two martyrs to science will, we believe, be received at the office of the *Courrier de l'Europe*, Tavistock Street, Covent Garden.

NOTES

THE Royal Society during the present session have elected the following nine eminent scientific men as foreign members:—Pierre J. van Beneden, of Louvain; Joseph Louis François Bertrand, of Paris; Alfred Louis Olivier Des Cloizeaux, of Paris; Hippolyte Louis Fizeau, of Paris; Elias Magnus Fries, of Upsal; Jules Janssen, of Paris; Auguste Kekulé, of Bonn; Gustav Robert Kirchhoff, of Berlin; and C. Ludwig, of Leipsic. Also the Earl of Carnarvon, Mr. W. E. Forster, and Sir Stafford Northcote have been elected Fellows of the Society.

THE names of the fifteen candidates for the Fellowship selected by the Council of the Royal Society to be recommended for election at the meeting on June 3 are W. Archer, J. R. Bennett, D. Brandis, J. Caird, J. Casey, A. Dupré, J. Geikie, J. W. L. Glaisher, J. B. N. Hennessey, E. Klein, E. Ray Lankester, Capt. Nares, R. S. Newall, W. C. Roberts, and Major-General Scott.

THE annual meeting of French astronomers took place recently at the Ministry of Public Instruction, under the presidency of M. Leverrier. It was composed of M. Dumesnil, the director of the Enseignement Supérieur, the members of the Council of the Paris Observatory, and the directors of the Marseilles and of Toulouse Observatories. The Observatory at Algiers not having been yet reorganised was not represented, though measures are very shortly to be taken to get this done. An Observatory is to be created at Bordeaux, and another at Toulouse. It is stated, moreover, that a Physical Observatory is to be created in Paris or the vicinity, and placed under the direction of the Bureau des Longitudes. The Council of the Observatory is said to have unanimously passed a vote recommending that no one should be a member of two observatories at the same time.

GENERAL SIR EDWARD SABINE has been elected a corresponding member of the French Academy of Sciences.

THE German Anthropological Society will hold its general meeting at Munich in August next, and it is intended to arrange an exhibition of the most interesting objects of Celto-Germanic origin, found upon Bavarian ground. Bavaria possesses great treasures of this kind in its Government and private collections, and these objects are of the highest importance as regards the history and culture of the earliest periods. Men of scientific authority will superintend the exhibition, which, it is proposed, is to consist of the following seven groups:—1. Flint implements found in Bavaria, such as hammers, knives, arrows, &c. 2. Bronze weapons and ornaments of the same material, particularly swords, daggers, lances, arrow-points, sickles, and objects used for personal adornment. 3. Iron weapons, such as swords, hatchets, daggers, and knives. 4. Ornaments of amber, glass, or earthenware (beads). 5. Glass and earthenware vases. 6. Casting-moulds for Celto-Germanic weapons. 7. Coins, principally Celtic ones, the so-called "rainbow-dishes." All the objects will be well taken care of, and a guarantee is given for safe keeping and return. All expenses for carriage will be defrayed by the Society.

DR. SCHWEINFURTH has just received news from the Upper Nile, stating that Mohamed Abd-es-Ssamat, the Nubian ivory dealer who had rendered the German traveller most important help in pursuing his explorations in the Niam-Niam and Mombuktu districts, was killed in December last by Niam-Niam soldiers, who had besieged and finally taken his Seriba (a sort of block-house). The assistance rendered to Dr. Schweinfurth by this ivory dealer was of the highest importance, and was acknowledged both by the German and Egyptian Governments. The history of the investigation of Inner Africa, which impartially notes down the names of all men of merit, independent of their nationality, faith, or colour, will also preserve that of Abd-es-Ssamat, by the side of his illustrious German friend.

