THURSDAY, MARCH 21, 1878

EASTERN EXCAVATIONS

Mycenæ. A Narrative of Researches and Discoveries at Mycenæ and Tiryns. By Dr. Henry Schliemann. (London: Murray, 1878.)

Troy and its Remains. A Narrative of Researches and Discoveries made on the Site of Ilium and the Trojan Plain. By Dr. Henry Schliemann. (London: Murray, 1875.)

Exhibition of Antiquities from Hissarlik at the South Kensington Museum. By Dr. Henry Schliemann.

Cyprus: its Ancient Cities, Tombs, and Temples. A Narrative of Researches and Excavations. By General Louis Palma di Cesnola. (London: Murray, 1877.)

TWO Eastern questions occupy the attention of Europe at the present time—one relating to the present, and, it is to be feared greatly, to the future; the other has reference to the past, and to the bridging over of that little-known protohistoric period which connects the civilisation of the far east, that is, Egypt and Assyria, with the culture of ancient Greece, to which we western Europeans are so much indebted. Different conditions of thought are engaged in the study of these two questions, yet both are connected, for the present crisis in the East represents the returning current of that same stream of culture which was flowing westward towards the dawn of our era. What Egypt and Assyria lent to Greece she passed on to Etruria and Rome, and the Romans carried to the shores of the Atlantic, there developing and fructifying, it has passed back eastward in a return wave, reviving the ancient monarchies in its path. Rome has regained its ancient landmarks. Germany has consolidated. Austria has been pushed, and is still pushing eastward. Greece is proclaiming the revival of its ancient nationality, and this will doubtless be followed in times to come by the resuscitation of Egypt and Palestine. The Turk, representing the last wave of the western flow, has been met and swamped by the returning ebb.

The time has been well chosen by our archæologists for an examination into the sites of those ancient cities whose history corresponds most closely to the period on which we are now entering; and to us English the parallel between the two eras has special interest. At a time when our fleets are massing in these seas in order to keep open our communication with the East, we are reminded that it was by means of a seafaring people that civilisation was spread over this region in ancient times. The comparison between ourselves and the Phœnicians has been often drawn; like causes produce like results. For the same reason that they peopled the shores and islands of the Mediterranean with their colonies, we have caused them to be studded with our military posts. What the Phœnicians did for the flow of civilisation in days of old, we, if we fulfil our functions rightly, shall do for its returning ebb at the present time. Other European nations are concerned in continental movements, but, like the Phœnicians, our path is by the sea. Syria, Cyprus, Crete, and Greece was the line they traversed, and this is the line which sooner or later we appear destined to occupy in the struggle to come.

It is not well to carry a simile too far, but one other parallel, as a natural outcome of the instincts of the two people, may be fairly drawn. It is said that in art, in modern times at least, we have no style of our own. Neither had they; devoted to navigation and commerce, their art, instead of being indigenous, was borrowed from the nations with whom they traded. This is well shown in the collection of antiquities from Cyprus, for the knowledge of which we are indebted to General di Cesnola, the American consul in that island. Cyprus was one of the first islands colonised by the Phœnicians. Three distinct styles of art are recognised in the Cypriote pottery, sculptures and glyptic representations, the Assyrian, the Egyptian, and the Greek. In the temple of Golgoi the objects belonging to these three different styles were found separately placed, the Egyptian by themselves, the Assyrian in like manner, and the Greek also together, showing in the opinion of the author that they were collected at different epochs, spreading over a long series of years. On the other hand a considerable number of the objects figured in General Cesnola's book distinctly include both the Assyrian and the Egyptian, for example, in the patera from Curium, figured in p. 329; the centre figure represents a winged warrior, probably a king, fighting with a lion, which is in true Assyrian style, whilst the outer circle of the same vessel is ornamented with figures that are as purely Egyptian. Probably between the eighth and tenth centuries B.C. both styles may have prevailed in Cyprus at different times, but it is evident that a period arose in which both styles as well as the Greek were united, and closely imitated, and this constitutes the chief characteristic of the Cypriote art.

Very different in this respect are some of the objects discovered by Dr. Schliemann in the royal tombs at Mycenæ, which, though rude and barbarous—more so, indeed, than the majority of the Cypriote antiquities—nevertheless show some attempt at realism. More especially may be noticed the bull's head, the bas reliefs, and some of the gold ornaments. In these we perceive an absence of that servile imitation of earlier styles which has been noticed as the characteristic of Cypriote art; and although falling far short of Hellenic greatness, there is a freedom from conventionality which left the artist at liberty to turn to nature as his instructor, and thus, with the aid of a little imagination, we may perhaps recognise potentially in these rude designs the germs of those qualities which made Greek art so famous in the times that followed.

The concentric circles of the Cypriote ornamentation are here replaced by a system of coil ornaments which resemble those in use during the bronze age of Europe rather than anything to be found in the countries immediately to the eastward. Notwithstanding this, however, the connection with Cyprus is apparent in many of the forms. The rude terra-cotta figures of men and animals correspond very closely with those found in Cyprus as well as Rhodes, and the long-nosed warriors drawn on the fragment of a painted vase (p. 133, "Mycenæ") might clearly claim family relationship with the lady figured on the Cypriote vase in Fig. 394 of General Cesnola's work. The mode of ornamenting the eyebrows by means of parallel incised lines is distinctly Cypriote. But perhaps the objects which most clearly attest the connection between the two places are the golden diadems (p. 186 "Mycenæ") found on the heads of the bodies in the tombs. These consist of pointed oval plates of gold, sometimes highly ornamented and having at the points, small holes by which they were fastened round the head with a wire. The position of the graves in which similar diadems to these were found at Idalium in Cyprus proves distinctly that they were more recent than the graves of the Phœnician period which lay beneath them. Similar forms of golden diadems from Kouyunjik are in the British Museum. The golden diadems found at Idalium are shown by these associated remains to belong to a more advanced period of art than the larger and more massive ones discovered in the royal tombs in the Agora at Mycenæ, the former being probably of the Greco-Roman age. Nevertheless the identity of the forms ought not to escape attention when considering the relative antiquity of the finds; they were, as Dr. Schliemann truly remarks (p. 189), in very extensive use in early times, and an investigation into the origin of these peculiar brow ornaments will without doubt have an important bearing on the period of the interments with which they are associated. It is to be regretted that General Cesnola, although he mentions the finding of these diadems in p. 75 of his work gives no illustration of them, but a number of them were sold at Sotheby's some years ago, and the remarks here made are based upon observations made at the time of the sale.

Turning now to Hissarlik our attention is naturally drawn in the first place to the so-called owl-faced vases which form so large a proportion of the antiquities discovered by Dr. Schliemann there. No subject has been more frequently applied to the ornamentation of funereal and other vases than the representation of a human face, as examples of which we may call to mind the rude jars representing Besa or Typhon in the Egyptian department of the British Museum, or our own Bellarmin jugs of the sixteenth century. Such representations are usually at first realistic, and expressive of the best endeavour of the designer, but in process of time the forms suffer degradation in the hands of inexpert or hasty workmen; the transmutation of form observable on British coins affords a well-known illustration of the gradual changes produced by means of imperfect copies, and similar degradation is often seen in the tribal and other ornaments and badges of modern savages. On the pottery found in the Peruvian graves a human face is of frequent occurrence. Some of these figures of faces are equal to the best productions of Cyprus or Mycenæ, whilst in others the features are so much dwarfed and distorted that little more than a line for the eyebrows and another for the nose remains to denote the intention of the potter, the other features having disappeared in those examples in which nothing more than a rude symbolism has been aimed at. An examination of the large collection of vases from Hissarlik, now exhibited by Dr. Schliemann at South Kensington is sufficient to show that this has been the true history of the γλαυκῶπις, or "owl-faced Goddess Minerva." In some of these vases all the features of the human face are present; in others some of them disappear or become conventionalised; the mouth is no longer represented, and the nose shrinks into a small beak-like projection beneath the eyebrows. Yet if the form of it is looked at carefully, it will be seen that it is still a nose, and in no case has it been the intention of the potter to represent a beak; its position is never that of an owl's beak beneath the line of the eyes. The eye of an owl is surrounded on all sides by a complete disc of feathers, but in no single instance has the lower and inner side of such a disc been represented on these vases; even in the most degraded examples the line which sweeps round the upper and outer portions of the eye is still seen to be an eyebrow, which is a feature that is entirely wanting in an owl. In many cases the ear has been retained, where the mouth has disappeared, and the ear is still distinctly human. It may be safely said that there is no example in the whole collection at South Kensington in which the form of an owl's face has been intentionally represented. In like manner the long upright projections on the sides of some of the vases, which, when associated with the symbolic features above spoken of, have been said to represent the wings of an owl, can be shown by a selected series to be nothing more than the handles of the pots developed and adapted to use in another form. Other handles, of which most of the pots are provided with three or four, have been dwarfed so as to dwindle into a mere reminiscence, marked by slightly raised lines on the sides of the vessels. Similar developments of handles may be seen in the specimens of terra-cotta lamps exhibited by the Palestine exploration committee at South Kensington. Then again, the small flat stone objects figured in page 36 of Dr. Schliemann's book, "Troy and its Remains," and supposed by him to be Athena idols, are clearly nothing more than symbolic vases. The lines denoting the face on these stone objects represent the face on the vases, the head, neck, and body of the vase and the horizontal lines across the neck marking the separation between the cover and body of the vase are all shown on these miniature models, which correspond to the stone models of vases which at a later period replaced those previously employed in Egyptian tombs, and it was no doubt by means of some such symbolism that these model vases at Hissarlik came to be introduced.