THE *Kölnische Zeitung* of April 17 contains an elaborate and highly interesting account of the festival which took place at Naples a few days ago, upon the occasion of the opening of the Zoological Station. Dr. Anton Dohrn, the founder of the station, made the opening speech. After him Prof. Panceri, of Naples University, thanked Dr. Dohrn in the name of Italy for his great efforts in carrying the important work to a successfu

* The *Times* correspondent states that M. Sivel leaves a widow as well as a child, and that M. Spinelli was the sole supportof his parents. To quote the words of the correspondent, "The scientific world will doubtless respond liberally to this appeal, for MM. Spinelli and Sivel lost their lives, not in gratifying foolhardy curiosity, but in endeavouring to penetrate the secrets of the atmosphere for the benefit of science." M. Tissandier's own account of the journey will be found in Monday's *Times*.

result. The Prefect of Naples had sent a deputy, and many eminent scientific men were present. After the festival, the guests visited the magnificent aquarium and the working room of the zoologists; there are eighteen gentlemen now working there. The States which have reserved working tables at the Station are Prussia, Italy, Russia, Austria, Bavaria, Baden, Holland, Saxony, Alsace and Lorraine, and Mecklenburg; also, as our readers know, a table has been reserved for the University of Cambridge.

THE writer of the article on the *Times* Weather Chart in last week's NATURE (p. 473), requests us to state that the word "barograms" in the fourth paragraph should have been "isobars."

MR. EDWARD BELLAMY, F.R.C.S., will commence his course of lectures on "The Anatomy of the Human Form" in the theatre of the South Kensington Museum on Friday, 23rd inst., at 4 P.M.

M. WURTZ has tendered his resignation as professor in the Paris Medical School, and it appears to have been accepted; but before taking any definite step, M. Wallon has summoned a meeting of the professors to ascertain who they thought ought to be appointed Dean of the Faculty of Medicine.

ON April 16 a meeting of botanists from various parts of Scotland was held at Perth to hear the report of the committee (appointed at the Fungus Show held in Aberdeen last autumn) to organise a Scottish Cryptogamic Society. A constitution was adopted, and office-bearers were elected for the present year, the President being Sir T. Moncreiffe of Moncreiffe, Bart.; Vice-president, Prof. Dickie, Aberdeen; Secretary, Dr. Buchanan White, F.L.S. It is intended to have a show of cryptogamic plants, especially of fungi, every year in various districts of Scotland in rotation, and the show for this year is to be in Perth in the last week of September, when it is expected that a very large number of specimens will be exhibited. The Society will also adopt other means of promoting the study of Cryptogamic Botany, and it is possible that it will from time to time issue a few fasciculi of "New or rare Scottish Cryptogamic Plants." English cryptogamologists desirous of becoming corresponding members of the Society should communicate with the Secretary (Dr. Buchanan White, Perth), from whom information regarding the Society or the show may be obtained.

M. LEVERRIER being deeply engaged in his official work at the Observatory, has no time to deliver his regular course of lectures on astronomy at the Sorbonne. M. Wolf has been appointed by him as his substitute.

LARGE meteors were seen during the recent clear nights in different places in France; at Havre on the 12th, and at Paris on the 10th. The Paris meteor was seen at two o'clock in the morning; the direction was not specified, but the colour was green. The Boulevard St. Michel appeared as if it were illuminated. The Havre meteor was very large, going with an immense velocity from south-east to north-west.

THE first storm of the season in Central France was felt on April 7 in the department of Gers, near the small picturesque town of Lectoure. The spire of Saint Martin de Gorgue was almost demolished by a thunderbolt. Very few French churches, especially in small country places, are supplied with lightning conductors.

THE halo which was observed by M. de Fonvielle at Paris on the 12th of March, and also in England, was observed at the same time at Montsouris Observatory, a bout six miles south of Montmartre, and termed "a trace of halo," instead of a perfect one. As the moon had the same altitude for both observers, the icy cloud must have been suspended at a small distance, and nearer the zenith at Montsouris that at Montmartre. If telegraphic signals were exchanged during their appearance, these phenomena could be discussed with great benefit to science. Auroræ Boreales were frequent during the beginning of March, which is in accordance with the opinion of meteorologists that they are caused by icy particles rendering the upper part of the atmosphere more conductive of electricity.

SIX useful lectures by Prof. Frankland on "How to teach Chemistry," originally delivered to science teachers, will shortly be published by Messrs. Churchill, from notes taken and edited, with Dr. Frankland's sanction, by Mr. George Chaloner, F.C.S.