The peculiar "crown-shaped" covers found by Dr. Schliemann at Hissarlik, and figured at page 25, are of interest, and serve by their form to fix the position of the Hissarlik antiquities in point of sequence. These crown-like lids are survivals of the neck and handles of earlier forms whose history is to be traced in other parts of the Levant. The form of vase with two handles, one on either side joining the mouth and body of the vessel, of which a good example is represented on page 102 of General Cesnola's work, appears to have given rise to a shape with a closed or dummy neck, in which the form of the neck and handles are retained, but the real opening is in a funnel-shaped mouth adjoining the dummy neck. Dr. Schliemann found specimens of these altered vases in the tumulus at Sparta and also at Mycenæ. An illustration of one from the latter place is given at page 64 of his work on Mycenæ. They are common in Rhodes, examples of which may be seen in specimens from Ialysos, in the British Museum. They are also found in Attica, Cyprus, and in Egyptian tombs. The "crown-shaped" covers found at Hissarlik represent a further degradation of this form in which the neck has disappeared, the mouth and handles only remaining. Three and four handles have been substituted, in some cases, for the double handle of the earlier vessels. The cover, with the dummy mouth and handles, of course occupies the position previously occupied by the true neck and handles on the top of the vase. As these crown-shaped covers are found in the lowest stratum, the "earliest city" discovered by Dr. Schliemann at Hissarlik, it follows, if the history of these forms has been correctly stated above, that the whole of the Hissarlik antiquities are of comparatively recent protohistoric date, though belonging, no doubt, to a people in a barbarous condition of culture, which accounts for the number of rude stone implements found from top to bottom throughout the excavations.

The so-called crest of the helmet of Athena (p. 283, Hissarlik), is a further degradation of these crown-shaped tops, and represents the dwarfed survival of one of the handles, the connecting links being represented by three specimens in the collection at South Kensington, where the vestiges of all three handles are shown in their proper places, and these were subsequently replaced by one, transferred for convenience' sake from the position formerly occupied by the three to the centre of the lid. In short, the history of every form may be traced by connecting links in the specimens exhibited at South Kensington, the whole collection forms a continuous sequence which, by judicious arrangement of connected forms, is capable of demonstration, and it is to be hoped that some such arrangement may be adopted before this interesting collection leaves the place. To apply the expression "Darwinism" to such a sequence of forms is no mere figure of speech, it expresses the truth as fully in its relation to savage art and ornament as to the forms of nature. Conservatism, acquired habits, and incapacity for improvement on the one hand, love of variety, economy of time and trouble, and imperfect copying on the other, combine to produce those slow and gradual changes which are characteristic of all barbarous art. Every object marks its own place in sequence by means of its form, and it is the recognition of this principle which supplies the place of written records in those prehistoric and protohistoric phases of culture with which we are dealing. Earlier forms are retained side by side with the more advanced ones and are applied to those objects and uses for which they appear fittest. If any evidence were wanting to disprove the absurd imputations that have been cast upon the genuineness of these antiquities, these connected varieties would alone suffice to prove that they were the work of a people in a very primitive condition of civilisation. Whatever difference of opinion may exist as to some of Dr. Schliemann's deductions no reasonable archæologist will be found to dispute the extraordinary merit of his discoveries. We are glad to hear that he is about to resume his excavations at Hissarlik. To the deep research and disinterested enthusiasm which has already placed him in the front rank of explorers, will now be added a large amount of archæological experience and knowledge of allied forms that he has acquired since his first excavations were conducted at this place, leading us to hope that his future discoveries will exceed them all in interest and importance.

PROFESSOR BELL'S "SELBORNE"

The Natural History and Antiquities of Selborne, in the County of Southampton. By the late Rev. Gilbert White, formerly Fellow of Oriel College, Oxford. Edited by Thomas Bell, F.R.S., F.L.S., F.G.S., &c., Professor of Zoology in King's College, London. 8vo. 2 vols. (London: Van Voorst, 1877.)

THE edition of this classic work for so many years expected from the hands of Prof. Bell, has at length appeared, and readers will regard it with much gratification and a little disappointment. The former feeling will arise from the large amount of new matter which it contains, and the latter from the conviction which cannot but force itself upon them that more was to be made of the whole than the editor seems to have been aware of. Yet Prof. Bell's long life—it is more than fifty years since he first won his spurs in the field of science—and his invaluable services in so many departments of zoology, render us very unwilling to say more than we are compelled in detraction of this, his latest labour, and the child of his old age. He writes now, as he always has written, pleasantly enough, but he fails to give us the notion that he has done the best he could with the materials placed at his disposal, and with his other unequalled opportunities. It is evident that his task grew upon him, and that a considerable portion must have been printed off before its extent was determined. This, indeed, is not an uncommon thing with young authors and editors; but Prof. Bell's literary experience, and the long time he is known to have had the present work in preparation, should have guarded him from an error of the kind. We might almost infer that when the memoir was written he had not mastered all the details of the deeply interesting correspondence which forms the bulk of his second volume, and certainly that he had not decided how many, and which, of the letters it contains should be given to the world. It is sufficient for us now to say that there is not one of them that could have been spared, for we must presently return to their consideration.

That any memoir of Gilbert White must, from the scarcity of facts relating to him, give a meagre account of that great and estimable naturalist, we are ready to admit, and that Prof. Bell's is at the same time far more copious than any other that has been published, will be obvious to all who are acquainted with the subject. But we cannot help regretting that the chief biographical facts have not been set forth in a clearer light than they appear, and proper as it is to tell us something of all the members of the family, we unfortunately find least is told us of those members of whom we should like to know most. Gilbert White had three brothers who were distinctly men of capacity above the average, beside two others much less, or hardly at all, distinguished. Of the former, Thomas, we are told, was successful in trade, and became a F.R.S., but in what trade or when he died we are left ignorant. Benjamin was the well-known publisher of natural history books—among others of Pennant's—for whom Prof. Bell has some hard words, not, perhaps, wholly undeserved, but it is very probable, to say the least, that had not Gilbert, through his brother, become acquainted with Pennant the "Natural History of Selborne" would never have been written. The third remarkable brother was John, who was for a considerable time chaplain at Gibraltar, of which place he wrote a zoology that unfortunately was never printed, and of which the manuscript seems to have vanished, though Prof. Bell says the introduction to it is in his possession. Pity it is he has not given us this fragment, for some of the hints and suggestions that Gilbert was always imparting to John, his "most steady and communicative correspondent," must surely be therein contained, and it could not fail to have been a valuable addition to these volumes. In the next generation were "Jack," son of the aforesaid John, and a pupil of Gilbert's, who thought highly of him, and Samuel Barker, another nephew, an agreeable and evidently valued correspondent of his uncle's. It seems hardly possible but that diligent research would not have recovered more of these younger men than we find here recorded.

Of Gilbert himself we doubt not Prof. Bell has done all in his power to gather information, and in some respects he has been successful. Born at Selborne in 1720, he went to school at Basingstoke, and to Oxford in 1739. There he graduated B.A. in 1743, and the following year was elected to a Fellowship at Oriel, which he enjoyed till his death. Taking orders he successively held two curacies in Hampshire, one at Selborne till 1752, when he filled the office of Proctor (*Junior* Proctor, Prof. Bell is careful to tell us) for a year. Then he took another Hampshire curacy for a couple of years, at the end of which time he came once more to live at Selborne, which remained his home till his death. In 1757 he accepted the living of Moreton-Pinkney, in Northamptonshire, but the preferment must have been small, as it did not incapacitate him from holding his Fellowship, and, according to the custom of the times, residence was not required of him. The following year his father died, but he did not come into the family property at Selborne—"The Wakes," now possessed by Prof. Bell—until the death of an uncle in 1763. He seems to have made Pennant's acquaintance about 1767, or perhaps a little earlier. In 1768 we find him writing to Banks, and the following year began his correspondence with Barrington, who, in 1774 and 1775, communicated to the Royal Society those ever-memorable monographs of the British *Hirundines*, which first made known White's powers of observation and felicity of expression. In 1774 he refused no fewer than three college livings, for he was doubtless in easy circumstances, and once more accepted the curacy of his birth-place. At the age of sixty-nine his single book was published, and he survived its appearance just four years. Another event in his life must be noted here —his attachment to the sister of his college friend Tom Mulso. What hindered their union does not appear, but in 1760 the lady was married to Mr. Chapone, and was subsequently the authoress of several well-known works, and a celebrated "blue-stocking." We have to thank Prof. Bell for collecting most of these facts and dates now for the first time published, but they are not very easily gathered from his memoir.

Of course we have no occasion here to review the letters to Pennant and Barrington which formed the original "Natural History of Selborne." Their place in literature and science is assured. It were impertinent to speak of their merits, or to indicate their few—very few —defects. Being the results of the personal experience of their author they will hold their ground for all time. Never before, perhaps, was there so careful an observer, and since, we know of but one other so accurate. That other has no doubt surpassed his predecessor in the ingenuity of his induction and the versatility of its application, but it is no detriment to Gilbert White that he should be ranked as an observer second only to Mr. Darwin. Numerous editors have tried their hand in annotating this ever-popular work, and many more will make the same attempt. Prof. Bell is chary—too chary, perhaps, of his comments—but if he errs he errs on the safe side, and readers who have been disgusted with the inanity or the flippancy of the notes to some recent editions, will rejoice that in him they have an editor whose remarks, if they be but few, are always to the point, and never in bad taste.

Now we ought to consider the new letters, but the length of this article warns us that we must be brief in what we say of them. They remove the present edition from comparison with any other, and we have sincerely to thank Prof. Bell for having shown us, by printing them, that White was even more than had formerly appeared. Every grace of style, every power of thought—in a word, every good quality which was foreshadowed in the famous epistles to Pennant and Barrington is doubled, or more than doubled in intensity in the letters now given to the public—letters, too, which were never prepared by their writer for publication. We have him before us as the instigator to good works, the sage adviser in matters literary and scientific, the self-denier, the man of affectionate relations, the man of high aspirations, yet humble; simple, yet full of humour; a recluse, yet a man of the world in the best sense. We long to subjoin extracts from them, but want of space renders that impossible. Our readers will read and judge for themselves. It must suffice to say that there are more than one hundred from Gilbert's pen, of which scarcely a dozen have ever been printed before, in addition to a most interesting correspondence between John White and Linnæus on the zoology of Gibraltar, and letters from various members of the family which faithfully reflect, as it were, in a remarkable manner Gilbert's own nature, besides a few—too few, unfortunately—addressed to him by men like Lightfoot, Skinner, Montagu, and Marsham. For the sake of these we readily forgive all the shortcomings of the present volume—even the want of a table of contents and of a good index.

OUR BOOK SHELF

Proceedings of the London Mathematical Society, vol. viii. (November, 1876, to November, 1877), 321 pp. (Messrs. Hodgson.)

THIS goodly-sized volume bears testimony to the activity of its members, and contains twenty-nine papers, published *in extenso*. We may specially refer to one or two. The "Pure" side of the subject of mathematics, as usual, is the favoured one, and furnishes memoirs by Prof. Cayley on the condition for the existence of a surface cutting at right angles a given set of lines, on a general differential equation, geometrical illustration of a theorem relating to an irrational function of an imaginary variable, on the circular relation of Möbius and on the linear transformation of the integral $\int \frac{du}{\sqrt{U}}$.—Prof. Clifford has an excellent paper on the canonical form and dissection of a Riemann's surface. Prof. H. J. S. Smith contributes the conditions of perpendicularity in a parallelepipedal system, and a very interesting presidential address on the present state and prospects of some branches of pure mathematics. Mr. Spottiswoode writes on curves having four-point contact with a triply infinite pencil of curves, and Prof. Wolstenholme gives an easy method of finding the invariant equation expressing any poristic relation between two conics.

LETTERS TO THE EDITOR

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

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

Trajectories of Shot

I HOPE you will be able to afford me space for a few remarks on the following extract from a paper on the Trajectories of Shot, by Mr. W. D. Niven, which appeared in the *Proceedings* of the Royal Society for 1877.

Mr. Niven arranges his paper under three heads, calling them the first, second, and third methods. The third method is the one he favours, while he endeavours to dispose of the other two in the following terms :—

"§ 11. It will be observed that the two foregoing methods each open with the same equation (a). Now there is a serious difficulty in the use of that equation. Suppose, for example, we were to integrate over an arc of 1°, we should have to use the mean value of k between its values corresponding to the velocities at the beginning and end of the arc. But we do not know the latter of these velocities ; it is the very thing we have to find. The first steps in our work must be to *guess* at it. The practised calculator can, from his experience, make a very good estimate. Having made his estimate, he determines k. He uses this value of k in equation (a), and if he gets the velocity he *guessed* at, he concludes that he *guessed* rightly, and that he has got the velocity at the end of the arc. If the equation (a) does not agree with him, he makes *another guess*, and *so on till he comes right*."

The case would be indeed hopeless, if all this was quite correct. But I have to inform Mr. Niven that, in all proper cases v_β may be found *accurately* from equation (a), and without any "guessing" whatever. Taking Mr. Niven's own solitary example, I will *calculate* the value of v_β at the end of an arc, not of 1°, but of 3°, and compare my result with his own. The initial velocity, v_α, is here 1,400 f.s., and the corresponding value of the coefficient k_α, given in my table, is 104·0. Substitute this value for k in equation (a), given below, and v_β will be found 1291·7 f.s., a *first* approximation. Now *calculate* the mean value of k between velocities 1,400 and 1,290 f.s. by the help of the table, and it will be found to be equal to 106·3. Substitute this new value of k in equation (a), and v_β will be found 1289·8 f.s., a *second* approximation. We must stop here, because if we attempted to carry the approximation further, we should obtain the same value of k, and therefore of v_β, as in the second approximation. Mr. Niven finds $v_\beta = 1290$ f.s.

Of course in ordinary cases, a calculator, in making his first approximation to v_β, would commence by taking a value of k corresponding to a velocity *somewhat below* the initial velocity. In this way a better *first* approximate value of v_β would be found. Thus, again referring to Mr. Niven's own example, I will take a step over an arc of 6°, from $\alpha = +3°$ to $\beta = -3°$. The initial velocity is 1,400 f.s. I now go so far as to "guess" that the mean value of k will correspond to a velocity considerably below 1,400 f.s., and take $k = 107·9$, corresponding to a velocity 1,300 f.s. This gives $v_\beta = 1208·1$, a *first* approximation. The mean value of k between 1,400 and 1,210 f.s. is now found to be 107·2, which gives $v_\beta = 1209·0$ f.s. Mr. Niven obtains 1207·4 by stepping over two arcs of 3°. If any further adjustment was required, proportional parts might be used, seeing that a correction $\delta k = -0·7$ gives $\delta v_\beta = +1·8$.

Mr. Niven then proceeds to question the *accuracy* of what he is pleased to call the "process of guessing," as follows :—

"It seems to me, however, that this method of going to work, leaving out of account the loss of time, is open to objection in *the point of accuracy*. For, first there is no method of determining on what principle the mean value of k is found—what manner of mean it is. Again, let us suppose for an instant that the velocity at the end of the arc *guessed* at, and the value of k, are in agreement ; that is to say, let the equation

$$\left(\frac{1,000}{v_\beta}\right)^3 \sec^3\beta - \left(\frac{1,000}{v_\alpha}\right)^3 \sec^3\alpha = \frac{d^2}{w}\,\frac{k}{g}(P_\alpha - P_\beta) - \text{(a)}$$

hold for the values of v_β and k used by the calculator. It by no means follows that he has hit on the right value of v_β and k. For if he is dealing with a part of the tables in which $\frac{dk}{dv}$ happens to be nearly equal to $-3\frac{wg}{d^2}\,\frac{\sec^3\beta}{P_\alpha - P_\beta}\,\frac{(1,000)^3}{v^4}$, it is obvious that there are ever so many pairs of values of v_β and k which will stand the test of satisfying the above equation. Now an examination of Mr. Bashforth's tables for ogival-headed shot shows that the value of k diminishes as v increases from 1,200 feet upwards, so that $\frac{dk}{dv}$ is negative for a considerable range of values of v which are common in practice. It is not at all unlikely, therefore, that the value for $\frac{dk}{dv}$ just stated may often be very nearly true ; in which the case the *process of guessing* becomes extremely dangerous."

I here observe that Mr. Niven is not entitled to assume that, because two quantities have the *same sign*, they will therefore be probably often nearly of *equal value*. Without discussing the value of his test of danger, I have to state that my tabular value of $\frac{\delta k_\beta}{\delta v_\beta}$, for velocities above 1,200 f.s., lies between 0 and $-0·09$. I have calculated the numerical values of Mr. Niven's expression for $\frac{dk}{dv}$, for shot fired from various guns, from the Martini-Henry rifle up to the 80-ton gun, and have always obtained a numerical result so far outside the limits of the tabular value, that, for the present, I conclude that Mr. Niven's condition (whatever may be its value) *is never nearly satisfied in any practical example*. But when a practical case is produced where "ever so many pairs of values of v_β and k," *differing sensibly*, "stand the test of satisfying the above equation" (a), it shall receive my best attention.

It is well known that the problem of calculating the trajectory of a shot, like so many other practical problems, does not admit of a direct and complete solution. So that all solutions, being approximations, are more or less erroneous. But I feel perfect confidence in the results given by my methods of calculation, because, the smaller the arcs taken at each step, and the nearer the *calculated* will approach to the *actual* trajectory. But methods of approximation require to be used with judgment. For instance with the heaviest shot in use, we may take steps of 5° for velocities above 1,100 f.s. ; while for small arm bullets arcs of half a degree will be quite large enough. In any case of real difficulty the remedy will be to divide the trajectory into smaller arcs.

From what I have said it appears that my method of finding the trajectories of shot, *when properly applied*, is neither a "process of guessing" nor yet "dangerous."

Minting Vicarage, March 8 F. BASHFORTH

Australian Monotremata

I AM surprised to find that "P. L. S." (vol. xvi. p. 439), was not aware that the Echidna *Tachyglossus hystrix*, is found in N. Queensland. For the benefit of your readers I may mention that the Australian Museum possesses a fine specimen of *T. hystrix* from Cape York. Mr. Armit, of Georgetown, Mr. Robt. Johnstone, and others, have frequently found them in various parts of Queensland. One specimen from Cape York was obtained there by our taxidermist, J. A. Thorpe, in 1867.

The Platypus (*Ornithorhynchus anatinus*) is also found in Queensland as far north as the Burdekin at least, perhaps further.

Tachyglossus, strictly speaking, has no pouch, but the *areola* is sunk in the skin, and when the young are first born this depression, or miniature pouch, is large enough to hold them; when about a month or so old, their hinder parts may be seen sticking out; when two or three months old, only the head, and afterwards, as they become larger, only the snout is hidden. the marsupial bones, which are well developed, support the weight of the young one while sucking. The young does not leave the mother until at least one-third grown, and *even when fully the size* of the adult, the quills are only then beginning to show through the skin, which is black, and thinly covered with black hair.

The new species, *T. lawesii*, Ramsay, from Port Moresby, may be distinguished at once by the stiff flat bristles of the face and the more cylindrical form of its spines; *T bruijnii* has a very long snout, nearly twice the length of any other species at present known. See *Proceedings* L. S. of N. S. W., Vol. ii., Pt. I. Pl. I.

E. P. RAMSAY

Australian Museum, Sydney, January 25

P.S.—It may interest your readers to know that Messrs. Ramsay Bros., of Maryborough, Queensland, have a fine series of *eleven Ceratodus alive* in a large tank constructed for them. These fish have now lived and thriven well in confinement for over eighteen months. I was the first to send the Ceratodus in spirits to England, although I never got the credit of it; nor did any of those naturalists to whom I forwarded specimens through a friend at the Zoological Society, ever think it worth their while to acknowledge them. Had it been otherwise, living specimens would have found their way to England long since. It is a great mistake to suppose the Ceratodus is now common; they can only be obtained at certain seasons and in certain parts of the Rivers Mary and Burnet. The Osteoglossum (*Barramundi*), with which the Ceratodus (*Teĕbi ne*) is often confounded, is plentiful enough in the western waters of Queensland.

E. P. R.

Fetichism in Animals.—Discrimination of Insects

I HAVE frequently noticed the fetichism of dogs, and was therefore much interested by Mr. G. J. Romanes' letter of December 27, which I have but just seen. Our terrier—a very queer character and a great warrior—is abjectly superstitious. He will not come near a toy cow that lows and turns its head, but watches it at a distance with nose outstretched. A vibrating finger-glass terrifies him; indeed he has so many superstitions that we often make him very miserable by working on his fears. I feel sure he constantly tries to understand, but never gets further than the sense of "uncanny"-ness. Dogs vary greatly as to this.