WE hear that New College and Balliol College, Oxford, and the municipal authorities at Bristol, have finally determined to establish a new College of Science and Literature at Clifton. (See NATURE, vol. x. p. 93.) It is anticipated that 50,000*l*. will be raised for the buildings in Bristol. The two above-named Colleges have each promised 5,000*l*. towards the foundation, and it is said that they both intend giving a further sum towards the endowment.

THE Committee appointed to examine into the advisability of a new survey of Massachusetts (see NATURE, vol. xi. p. 381) have reported strongly in its favour, almost to the full extent desired by the scientific men whose advice they asked. To a small pamphlet on the subject which has just come to hand, is appended what we take to be the draft of an Act which the Committee advise the Senate and House of Representatives to pass. The Act recommends the appointment of a Board of seven persons, with the Governor and a Secretary. This Board will employ suitable persons to make a thorough topographical, geological, and biological survey of the State. The Board is to see to the preparation of a topographical map on the scale of 1 : 25,000, and also will prepare from the surveys enlarged maps on the scale of 1 : 10,000. Careful reports are to be prepared upon the geology of the State, with special reference to the discovery of coal, ores, and building material of economic value; also reports on the zoology and botany of the State, comprising catalogues of the animals and plants, with particular reference to those injurious and those beneficial to man. The proposed Act also provides that 30,000 dollars be annually appropriated for the expenses of the survey, and that yearly reports be presented to the Legislature. These provisions are on the whole satisfactory, and there is no doubt the Massachusetts Legislature will give them the force of law.

FROM the Seventeenth Report of the East Kent Natural History Society, we are glad to see that it continues prosperous, "losing nothing of its interest and usefulness." The total number of members is ninety-four. The Report contains a brief account of the Society's meetings during 1874, from which it would seem that the actual work of the Society is carried on by a very small proportion of the members.

THE additions to the Zoological Society's Gardens during the past week include an Australian Dingo (*Canis dingo*) from Australia, presented by the Zool. and Accl. Soc. of Victoria; a Crested Porcupine (*Hystrix cristata*) from W. Africa, presented by Mr. G. W. Venderkist; two Red-footed Crab-eating Raccoons (*Procyon cancrivorus*) from Demerara, presented by Mr. J. R. H. Wilton; an Impeyan Pheasant (*Lophophorus impeyanus*) from the Himalayas, presented by Capt. J. E. Whitting; a Rufous Tinamou (*Rhynchotus rufescens*) from Brazil, presented by the Viscount Hill; a Sharp-nosed Crocodile (*Crocodilus americanus*) from Jamaica, presented by Capt. A. M. Drummond; ten Green Lizards (*Lacerta viridis*) from Jersey, presented by Mr. G. E. Drage; a Quica Opossum (*Didelphys quica*) from Brazil, a Red Ground Dove (*Geotrygon montana*) from South America, purchased.

ACCIDENTAL EXPLOSIONS *

III.

A FEW substances well known to chemists are so very unstable in character, or are so very difficult to prepare in a condition approaching purity, that they either begin to undergo change as soon as they have been produced, or very shortly afterwards, such change proceeding sometimes gradually and quietly until the substance has been transformed into non-explosive bodies, or occurring, in other instances, with a rapidity speedily resulting in the violent decomposition or explosion of the substance. Injuries more or less severe have been inflicted upon the discoverers or investigators of substances of this kind, or upon those who prepare them and exhibit their properties for instructional purposes, and such accidents occasionally occur even though all possible or reasonable precautions appear to have been taken to guard against them. It has occasionally also happened that serious accidents have resulted from attempts to apply to practical purposes the explosive power of such substances (as, for example, the chloride of nitrogen and iodide of nitrogen) by persons imperfectly acquainted with their properties or those of explosive substances generally. The great danger in which want of knowledge may involve experimenters in this direction is too obvious to need being dwelt upon.