A propos of the discriminating power of insects. I have seen humming-bird moths deceived by sight. They were seeking in an open loggia, ceiled with wood, some dark place in which to hide; the pine wood was studded with brown knots. Again and again the two moths flew from knot to knot, felt and rejected them. At last they reached the open work—holes which looked much like the knots—and in them they hid themselves.

I was much struck at the time, as it appeared to me to show they possessed some dim sense of colour, but no defining perception of surface.

C. G. O'BRIEN

Cahirmoyle, Ardagh, Co. Limerick

Nitrification

IT seems right to direct attention to the fact that Bacteria were observed by Meusel to convert nitrates into nitrites; an abstract of which observations is to be found in the *Annals and Magazine of Natural History* for February, 1876; this abstract is copied from *Silliman's Journal* for January, 1876, where the reference to Meusel's paper will be found. This reference is *Ber. Berl. chem. Gesel.*, October, 1875.

No indication of their knowledge of these observations is to be found in Schloesing and Munk's paper in the *Comptes Rendus* (February, 1877) or in Mr. Warington's communication to NATURE, vol. xvii. p. 367.

F. J. B.

Oxford, March 11

The Wasp and the Spider

MAY I suggest a possible explanation of the curious case of spider-hunting by a wasp cited by Mr. Cecil; had the prey so accurately tracked by the wasp been anything but a spider, it would, indeed, have seemed an almost conclusive instance of hunting by scent; but when one recollects the fine line usually left by spiders as they go, it is evident that sight or feeling may have been the sense exercised, and that the fatal clue may have been the guide to the wasp.

E. HUBBARD

March 18

ENTOMOLOGY AT THE ROYAL AQUARIUM

AN aquarium is put to its legitimate use when it is made the home of natural history exhibitions, and any attempt to rescue one from the too dominant sway of the showman deserves every support at the hands of science. The Entomological Exhibition, the opening of which at the Royal Aquarium we noticed last week, is also quite a novelty, though it is the outcome in a particular branch of the idea that led to the Loan Exhibition of Scientific Apparatus at South Kensington; as in that case the exhibitors are induced by no hope of prizes, but merely from the love of their science to lend their treasures. One learns from such an exhibition as this how much genuine love for natural history exists amongst men whose daily lives are devoted to manual labour, and that there are those who live within sound of Bow Bells, who make as good a use of their more limited opportunities as Edward in Banffshire. Here is a Mr. Machin, compositor by trade, whose long day's work has not prevented him from collecting and rearing a magnificent series of crepuscular and nocturnal moths, shown in twenty beautifully-arranged cases and accurately named; and the collections of some others are scarcely less noticeable in this respect. But apart from the interest attaching to some of the exhibitors, the material brought together affords an opportunity both to the entomologist proper and to the general naturalist not often to be met with. The greater portion of the whole exhibition is perhaps inevitably taken up with British lepidoptera, but these are not, as might be feared, an endless multitude of specimens of no special interest beyond their rarity and beauty, but are made to teach as well as please. Lord Walsingham, for example, shows the larvæ, pupæ, and imagines of nearly 370 species with the plants on which they occur—so that we have their complete life-history so far as it can possibly be represented to us. This, perhaps, from its scientific character and the beautiful means of preservation adopted, is the most interesting to the general naturalist, but there are others more limited, but scarcely less instructive—as those shown by the Messrs. Adams, in which the usual parasites are included in the series with each insect. Other instructive collections are those which illustrate the varieties of a single species; such is the set of specimens of *Colias edusa*, exhibited by Mr. Harper, a grand series showing insensible passages between perfectly distinct colourings. The influence of climate on colour is well illustrated in the melanic northern varieties of several species of moths, which are usually of a lighter colour in the south of England, the two varieties being placed side by side in the Yorkshire collections, and the results of selective breeding in the same direction in the photographs, unfortunately not specimens, of the common gooseberry moth, varying from nearly white to almost entirely dark. The moths and butterflies of the fen districts, which are now becoming so scarce, are represented by a very large collection by Mr. Farn. But one of the most interesting objects is a large white close-set web, in appearance like a cloth—some eight feet by four feet, spun by the larvæ of a moth, *Ephestia elutella*, that feeds on chicory. It is a portion only of a larger web, six times the size, formed on the walls and ceiling of a chicory warehouse in York, by the incessant marching to and fro of the well-fed larvæ. The threads composing it are less than $\frac{1}{6000}$ inch in diameter, and as they are nearly contiguous and eight or ten deep, the portion exhibited represents about 4,000 miles of their wanderings. When twisted into a rope, it has been made to support a weight of 56lbs. The foreign Lepidoptera also figure largely, and are naturally attractive from their beauty, and in General Ramsay's cases from Nepaul, for their rarity. This portion of the series, however, is chiefly valuable for the illustrations of protective mimicry which it affords. Admirable specimens of the leaf butterfly, *Kallima inachis*, with the varying tints of their under surfaces, are in Gen. Ramsay's collection, and Mr. Swanzy has a grand series specially arranged of Diademas and Papiliones mimicking—some in the females and some in both sexes—the nauseous smelling members of the Danaidæ and Acraidæ. Similar series are shown by Rev. J. A. Walker and Mr. Weir. The extraordinary differences between male and female in some butterflies is well illustrated by Mr. Briggs' collection of Lycænas.

The remaining orders are in some instances admirably illustrated, but by far fewer exhibitors. Dr. Powers' nearly complete collections of British coleoptera and British hemiptera, are among the best ever made; and Mr. Frederick Smith's hymenoptera, which supplied much of the material for the British Museum Catalogue, and Mr. Stevens' exhaustive collection of weevils, both the results of forty years' work, are here exhibited. A most instructive series of Grecian hymenoptera, with their galleries bored in briars, and some magnificent coleoptera from Ashantee, containing beautiful examples of *Goliathus Drurii*, complete the list of the more noteworthy objects. Some important orders are thus without special illustration here, but no doubt this will not be the last as well as the first of such exhibitions; and when it comes round to the insects again we may hope to see as complete sets of diptera or neuroptera as of other orders. It would be a great advantage to students if such exhibitions of limited classes could be periodically instituted by loan, and Mr. Carrington certainly deserves our thanks for the idea and its successful realisation.

THE GOVERNMENT RESEARCH FUND

THE following list of grants to be paid from the Government Fund of 4,000*l.* on the recommendation of the Royal Society, during the present year, in aid of scientific research, has been sent us for publication:—

Not Personal.

David Gill, 93, Wimpole Street, W.—To defray Expenses connected with a Determination of the Solar Parallax by Observation of the Diurnal Parallax of Mars £250

Rev. Dr. Haughton, Trinity College Dublin.—For Aid in the Numerical Reductions of the Tidal Observations made on board the *Discovery* and *Alert* in the late Arctic Expedition £75

Prof. Fleeming Jenkin, 3, Great Stuart Street, Edinburgh.—For Experimental Investigations on Friction £50

W. Chandler Roberts, Royal Mint, Tower Hill, E.—For Researches on Metals and Alloys in a Molten State passing through Capillary Tubes £25

J. Kerr, Free Church Training College, Glasgow.—For Continuation of Electro-Optic and Magneto-Optic Researches £50

J. Norman Lockyer, 16, Penywern Road, South Kensington, S.W.—For Continuation of Spectroscopic Researches £200

Dr. O. J. Lodge, University College, Gower Street, W.C.—For Investigations into the Effect of Light on the residual Charge of Dielectrics; on the Conductivity of Hot Glass, and other Transparent Conductors, on Electrolytic Conduction, and other Subjects £100

Thomas Stevenson, Hon. Sec. Scottish Meteorological Society, General Post Office Buildings, Edinburgh.—For Aid in carrying on a Simultaneous Series of Anemometrical Observations at different heights, and in sheltered and unsheltered situations £50

W. Galloway, Cardiff.—For further Investigation of the Explosive Properties of Mixtures of Fire Damp and Coal Dust with Air £100

Sir William Thomson, University College, Glasgow.—For Tidal Investigations £100

For Experiments in Magnetisation of different Qualities of Iron, Nickel, and Cobalt under varying Stresses and Temperatures £100

J. E. H. Gordon, Pixholme, Dorking.—For Continuation of Experimental Measurements of the Specific Inductive Capacity of Dielectrics £100

H. Tomlinson, 36, Burghley Road, Highgate Road.—For Researches on the Alteration of Thermal and Electrical Conductivity produced by Magnetism, and on the Alteration of Electrical Resistance produced in Wires by Stretching £100

Prof. H. Alleyne Nicholson, University of St. Andrew's; R. Etheridge, jun., Geological Survey Office, Edinburgh.—For Aid in examining the Fauna of the Silurian Deposits of the Girvan District, Ayrshire, and in publishing a Descriptive List of the same £75

R. McLachlan, 39, Limes Grove, Lewisham—For Aid towards the Expense of Publication of a Revision and Synopsis of European Trichoptera £50

C. Callaway, Wellington, Shropshire.—For Aid in working out the so-called Eruptive Rocks of Shropshire, and in verifying certain points in Local Geology £25

H. T. Stainton, Mountsfield, Lewisham.—In Aid of the Publication Fund of the Zoological Record Association... ... £150

Dr. J. W. Dawson, McGill College, Montreal.—For Aid in excavating Erect Trees in the Coal Formation of Nova Scotia, in Beds where they are known to contain Reptilian and other Remains £50

Dr. R. H. Traquair, Museum of Science and Art, Edinburgh.—For Aid in preparing and publishing a Monograph on the Carboniferous Ganoid Fishes of Great Britain £75

W. Saville Kent, St. Helier's, Jersey.—To pay for Microscopical Apparatus for the Further Prosecution of Investigations into the Structure and Life-History of certain Lower Protozoa £50

Dr. W. A. Brailey, 38, King's Road, Brownswood Park, Green Lanes, N.—For Researches on the Causes determining the Tension of the Globe of the Eye in Man and Animals, and on the Physiological Influence on this Tension of such Substances as Atropia, Daturin, Eserine, and Pilocarpine £25

E. A. Schäfer, University College, Gower Street.—For Payment of an Assistant in Continuing his Histological and Embryological Investigations £50

H. Woodward, 117, Beaufort Street, Chelsea.—For Continuation of Work on the Fossil Crustacea, especially with reference to the Trilobita and other Extinct Forms, and their Publication in the Volumes of the Palæontographical Society £75

Prof. H. G. Seeley, 61, Adelaide Road, N.W.—For an Examination of the Structure, Affinities, and Classification of the Extinct Reptilia and Allied Animals £75

Dr. C. R. A. Wright, St. Mary's Hospital, Paddington.—For Continuation of Researches on Certain Points in Chemical Dynamics; on the Determination of Chemical Affinity in Terms of Electrical Magnitudes; and on some of the lesser-known Alkaloids £100

Prof. C. Schorlemmer, Owens College, Manchester.—For Continuation of Researches into (1) The Normal Paraffins. (2) Suberone. (3) Aurin £100

Prof. E. J. Mills, 234, East George Street, Glasgow.—For a Research on Standard Industrial Curves £100

Personal.

J. Allan Broun, 9, Abercorn Place, St. John's Wood, N.W.,—For Continuation of Correction of the Errors in the published Observations of the Colonial Magnetic Observatories £150

Dr. J. P. Joule, 12, Wardle Road, Sale, near Manchester.—For an Exhaustive Inquiry into the Change which takes place in the Freezing and Boiling Points of Mercurial Thermometers by long Exposure to those Temperatures £200

Prof. W. K. Parker, 36, Claverton Street, S.W.—For Assistance in Continuation of Researches on the Morphology of the Vertebrate Skeleton and the Relations of the Nervous to the Skeletal Structures chiefly in the Head £300

Prof. A. H. Garrod, 10, Harley Street, W.—For Aid towards Publication of the Second Fasciculus of an Exhaustive Treatise on the Anatomy of Birds £100

Rev. J. F. Blake, 11, Gauden Road, Clapham, S.W.—For Aid in continuing the Publication of a Synopsis of British Fossil Cephalopoda £100

Dr. W. A. Brailey, 38, King's Road, Brownswood Park, Green Lanes, N.—For Researches on the Causes determining the

Tension of the Globe of the Eye in Man and Animals, and on the Physiological Influence on this Tension of such Substances as Atropia, Daturin, Eserine, and Pilocarpine £25

Dr. C. R. A. Wright, St. Mary's Hospital, Paddington.—For Continuation of Researches on certain Points in Chemical Dynamics; on the Determination of Chemical Affinity in Terms of Electrical Magnitudes; and on some of the lesser-known Alkaloids £200

Prof. Schorlemmer, Owens College, Manchester.—For Continuation of Researches into (1) the Normal Paraffins, (2) Suberone, (3) Aurin £150

W. N. Hartley, King's College, Strand.—For Investigation of the Fluid Contents of Mineral Cavities; of the Properties of the Phosphate of Cerium; of Methods of Estimating the Carbonic Acid in small Samples of Air; and of Photographic Spectra £150

Dr. Armstrong, Lewisham Village, S.E.—For Continuation of Researches into the Phenol Series... ... ... £250

THE SOURCES OF LIGHT[1]

WHEN the sun rises in the morning, the darkness of the night seems to fade away, and, wherever we look, without or within, all the air and space about us appears to be full of light. When evening comes again, the daylight disappears, and the moon and the stars give us another light. In the house we start the lamps, and they give us another light. Out-of-doors, in the dusky meadows, we see the fire-flies darting about, and giving out pale sparkles of yellow light as they fly. We look to the north in the night and see the aurora, or we watch the lightnings flash from cloud to cloud, and again we see more light.

This light from sun and moon, the stars, the fire, the clouds, the sky, is well worth studying. It will give us a number of the most beautiful and interesting experiments, and by the aid of a lamp, or the light of the sun, we can learn much that is both strange and curious, and perhaps exhibit to our friends a number of charming pictures, groups of colours, magical reflections, spectres, and shadows. All light comes from bodies on the earth or in the air, or from bodies outside of the atmosphere; and these bodies we call the sources of light. Light from sources outside of the atmosphere we call celestial light, and the sources of this light are stars, comets, and nebulæ. The nebulæ appear like flakes and clouds of light in the sky, and the comets appear only at rare intervals, as wandering stars that shine for a little while in the sky and then disappear. The stars are scattered widely apart through the vast spaces of the universe, and they give out their light both day and night. The brightest of these stars is the sun. When it shines upon us, the other stars appear to be lost in the brighter light of this greater star, and we cannot see them. At night, when the sun is hid, these other stars appear. We look up into the sky and see thousands of them, fixed points of light, each a sun, but so far away that they seem mere spots and points of light. Besides these stars are others, called the planets, that move round the sun. These give no light of their own, and we can only see them by the reflected light of the great star in the centre of our solar system. Among these stars are the Moon, Venus, Mars, Jupiter, and many others. We might call celestial light starlight; but the light from the great star, the sun, is so much brighter than the light of the others, that we call the light it gives us sunlight, and the light from the other suns we call starlight. For convenience, we also call the reflected light from the planets starlight, and the light from our nearest planet we call moonlight.

Terrestrial light includes all the light given out by things on the earth, or in the air that surrounds the earth. The most common light we call firelight, or the light that that comes from combustion. When we light a lamp or candle, we start a curious chemical action that gives out light and heat. The result of this action is fire, and the light that comes from the flame is firelight. When a thunder-storm rises, we see the lightning leap from the clouds, and give out flashes of intensely bright light. Sometimes, at night, the northern sky is full of red or yellow light, darting up in dancing streamers, or resting in pale clouds in the dark sky. You have seen the tiny sparkles of light that spring from the cat's back when you stroke her fur in the dark, or have seen the sparks that leap from an electrical-machine. All these—the aurora, the lightning, and the electric sparks—are the same, and we call such light electric light.

Sometimes, in the night, we see shooting-stars flash across the sky. These are not stars, but masses of matter that, flying through space about the earth, strike our atmosphere and suddenly blaze with light. The friction with the air as they dart through it is so great that these masses glow with white heat, and give out brilliant light. Two smooth white flint pebbles, or two lumps of white sugar, if rubbed quickly together, will give out light, and this light we call the light from mechanical action.

Sailors upon the ocean sometimes see, at night, pale-yellow gleams of light in the water. A fire-fly or glow-worm imprisoned under a glass will show, in the dark, bright spots of light on his body. A piece of salted fish or chip of decayed wood will sometimes give a pale, cold light in the night; and certain chemicals, like Bologna phosphorus and compounds of sulphur, lime, strontium, and barium, if placed in the sunlight in glass vessels and then taken into the dark, will give out dull-coloured lights. All these—the drops of fire in the sea, the glow-worm, the bit of decayed wood, and these chemicals—are sources of the light called phosphorescence.

These are the sources of light—the stars, the fire, electricity, friction, and phosphorescent substances. We can study the light from all of them, but the light from the sun or a lamp will be the most convenient. The light of the sun is the brightest and the cheapest light we can find, and is the best for our experiments. A good lamp is the next best thing, and in experimenting we will use either the sun or a lamp, as happens to be most easy and convenient.

The Heliostat.

In looking out of doors in the daytime we find that the sunlight fills all the air, and extends as far as we can see. It shines in at the window and fills the room. Even on a cloudy day, and in rooms where the sunshine cannot enter, the light fills everything, and is all about us on every side. Now, in studying light we do not wish a great quantity. We want only a slender beam, and we must bring it into a dark room, where we can see it and walk about it and examine it on every side, bend it, split it up into several beams, make it pass through glass or water, and do anything else that will illustrate the laws that govern it.

Choose a bright, sunny day, and go into a room having windows through which the sun shines. Close the shutters, curtains and blinds, at all the windows save one. At this window draw the curtain down till it nearly closes the window, and then cover this open space with a strip of thick wrapping-paper. Cut a hole in this paper about the size of a five-cent piece, and at once you will have a slender beam of sunlight entering the hole in the paper and falling on the floor. Close the upper part of the window with a thick shawl or blanket, and, when the room is perfectly dark, our slender beam of light will stand out clear, sharp, and bright.

As soon as we begin to study this beam of light, we find two little matters that may give us trouble. The sun does not stand still in the sky, and our beam of light

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[1] From a forthcoming volume of the "Nature Series"—"Light: a Series of Simple, Entertaining, and Inexpensive Experiments in the Phenomena of Light, for the Use of Students of Every Age," by Alfred M. Mayer and Charles Barnard.

keeps moving. Besides this, the beam is not level, and it is not in a convenient place. We want a horizontal beam of light, and some means of keeping it in one place all day. An instrument that will enable us to do this, and that can be adjusted to the position of the sun in the sky at all seasons of the year and every hour of the day, may be readily made, and will cost only a small sum of money.

We give several drawings giving different views of such an instrument and some of its separate parts. It is called a heliostat, and we shall find it of the utmost value in our experimenting in light, heat, sound, electricity, and other branches of physical science.

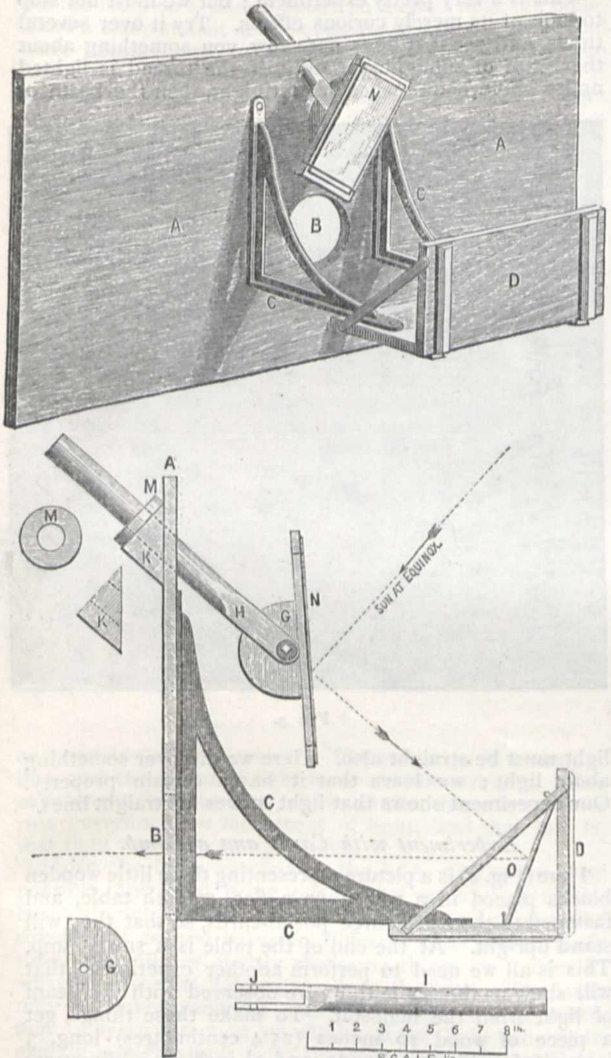

FIG. 1.