The risk of accident resulting from the liability of explosive compounds to so-called spontaneous decomposition has been on several occasions exemplified in the past history of the two most important of these compounds, gun-cotton and nitro-glycerine. The stability of properly purified gun-cotton, as well as that of nitro-glycerine, have, however, now been for some time past fully established, and no difficulty exists in carrying on with safety their manufacture on such a scale as to satisfy the continually increasing demand for efficient preparations of these violent explosive agents. At the same time the experience of the last few years has afforded repeated illustrations of the terrible risks and responsibilities incurred by manufacturers of these substances by the slightest departure from conditions essential to perfection and safety of manufacture, or by a relaxation of the strictest supervision in the production, purification, and storage of the materials.

In these respects the utilisation of explosive compounds of this class involves special risks not attendant upon the manufacture of gunpowder and modifications of that substance; in others, however, it presents important elements of comparative safety. For example, the manufacture and purification of gun-cotton, and its conversion into the compressed or granulated substance, are absolutely safe operations, the material being wet throughout the entire course, and therefore quite uninflammable, until, when completed, it is dried by long exposure to air, or by artificial heat. On the other hand, gunpowder, and all preparations of similar nature, are explosive from the very commencement of their manufacture.

Accidents at gunpowder factories are very frequent, and though they may not often involve considerable loss of life or destruction of property, the fact that their occurrence must in most instances be caused by partial, occasional, or complete and persistent neglect of precautions absolutely essential to the safety of the people employed in the works, or to a reduction of the risks of accident to the minimum, points to the necessity for improved legislation connected with manufactories of gunpowder and other explosive preparations, whereby the proper attention to regulations and precautions for safety may be rendered compulsory, and seconded by an efficient system of inspection.

After stating a number of precautions that ought to be adopted in all gunpowder manufactories, Prof. Abel said that lastly, though properly first in importance, the manufacturers of gunpowder and other explosive agents should not only themselves possess some scientific as well as a practical knowledge of the nature and properties of the substances in the manufacture of which the lives of their workmen are at stake, but they also should ascertain and insist that at any rate the persons who act as managers and foremen in their factories should not be deficient in the elementary knowledge indispensable to a proper performance of their duties.

Major Majendie, the Government Inspector of Gunpowder Works, &c., has reported officially that he was "much struck, in the course of his inspections, with the extraordinary ignorance of even the most elementary dangers, and the precautions necessary for avoiding them, which prevails among persons in charge of important factories and magazines," and that there can be no doubt that to the ignorance and incompetence of such persons a large number of the accidents which occur are indirectly due. Surely it is in the interest of employers to adopt measures for securing that the management of their works is in the hands of competent men, experienced in the details of the manufacture, and possessing adequate general education and technical knowledge to fit them for posts of such responsibility. The obvious mode of securing this is to render it compulsory for such men to obtain certificates of competency before they can hold responsible appointments in manufactories of gunpowder and other explosive agents.

The manufacture of fireworks, ammunition, percussion caps, and other articles involving the application of explosive agents is, it need scarcely be stated, attended by liability to accidents similar to and sometimes even greater than that existing in manufactories of gunpowder and materials of similar nature, and necessitates the adoption of precautions of the same nature as apply to these works.

Such necessity has, however, been very much disregarded in the arrangement and management of factories of this kind, and many very sad casualties have resulted either from utterly inadequate arrangements for localising explosions and reducing them to small proportions, by regulating the quantities of material dealt with in one building, and sufficiently separating and subdividing the manufacturing operations, or from neglect of simple regulations for excluding sources of fire from the buildings.

There are several important instances of accidental explosions on record which have occurred in the manufacture of pyrotechnic compositions and other articles of explosive nature, in consequence of a liability to the establishment of chemical activity between the ingredients of such preparations by even very slight inciting causes. Thus, certain descriptions of coloured fires are readily susceptible of so-called spontaneous ignition or explosion, either simply from the unstable nature of one or other of their ingredients, or from so apparently trifling a cause as the absorption of a small amount of moisture, or the employment of a small quantity of an easily oxidisable oil or fat in connection with their application to pyrotechnic purposes. In one instance, some signal lights, composed of a mixture of ingredients which long experience had shown to be in every way as permanent as those of gunpowder, were found to be undergoing decomposition to an extent which, had it not been noticed in time, must have resulted in serious consequences. The cause of this change baffled inquiry for some time, but ultimately it was clearly established that a very minute quantity of free acid contained in the paper linings of the cases in which the composition was confined (and derived from the antichlore used in the manufacture of the paper) had set up an action between the saltpetre and the orpiment composing this material, which spread gradually but with increasing rapidity through the highly compressed mass, being of course accelerated by the heat developed.