The first drawing represents a front-view of the heliostat. The second drawing gives an end-view, and we can now make one by simply following these few directions: The part marked A in the two drawings is a piece of pine board, 23 inches (58·4 centimetres) wide and two or more feet long, or as long as the window where it is to be used is wide. Any boy who can use plane and saw can make this piece of work out of common inch-board, and, if you have no pieces so wide as that, it can be made of two or more pieces fastened together with cleats; but, in this case, all the cracks must be close and tight. In the middle of this board, cut a round hole 5 inches (12·7 centimetres) in diameter, with its centre 8 inches from the bottom of the board. In the first drawing this hole can be seen at B, and in the second drawing it is shown by dotted lines at B. On one side of the board screw two iron brackets, using brackets measuring 14 inches (35·5 centimetres) by 12 inches (30·5 centimetres). These brackets are placed one on each side of the hole in the board, and are placed 14 inches (35·5 centimetres) apart, and with the short arm of the bracket against the board. In the first drawing the two brackets are shown, and in the second drawing one is shown in profile, and they are marked C in both drawings. On the end of the brackets is placed a flat piece of board, 6½ inches (16·5 centimetres) wide and 14 inches (35·5 centimetres) long, or long enough to reach from one bracket to the other. This board may be screwed up to the brackets, and thus make a shelf. Care must be taken in fastening this shelf to the brackets to place it so that the outside edge of the shelf will be 16 inches (40·6 centimetres) from the large board. On the outside edge of this shelf another board, 7 inches (17·8 centimetres) wide, is placed upright, and secured with screws and small strips of wood at the ends, as in the drawing. This shelf, with the wooden back, is marked D in the drawings.

These things make the fixed parts of the heliostat, and we have next to make the movable parts, or the machinery whereby it can be adjusted to the movement of the sun in the heavens. First, get out a flat piece of board 10½ inches (26·7 centimetres) long, 6¼ inches (16 centimetres) wide, and ½ inch (12 millimetres) thick. Then make a flat, half-round piece, shaped like the figure marked G. This piece must be ¼ inch (7 millimetres) thick, 5½ inches (14 centimetres) along the straight side, and with the circular part with a radius of 3 inches (7·6 centimetres). A hole, ½ inch (12 millimetres) in diameter, is made in this, as represented in the drawing, and then the half-round piece must be screwed to the flat piece of wood we just cut out. In the part marked N in Fig. 1 you will see these two pieces fastened together. The piece marked I is the most difficult piece of all. It should be made of ash or some hard wood. One end is square, and has a deep slot cut in it; the rest is round, and may be 1½ inch (32 millimetres in diameter. The square part must be large enough to slip over the half-circular piece, G, as is shown at H. A hole, ½ inch (12 millimetres) in diameter, is cut in the two ends, as marked by dotted lines at J, and through these holes an iron bolt and nut are fitted, so as to hold the circular piece, G, and yet allow it to turn freely in every direction. A hole, 1¼ inch (32 millimetres) in diameter, is cut through the triangular piece of wood K, as shown by the dotted lines, and then this block is securely fastened to the back of the large board, as shown in the second drawing. An opening of the same diameter, and having the same direction, is also cut through the board, and the movable piece, marked I, is put through this hole, as in the drawing. Finally, we want a wooden washer, 3½ inches (8·7 centimetres) wide, as represented at M. This we slip over the long wooden handle, as shown in the second drawing, and this washer rests on the block K, the top of which is 3½ inches square. This makes all the movable parts of the heliostat, and, when we have put in the mirrors, the instrument is finished and ready for use. We must have two mirrors, one 6 inches (15·2 centimetres) square and one 10 inches (25·4 centimetres) long and 6 inches (15·2 centimetres) wide. These may be made of common looking-glass: but plate-glass with silvered back is far better, and costs only a little more.

Any carpenter can make this instrument, and the cost will be about as follows: Wood, 50 cents; labour, $1.75; glass, $1; iron nut, 5 cents; brackets, 50 cents—total, $3.80. When finished, the instrument should have a coat of shellac-varnish, and, when this is done, the mirrors may be put in place, and fastened on with very heavy bands of rubber. This will enable us to take the glasses off when the instrument is not in use, and if the elastic bands or rings are very strong, they will answer perfectly. The long mirror is to go on the movable piece at N, and the small mirror stands on the shelf, facing the opening in the board, at O. This mirror stands at the angle shown in the next drawing (Fig. 2), and the other mirror is adjusted to the sun at its various positions in the sky at different seasons of the year.

Here is a diagram showing the position of the handle of the heliostat, and the mirror for different seasons and in different parts of the country. The handle must be placed on a line parallel with the axis of the earth, and the four dotted lines give its position when the heliostat is to be used in Boston, New York, Washington, and New Orleans. This also causes the block of wood marked K to have a slightly different shape, so that the hole through it will be in the middle. The dotted line marked "At Equinox" shows the path of the light from the sun, and the three dotted lines show the paths of the reflected light as it passes from one mirror to the other. The position of the movable mirror is also shown in the positions it has at the summer and winter solstices.

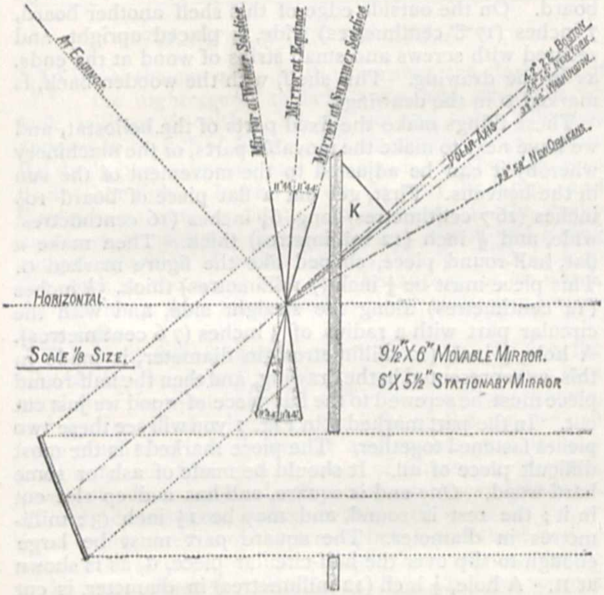

FIG. 2.

First Experiment with the Heliostat.

Choose a bright sunny day, and take the heliostat into a room having a window facing the south. Raise the sash and place the instrument in the window, and fasten it there so that it will be firm and steady. Before closing the window down upon it, move the larger mirror on its axis till it reflects a beam of light into the small mirror. Then turn the handle to the right or left, and a round, horizontal beam of light will enter the room. When this is done, close all the windows, so as to make the room as dark as possible. To do this, shawls or blankets or enamelled cloth will be found useful inside the curtains and shutters. Then get a piece of cardboard, about 6 inches (15·2 centimetres) square, and lay a five-cent piece in the centre, and, with a knife, cut a hole in the card just the size of the coin. Then fasten this, with pins or tacks, over the opening in the heliostat.

We have now a slender beam of light in a dark room. Walk about and study it from different sides. See how straight this slender bar of light is; it bends to neither the left nor the right, but extends across the room in an absolutely straight line. As the sun moves, turn the handle of the heliostat to keep the light in place.

Here (Fig. 3) is a picture of a dark room, in the window of which is the heliostat. In the centre of the piece of cardboard is the small hole where the light enters the room. A boy is holding one end of a long piece of linen thread just at the bottom of the hole in the card, and another boy has drawn the thread out straight and tight, so that it just touches the beam of light throughout its length.

Were you to try this experiment, you would see that the thread would suddenly be lighted up throughout its whole length, and would shine in the dark room like silver. Then if the boy allows the thread to become slack and loose, or if he lowers it even a very little, it will disappear in the darkness. If he raises and lowers it quickly, it will seem to appear and disappear as if by magic.

This is a very pretty experiment; but we must not stop to look at its merely curious effects. Try it over several times, and see if it does not show you something about the beam of sunlight. Plainly, if the thread is lighted up its whole length when it is straight, then the beam of light must be straight also. Here we discover something about light; we learn that it has a certain property. Our experiment shows that light moves in straight lines.

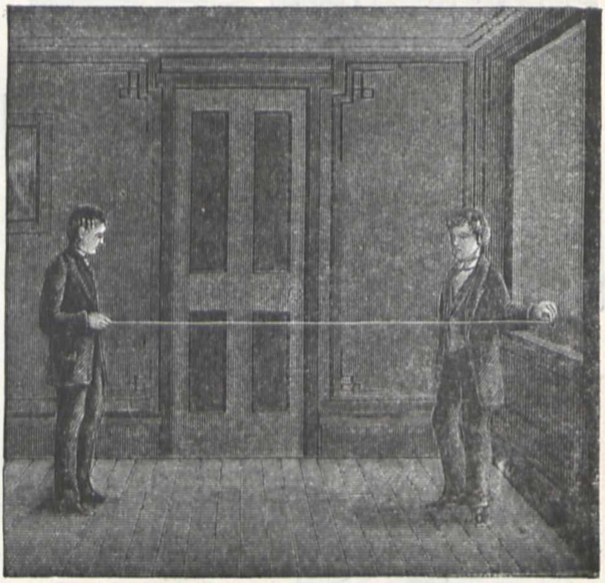

FIG. 3.

Experiment with Cards and a Lamp.

Here (Fig. 4) is a picture representing three little wooden blocks placed in a row upon a flat, smooth table, and fastened to them are three postal-cards, so that they will stand upright. At the end of the table is a small lamp. This is all we need to perform another experiment, that will show us the same thing we observed with the beam of light from the heliostat. To make these things, get a piece of wood 10 inches (25·4 centimetres) long, 3 inches (76 millimetres) wide, and 1½ inch (37 millimetres) thick, and saw it into 5 pieces, each 2½ inches (64 millimetres) long. Next make three slips of pine, 4 inches (10 centimetres) long, 3 inches (76 millimetres) wide, and ⅛ inch (4 millimetres) thick. Having made these, get three postal-cards, and lay them flat on a board, one over the other. Just here we need a tool for making small holes and doing other work in these experiments; and we push, with a pair of pliers, a cambric needle into the end of a wooden penholder or other slender stick, putting the eye-end into the wood, and thus making a needle-pointed awl. Measure off one-half inch from one end of the top postal-card, and with the awl punch a hole through them all, just half-way from each side. Lift the cards up, and with a sharp penknife pare off the rough edges of the holes, and then run the needle through each, so as to make the holes clean and even.

Take one of these cards and one of the wooden slips, and put the card squarely on one of the wooden blocks and place the slip over it, and tack them both down to the block. This will give us the cards and blocks as shown in the picture. When each card is thus fastened to a block, we shall have two blocks left. These we can lay aside, as we shall need them in another experiment.

Now light the lamp, and place one block on the table, quite near the lamp. Look at the lamp carefully, and see that the flame is just on a level with the hole in the card. If it is too high or too low, place some books under it, or put the lamp on a pile of books on a chair near the table. Take a chair and sit at the opposite end of the table, and place another card before you. Now look, through the hole in this card, at the first card before the lamp. If the table is level, you will see a tiny star or point of light shining through the holes in the two cards. Without moving the eye, draw the third card into line between the others, and in a moment you will see the yellow star shining through all three cards.

Next take a piece of thread and stretch it against the sides of the three cards, just as they stand, and immediately you see that they are exactly in line. The holes in the cards we know are at the same distance from the edges of the cards, and our experiment proves that the beam of light that passed through all the holes must be straight, or we could not have seen it. The cards are in a straight line, and the beam of light must also be straight. This experiment, like the first, shows us that there is a law or rule governing the movement of light, and that law is, that light moves in straight lines.

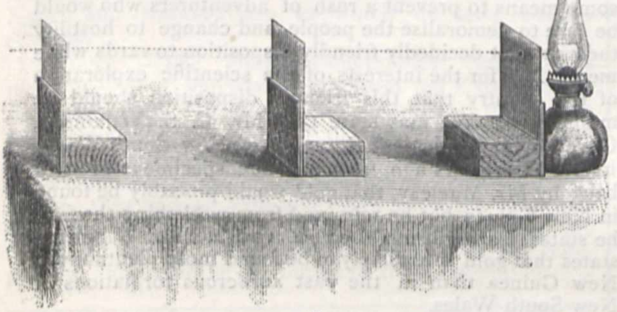

FIG. 4.

Move the lamp as near to the edge of the table as possible, and then bring one of the cards close to the lamp chimney. Then change your seat, and repeat this experiment several times in different directions. Each time you will see exactly the same thing, no matter in what direction the light moves from the lamp. The lamp may be moved from one side of the table to the other, and in every direction we shall find the light moving in exactly straight lines from the source of light. This is true whether the source be the sun, a lamp, or a star. One can walk all about the lamp and see it from every side, and we can place our three cards in any direction, north or south, up or down, east or west, or in any and every direction, and every time it will give the same result.

Thus we have found out the law by which light moves, viz., it moves in straight lines in all directions from the source of light.

Knowing this, you can readily think of a number of things in which these laws are made useful. A farmer planting an orchard, an astronomer fixing the positions of stars, a sailor steering his ship by night, employs this law: the first, to arrange his trees in straight lines; the second, to measure out vast angles in the sky; and the third, to lay the courses of his ship in safety. Each employs these laws with certainty and safety, because they are fixed and never change.

OUR ASTRONOMICAL COLUMN

DOUBLE STARS.—Vol. xliii. of the *Memoirs of the Royal Astronomical Society* contains two series of micrometrical measures of double stars. The first, by Mr. Knott, includes measures taken near Cuckfield, Sussex, between the years 1860 and 1873, with a refractor by Alvan Clark, having an aperture of 7⅓ inches, one of the instruments formerly in the possession of the Rev. W. R. Dawes. Measures of most of the well-known binaries will be found in this series, as also of a number of objects not so frequently under observation. Amongst the latter is the suspected variable, U Tauri, which has been observed on several occasions since November, 1863; D'Arrest first pointed out that this star, supposed to be variable by Mr. Baxendell, is really double; it is included in Schönfeld's last catalogue of suspicious objects with the query, "welche Componente veränderlich?" Mr. Knott's observations throw no light on this point, as he appears to have failed to notice any certain traces of change. A note referring to a star near β Leonis deserves attention. Smyth, in his *Cycle of Celestial Objects*, gives a measure, or, as it should perhaps be termed, an estimation of the position of a companion to this bright star, which he calls an eighth magnitude, and *dull red*, position 114°, distance 298″. At the epoch 1864·38 there was no star of such magnitude in this place, but Mr. Knott measured one which by the method of limiting apertures was found to be 11·6m., position 115°·4, distance 303″·5. The inference, especially in presence of Smyth's judgment of the colour of his companion, must be that we have here a new variable star. The *Durchmusterung* has nothing in this position.

The other series of double star measures to which we have referred emanates from the Temple Observatory, Rugby, and forms the second catalogue issued by Mr. Wilson and Mr. Seabroke. The previous catalogue was printed in the preceding volume of the *Memoirs*, and contains some introductory remarks that are wanting in the present one. The selection of objects and the instrumental means appear to be the same; the stars are found either in the Dorpat Catalogue or in the Pulkowa Catalogue of 1850. Amongst them may be noted O.Σ. 298, the first measures of which by the discoverer gave, for 1846·49, position 183°·8, distance 1″·19, while the Temple Observatory measures, 1873·48, assign for the position 232°, with an estimated distance, 0″·45, and the intermediate measures by Baron Dembowski, in 1866, confirm the change in angle and distance. A great change is remarked in Σ 651; at the epoch 1829·67 we have, position 101°·8, distance 10″·82, whereas the Rugby measures give for 1875·18, position 59°·3, distance 16″·26. In this case it is probable that the alteration is caused by proper motion of one of the components: thus the measures may be reconciled, if we suppose an annual motion of the principal star of about 0″·243 in the direction 17°·9. Of 32 Orionis it is remarked "not divided, perhaps binary," and the angle for 1874·1 is 198°·5; between 1830 and 1853 the distance appears to have been about one second without any decided change in the position, which by a mean of Struve, Dawes, and Jacob was 203°·6; the star seems to require further attention. Of 33 Pegasi, another object measured at Rugby, Struve remarks "comes in cœlo prorsus quiescit," or in other words the change in angle and distance noted between his measures in 1829 and 1851, is due to the proper motion of the principal star, which, according to Mädler, amounts to 34″·0 in the century, in the direction 93°·5. Mr. Wilson's measures of O.Σ. 311 confirm the marked diminution of distance mentioned by Dembowski in *A.N.* 1823—proper motion of one component is no doubt here also the cause of change.

These catalogues of double-star measures made at the Temple Observatory are meritorious productions from an institution not exclusively devoted to a regular course of observations, but also occupied in endeavouring experimentally to interest the youths of the school in astronomical science, with the hope that some, to use the words of the last Annual Report of the Royal Astronomical Society, "may hereafter join that band of amateurs to whom is owing much of what is most characteristic of English astronomy."

While referring to this Report it occurs to us to mention an article by O. Struve on the Baron Dembowski's long series of measures of double stars which is not noticed in the address of the President of the Society, on the occasion of the richly-merited award of the gold medal to the Italian astronomer. It is published in vol. viii. of the *Vierteljahrsschrift der astronomischen Gesellschaft*. After a general outline of the Baron's work, there is given an index to the volumes and numbers of the *Astronomische Nachrichten*, in which his measures have appeared, and which, though not entering into much detail, is useful in their present scattered state. Is it too much to hope that eventually the results of the indefatigable Gallarate observer, may be presented in a collective form, at least as regards their annual means?

SCHMIDT'S LUNAR CHART.—It is understood that this great work, which has been engraved at the expense of the Prussian Government, will, with accompanying letterpress description, be ready for issue in the course of a few weeks. We believe Prof. Auwers, of Berlin, is superintending its publication.

TEMPEL'S COMET OF SHORT PERIOD (1873 II.)—It is probable that the period of revolution of this comet, determined by Mr. W. E. Plummer, from observations extending from July 3 to October 20, will not be found to require very material correction; according to his orbit, the comet cannot attain the distance of Jupiter in its aphelion, and as at the last passage through this point, the planet was distant from it 7·70 (the earth's mean distance = 1) perturbations during the actual revolution are likely to be small. Assuming, then, with Mr. Plummer, that the revolution occupies 1,850 days, the comet may again arrive at perihelion about July 19·5 in the present year. Reducing the perihelion and node to 1878·0, we have the following expressions for the comet's heliocentric co-ordinates referred to the equator:—

$$x = r\,[9{\cdot}99212]\sin(v + 36^\circ\ 51'{\cdot}8)$$
$$y = r\,[9{\cdot}98170]\sin(v + 310\ \ 7{\cdot}9)$$
$$z = r\,[9{\cdot}53313]\sin(v + 274\ 53{\cdot}1)$$

Combining the co-ordinates thus found with the X, Y, Z of the *Nautical Almanac*, and taking July 19·5 for the time of perihelion passage, the following apparent track results:—

12h. G.M.T.

	Right Ascension.	North Polar Distance.	Distance from Earth.
April 20	281° 1′	95° 56′	1·025
May 20	297 53	93 50	0·708
June 19	316 7	95 12	0·488
July 19	334 42	104 56	0·376
August 18	347 22	118 45	0·397

The comet would be nearest to the earth on July 29, and brightest about that date. With such a course it should be well observed. Though, possibly, observations may have been made later than October 20 in 1873, so far as we know none such have been published. Mr. Plummer's elements will be found in the *Monthly Notices* R.A.S. for December, 1873.