After referring to the great dangers arising from the manufacture of fireworks in dwelling-houses of the lower classes in crowded districts, the lecturer said that the fearful recklessness with which gunpowder and other explosive agents are handled and used by uneducated persons, such as these small firework makers, of which there are large numbers in the mining and manufacturing districts, and by the most extensive consumers of powder, namely, the miners and quarrymen, can scarcely be realised by anyone who has not had opportunity to acquire by personal observation a knowledge of the state of things.

Prof. Abel then gave instances of the incredible carelessness frequently shown by miners in their preparations for blasting both with gunpowder, gun-cotton, dynamite, and other explosive substances.

It is, however, more particularly from the fact that there are no regulations forbidding or restricting the making up, in dwelling-houses, of blasting cartridges, mining fuses, and the so-called powder straws used in blasting, that the chief liability to accidental explosions in mining districts arises. Miners are constantly in the habit of keeping considerable quantities of powder in their dwelling-rooms, and making up their cartridges or fuses (straws) at night.

After giving some illustrations of the disastrous results of carelessness in the handling of gunpowder, Prof. Abel said that it naturally follows that other explosive agents, such as dynamite and gun-cotton, should be treated with similar and perhaps even greater recklessness. The apparently less dangerous nature of

* Abstract of a lecture delivered at the Royal Institution, March 12, by Prof. F. A. Abel, F.R.S. Continued from p. 478.

such materials when unconfined tends to render the miner even more regardless of precautions, and hence it is unquestionably wrong to foster the notion of the safety of these materials in the hands of the miner, especially as it frequently occurs that the men who use these materials are unable to read the printed instructions which are supplied by the manufacturers with the cartridges for the purpose of guarding against accident.

It does not admit of dispute that the recklessness of the miner has actually been fostered hitherto by the utter disregard of all ordinary precautions which they must but too frequently witness at the stores where the powder is sold or issued to them. The practices of small dealers in gunpowder present illustrations of ignorance and recklessness, if anything, even more appalling than those which the habits of the miners furnish. The manner in which powder is often dealt with by those in charge of the stores or magazines in quarries or mines, and who have to issue supplies to the men, is illustrated by one or two examples from a report to the Home Office by Major Majendie. As an extreme instance of recklessness the case of a man is quoted who was in the habit of boring into the barrels with a red-hot poker; on one occasion, the lid of the barrel being thinner than usual, the heated iron was thrust into the contents of the barrel, and the man fell a victim to his very original mode of dealing with packages of gunpowder.

In some mining districts it has been customary to pay no regard whatever to the suitability, in point of safety, of the localities selected for the storage of powder. It has not unfrequently been kept in large quantities (*e.g.* 500 lb.) in ordinary buildings, quite close to dwelling-houses. Even where magazines have been provided, in connection with extensive mines and quarries, many instances are on record of gross ignorance or carelessness in regard to the precautions essential to the safe handling of gunpowder.

The strenuous exertions of the Government inspectors during the last few years have already resulted in a considerable amelioration of this lamentable condition of things, although the existing state of the law affords them little power to enforce simple regulations which are vital to the safety of the people employed, and often of the neighbourhood, but scant regard being but too frequently paid to the position of even extensive stores or magazines with reference to contiguous habitations.

The utter inadequacy of the existing regulations as to the transport of powder, &c., by land or water, and the flagrant manner in which even these defective regulations are but too frequently disregarded, are matters to which public attention has been much directed since the explosion in October last, and which are but in harmony with the negligence and ignorance displayed to so alarming an extent in connection with the handling and storage of gunpowder. Thus, the packages (barrels, &c.) in which powder is transmitted to distant places are often so imperfectly constructed that the grains escape into the cart, or the hold of a vessel, where they may become mixed up with grit and be eventually trampled upon. As regards the vehicles in which the powder is transported, some regulations exist with respect to the employment of covered or uncovered carts with reference to quantities of powder exceeding considerable limits, but there is no law requiring carts or barges to be specially constructed or employed so as to exclude sources of danger. In the mining districts and even in towns powder is constantly conveyed in dangerous quantities in ordinary carts, which may have been used for carrying stones, coal, or road rubbish, and is often packed with other goods, such even as lucifer matches and petroleum; there is no regulation to prevent the person in charge from smoking while in his cart, or stopping at a public-house, leaving the powder standing at the door. Prof. Abel quoted instances of the reckless carriage of powder in public conveyances, and of the transport of very large quantities (many tons) of powder through crowded thoroughfares in large towns (Edinburgh and London) with little or no precautions. The disregard of necessary precautions in the transport of merchants' powder by *water* was dwelt upon and contrasted with the precautions adopted by Government as absolutely necessary, and some severe comments were made upon the practice, which had been common, of stowing gunpowder in barges as part of miscellaneous cargoes which include even such materials as petroleum spirit.

After referring in detail to the precautions insisted on in the transport and storage of Government gunpowder, and to the effect of recent legislation with regard to explosive substances, Prof. Abel concluded by stating that the beneficial results attainable by a systematic and thoroughly authoritative supervision, by Government inspectors, of factories and stores of explosive agents, if conducted with intelligence and discretion, have been most convincingly demonstrated by the great good which it is admitted on all sides that the inspectors have already succeeded in accomplishing, even with the very insufficient powers which the present state of law affords them. The favourite argument of some, that Government inspection must operate mischievously, by diminishing private responsibility, has certainly received no support from the results of inspection, so far as the experiment has been tried. It will scarcely be asserted that a manufacturer or store-holder who may have willingly adopted, as suggestions which the inspector has no power to enforce, measures conducive to the safety of life and property, would be careless in the application of those measures because their adoption was no longer optional, or because the responsibility for their due observance was to some extent shared by the inspector. This very system of inspection cannot fail to benefit those interested in different branches of the industry of explosives by reducing the necessity for hard and fast rules with respect to the arrangement and conduct of works, which might in many instances entail hardship or inconvenience without any real necessity, and by strengthening the hands of factory-owners, and thus rendering comparatively easy the proper observance and enforcement of regulations for the safety of the men and the works. It is, however, especially in connection with the storage, transport, and employment of gunpowder and other explosives in mining districts that efficient inspection, supported by the reasonable power which a well-considered Act of Parliament cannot fail to afford, may be confidently expected to produce important beneficial results, not the least of which will probably be the wholesome influence exercised indirectly, by the force of example, upon the miner or pitman, whose ignorance has fostered the indifference with which long habit has led him to regard the possibility of danger.

But although improved legislation, and the beneficial regulations thus supplied, may be confidently hoped to effect an important reduction in the number and magnitude of the disasters now recorded as accidental explosions, it would obviously be worse than shortsighted to encourage a reliance upon legislation alone as a safeguard against the evils which lead to casualties of this kind. Punishments inflicted for transgression of the law may engender caution, but the disasters which arise from ignorance are not likely to be importantly reduced in number by legislative enactments alone.

It is to the general promotion of education among the people, and to the spread of scientific and technical knowledge, if even of the most elementary kind, among employers and employed, that we must look for a substantial diminution of these casualties, which the uneducated mind is but too prone to attribute to accident, and the prevention of which rests, at any rate to a large extent, with those who are at present tacitly content to regard them as inevitable.

SOCIETIES AND ACADEMIES

London

Royal Society, April 8.—"On the Development of the Teeth of Fishes" (Elasmobranchii and Teleostei), by Charles S. Tomes, M.A.; communicated by John Tomes, F.R.S.

Observations upon many mammals, reptiles, and fishes, led the author to the following general conclusions as to the development of teeth:—

(i.) All tooth-germs whatever consist, in the first instance, of two parts, and two alone—the dentine papilla and the enamel-organ.

(ii.) The existence of an enamel-organ is wholly independent of the presence or absence of enamel upon the teeth; examples of this have been recorded by Professor Tomes and by the author among mammalia, and are common amongst reptiles and fishes.

(iii.) Nothing justifies the arbitrary division into "Papillary," "Follicular," and "Eruptive" stages; nor does any open primitive dental groove or fissure exist in any creature examined.

(iv.) In all cases an active ingrowth of a process from the oral epithelium, dipping inwards into solid tissue, is the first thing distinguishable, although the formation of a dentine papilla opposite to its deepest extremity, goes on *pari passu* with it from the development into an enamel-organ.

(v.) A special capsule or follicle to the tooth-germ may or may not be present; when present it is in part a secondary development from the base of the dentine papilla, in a part a mere condensation of surrounding tissue.

"Experiments to ascertain the Cause of Stratification in Electrical Discharges *in vacuo*," by Warren De la Rue, Hugo W. Müller, and William Spottiswoode.

"First Report of the Naturalist attached to the Transit of Venus Expedition to Kerguelen's Island, December 1874," by the Rev. A. E. Eaton; communicated by the President.

[These are two long and important papers, which we hope to be able to be able to give next week.]

Linnean Society, April 15.—Dr. G. J. Allman, president, in the chair.—Prof. A. Dickson, M.D., Mr. J. F. Duthie, and Mr. H. C. Sorby, F.R.S., were elected fellows. The following papers were read:—On the nature and productions of the atolls of the South Pacific, by the Rev. Thos. Powell.—Papers on the botany of the *Challenger* Expedition: xxv., On the Diatomaceæ collected by Mr. H. N. Moseley in Kerguelen's Land, by the Rev. E. O'Meara; xxvi., Letter from Mr. H. N. Moseley on an edible Chinese *Sphæria*, known as "winter worm-grass," parasitic on certain larvæ (this was stated by Mr. Currey to be *Torrubia sinensis*); xxvii., On the Musci and Hepaticæ collected by Mr. H. N. Moseley, by Mr. W. Mitten, F.L.S. (these were from Teneriffe, Tristan d'Acunha, Kerguelen's Land, &c.)—On Algæ collected by the Rev. W. W. Gill near the island of Mangara, by Dr. Dickie, F.L.S.—List of plants collected by Dr. A. B. Meyer in New Guinea, in 1873, by Prof. Oliver, F.R.S. (these were only ten in number, including two new species).—Mr. W. S. Mitchell made some additional observations on the male Octopus.

Chemical Society, April 15.—Prof. Abel, F.R.S., in the chair.—Mr. J. W. Thomas read a paper on the gases enclosed in coals from the South Wales basin, and the gases evolved by blowers and by boring into the coal itself. These gases were found to be marsh gas, carbonic anhydride, and nitrogen, in all three of the classes of coal examined, namely, bituminous coals, steam coal, and anthracite.—A paper on narcotine, cotannine, and hydrocotannine, Part I., by Mr. P. H. Beckett and Dr. C. R. A. Wright, was then read by the latter; after which Dr. H. E. Armstrong communicated a note on isomeric change in the phenol series.

Zoological Society, April 6.—Dr. E. Hamilton, vice-president, in the chair.—A letter was read from Dr. G. Hartlaub, stating that the Finch described by him and Dr. Finsch as new in the Society's Proceedings for 1870, p. 817, and named *Lobiospiza notabilis*, was probably only the young bird of *Amblyura cyanovirens*.—Dr. A. Günther exhibited the skin of a new species of Mole from British Caffraria, which he proposed to call *Chrysochloris trevelyani*.—The Secretary exhibited, on behalf of Mr. J. Gould, F.R.S., the original specimen of the Parrot (*Aprosmictus insignissimus*), spoken of by Mr. Gould in his communication to the Society on the 3rd of November, 1874 (P.Z.S., 1874, p. 499); also specimens of two other new species of birds from Northern Queensland, a new Honey-eater, proposed to be called *Ptilotis flavostriata*, and a new Parrot, proposed to be called *Cyclopsitta maccoyi*.—Mr. Osbert Salvin, F.R.S., read a memoir on the avi-fauna of the Galapagos Archipelago. After a summary of what was known of the history and physical peculiarities of these islands, Mr. Salvin proceeded to give a complete account of the birds as at present known to us from the visits of Mr. Darwin, of the naturalists of the Swedish frigate *Eugenie*, and of Dr. Habel, whose collection afforded the principal materials upon which the present communication was based. Of the fifty-seven species of birds known to exist in the Galapagos, about two-thirds were stated to be peculiar to the Archipelago.—Mr. A. G. Butler read a memoir on the Heterocerous Lepidoptera of the family Sphingidæ, in which a complete revision of the various genera and species of this family was given.—A communication was read from Dr. J. S. Bowerbank, entitled "A Monograph of the Siliceo-Fibrous Sponges," Part III., being the third of a series of memoirs on this class of sponges. A second communication from Dr. Bowerbank contained the seventh part of his contributions to a general history of the Spongidæ.—Mr. A. H. Garrod read a paper on the form of the trachea in *Tantalus ibis*, in which the peculiar and numerous convolutions of that tube within the thorax of that bird were described.—A communication was read from Mr. G. S. Brady, in which he gave a revision of the known species of British Marine Mites, together with descriptions of some new species.—Mr. C. A. Wright read a paper on the question of the specific identity of the Weasel found in Malta, which he was inclined to refer to *Mustela boccamela*, Bp., hitherto only known to occur in Sardinia.

PARIS

Academy of Sciences, April 12.—M. Frémy in the chair.—The following papers were read:—On the comparison of the first observations of the Transit of Venus; a letter addressed by M. Puiseux to M. Dumas, President of the Transit Commission. From the data, M. Puiseux (NATURE, vol. xi. p. 474) finds the mean solar parallax to be 8″·879. This value differs little from that found by experiments on the velocity of light, made by MM. Foucault and Cornu, which is 8″·86; the latter is also the average value of those calculated by M. Leverrier from the perturbations of planets.—On the last number of the *Memorie di Spettroscopisti Italiani*, by M. Faye; this paper has special reference to M. Langley's memoir on the minute structure of the photosphere.—On the periodical variations and inequalities of the temperature (eleventh note); period of the twelve-fold twentieth day; by M. Ch. Sainte-Claire Deville. An extremely elaborate paper, with seven diagrams.—M. Cahours then presented to the Academy the third volume of his "Traité de Chimie Organique," and made some remarks on the same.—The Academy then nominated General Sabine as correspondent to their Section of Geography and Navigation, in lieu of the late M. Chazallon.—Researches on the transmission of air by a steam or air jet, by M. F. de Romilly.—On a new substance found in urine after the ingestion of chloral hydrate, by MM. Musculus and de Mermé. The authors gave it the name *urochloralic* acid.—A note by M. Bobierre, on the use of a little apparatus called *cherche-plomb* (lead-finder), which shows the presence of lead in alloys suspected of containing it, by contact with glacial acetic acid and iodide of potassium.—A note by M. G. Helznem, on an insect living, like Phylloxera, upon roots. It is principally found on *Abies balsamea* and *Abies Fraseri*.—M. R. de Wouves reminds the Academy, upon the occasion of the interesting researches now published by M. Ch. Sainte-Claire Deville, that as far back as December 20, 1870, he presented to the Academy a memoir entitled "On the Periodicity of the Weather."—Calorimetric researches on the carbon compounds of iron and manganese, by MM. L. Troost and P. Hautefeuille.—On the preparation of ethylene perchloride, by M. E. Bourgoin.—Researches on the quantities of heat disengaged in the decomposition by water of the bromides of some of the fatty acids, by M. W. Longuinine.—On the determinations of the carbonic acid of the air made in the balloon *Zenith*, by M. G. Tissandier. The percentage of carbonic acid varied between 2·40 (at 890 metres elevation) and 3·00 (at 1,000 metres) volumes in 10,000 volumes of air.

BOOKS AND PAMPHLETS RECEIVED

COLONIAL.—Monthly Record of Results of Observations in Meteorology, Terrestrial Magnetism, &c., taken at the Melbourne Observatory during August 1874: Robert L. J. Ellery (Melbourne, John Ferris).—Geological Survey of Victoria. Observations of New Vegetable Fossils of the Auriferous Drifts: Baron Ferdinand von Mueller (Melbourne, John Ferris).

AMERICAN.—Observations on the Phenomena of Plant Life. Paper presented to the Massachusetts Board of Agriculture by W. S. Clarke (Boston, Wright and Potter).

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