[Since the above was written, we learn that Herr Schulhof is engaged upon this comet, with the view to providing an ephemeris for the approaching appearance.]

GEOGRAPHICAL NOTES

AMERICAN LONGITUDES.—The United States Hydrographic Office is continuing the work of establishing secondary meridians of longitude by the electric telegraph. Lieut.-Commander F. M. Green, U.S.N., with the same officers who have been engaged in similar work in the West Indies for some time past, has commenced the determination of South American meridians by measuring from the Royal Observatory at Lisbon through the cables of the Brazilian Submarine Company to Madeira and St. Vincent. The measurement will be continued by way of Pernambuco to Bahia, Rio de Janeiro, Buenos Ayres, and Valparaiso. The longitude of the Royal Observatory at Lisbon will shortly be determined with great exactitude by electrical measurement from London and Paris. The expedition has met with the most gratifying and cordial assistance from the officers of the Portuguese Government and the authorities of the telegraph companies.

NEW GUINEA.—The statement that gold has been discovered in New Guinea by Mr. Goldie, a plant-collector sent out by Messrs. Williams and Co., has caused considerable excitement in the Australian Colonies, but a letter in yesterday's *Times*, from the Rev. W. G. Lawes, who has just returned from a three years' residence on the south-east coast, ought to make would-be gold-hunters cautious. As yet the metal has been found in almost infinitesimal quantities, and we heartily support Mr. Lawes' recommendation that Government ought to take some means to prevent a rush of adventurers who would be sure to demoralise the people, and change to hostility their present decidedly friendly disposition towards white men. It is for the interests of the scientific exploration of the country that this friendly disposition should be maintained. We may state that Mr. C. S. Wilkinson, Government Geological Surveyor of New South Wales, inferred two years ago, from the rock specimens brought back by Mr. Macleay, that gold would probably be found in New Guinea, but he refrained from publishing the fact, he states, fearing it might cause a rush. Mr. Wilkinson states that gold is not likely to be found more plentifully in New Guinea than in the vast auriferous formations of New South Wales.

AFRICAN EXPLORATION.—Dr. Emin Effendi, who in 1876 travelled with Gordon Pasha to the Somerset River, sends from Mruli to Dr. Petermann, a sketch dated November last, of his second journey from Magungo on the Albert Nyanza, across Kirota and Masindi to Mruli in August last, and from Mruli to Mpara-Njamoga, in the south of Masindi, and back to Mruli (in September and October). Sir Samuel Baker, it will be remembered, found Kaba Rega, the lord of Ungoro, utterly intractable; but Dr. Emin Effendi spent a month alone with him, showing the impossibility of anticipating the chances of such travels. In November Dr. Effendi was to go from Mruli to Uganda and Karague, and thence, according to Gordon Pasha's desire, to reach, if possible, Lake Akanyaru, the Mfumbiri Mountains, and Ruanda.

ARCTIC EXPLORATION.—The U.S. Senate has passed the Bill for allowing the *Pandora*, which has been chartered by Mr. James Gordon Bennett for an Arctic Expedition, to sail under the American flag, and for permitting United States naval officers to be detailed for service on board that vessel during the proposed expedition.

PETERMANN'S MITTHEILUNGEN.—As a sequel to a former paper on the distribution of the sedimentary formations of Europe, Petermann's *Mittheilungen* for March contains another on Europe during the two glacial periods, accompanied by a map. The paper on the distribution of palms is concluded, and the first instalment of a summary of exploration of the Ogové given, accompanied by a map.

The April part will contain a long paper, with map, by Prof. Hertzberg, on the Ethnology of the Balkan Peninsula in the fourteenth and fifteenth centuries, and the conclusion of the paper on Prof. Nordenskjöld's proposed expedition from Norway to Behring's Straits. There is also the itinerary (with map) of a journey between Ozaka, Kioto, Nara, and Ominesanjo, in Nippon, Japan, by Dr. Knipping.

AMERICAN GEOGRAPHICAL SOCIETY.—In the *Bulletin* of the Society, No. 5 (1876-7) will be found a pretty full account of the work of the American Palestine Exploration Society, by Dr. Merrell, and a paper on a trip up the Magdalena, and among the Andes, by Mr. J. A. Bennett, U.S. Consul at Bagotá. At the meeting of the society on February 27, the president, Chief-Justice Daly, gave his annual address, summing up in an interesting and complete manner the geographical work of the past year.

BERLIN GEOGRAPHICAL SOCIETY.—The fiftieth anniversary of the foundation of this Society will be celebrated in the Kaisersaal of the Flora. The Crown Prince of Germany, several ministers, and numerous foreign guests, are expected to be present at the festival, which will begin on April 31. The last three numbers for 1877 of the *Verhandlüngen* of this Society contain some papers which may interest geographers and ethnologists. Among these (in No. 8) are a paper by Prof. Virchow on "The Anthropology of America," and in the same number a paper on "The Hygiene of the Tropics," by Herr Falkenstein; in No. 10 a paper by Dr. Hildebrandt on his travels in East Africa, in his attempt to reach Mounts Kenia and Kilima-Njaro, to which we have already referred.

SUMATRA.—The Dutch Geographical Society has recently received important news from the Expedition in Sumatra. MM. van Hasselt and Veth report that in the course of their exploration of the southern highlands of Padang, they ascended the Peak of Indrapura, the highest mountain in Sumatra. From the summit of this volcano they had an extensive view over the land and lakes of Korintji. The travellers also report that of late they had met with less enmity on the part of the independent chiefs than at the outset of their expedition.

NOTES

DURING the field operations of one of the parties connected with the U.S. Geological Survey of the Territories, in charge of Prof. F. V. Hayden, portions of south-western Colorado, north-western New Mexico, and north-eastern Arizona, were traversed, embracing that broken-up country occupied in remote times by a race of people who were known as the cliff-dwellers. This subject is well known to readers in general, but we must recur to it again so as to be able to reach the importance of the discovery to be described. In one of the cañons, known as the Chaco, Mr. H. W. Jackson made detailed investigations and measurements of the immense ruined buildings. In one of the arroyas or dry water-courses, the sectional view of the alluvial deposit was exposed to a depth of about sixteen feet. Fourteen feet beneath the surface, a layer of pottery and *débris* came to view. This may not seem strange, as, in a comparatively narrow valley, dirt and gravel to the depth of fourteen feet might be deposited in a short term of years. But ten feet above this layer the foundation walls of ancient buildings were visible, built upon another layer of gravel and sand. These were in time covered with the alluvium upon which now stand the famous ruins, of which no history is extant, and of the builders of which no history will ever be known. How many ages have passed since the lower or first bed was the surface upon which moved the numerous hordes, of which all evidence at present is hidden behind the veil of the dark past? Now, a skull comes to view upon the layer of pottery, which is beneath two eras of occupation and semi-civilisation. This skull, in its contour, is unique. Its closest relations are the ancient Mexicans, Peruvians, Caribs, and Natchez. There is an extraordinary flattening of the upper posterior portion of the head (posterior parietal), which is evident in those figured in Morton's *Crania Americana*. The contents of the skull as found, consists of sand, which is now as hard as ordinary agglutinated sandstone, and has, in nearly all portions, the appearance of liminite. The skull will be described and figured by Dr. W. J. Hoffmann, of the U.S. Survey, and it affords another strong link in the chain of facts and hypotheses of the cliff-dwellers and the ancient Mexicans being more nearly related than is generally admitted or supposed.

MR. PARK HARRISON telegraphs to us from Worthing that he has just (yesterday) exhumed, at Cissbury, a contracted skeleton, sixteen feet deep, lying in the centre of the pit, over which the cist was found last autumn. The work will be continued on Saturday and next week.

A SCRUTINY took place on the 18th instant at the Academy of Sciences for the nomination of a successor to M. Leverrier as member of the section of astronomy. The successful candidate was M. Tisserand, the Director of Toulouse Observatory, who took thirty-two votes out of fifty-five, against M. Wolf. M. Tisserand was the second astronomer of the Japan Mission for the Transit of Venus, which was led by M. Janssen.

AS we have already stated, a subscription list has been opened in France for the foundation of a memorial to Claude Bernard. A small sub-committee has been formed to obtain subscriptions in this country, consisting of Sir James Paget, Dr. J. Burdon Sanderson, Prof. Humphry, Dr. Michael Foster, Mr. Ernest Hart, Mr. Romanes, and Prof. Gerald Yeo, King's College, to the latter of whom, as honorary secretary of the Physiological Society, subscriptions may be sent.

PORTER AND COATES of Philadelphia are about to bring out a new and cheap edition of Wilson and Bonaparte's "American Ornithology," three volumes in one, together with 103 new plates.

THE report of Major Feilden, the naturalist of the Arctic Expedition, is now nearly completed, and will shortly make its appearance as a Parliamentary Paper, together with some interesting additional remarks by Sir George Nares.

GENERAL DE NANSOUTY published in the beginning of March a letter stating that a sum of 20,000 francs was required to complete the Pic-du-Midi Observatory, of which he is director. Three days after the publication of his letter in the *XIXme Siècle*, an inhabitant of Calais sent him 5,000 francs, and five days later he was presented with a sum of 15,000 francs by M. Bischofsheim, the eminent Parisian banker, whose generosities to science we have so often to record.

Brownea grandiceps is producing its fine *Rhododendron*-like heads of flowers in No. 1 house at Kew.

KING HUMBERT of Italy has granted four annual prizes of 5,000 lire each (about 190*l.*) for the best productions in art, science, and literature. The Academia dei Lincei, at Rome, is charged with the annual award and distribution of these prizes.

A COMPETITIVE trial of German and Swiss chronometers took place recently at the Deutsche Seewarte at Hamburg, by order of the German Admiralty. The best instrument was furnished by Herr Bröcking, and its performance is said to be superior to that of any chronometer examined at Greenwich during the last three years.

MAJOR-GENERAL SIR HENRY RAWLINSON, K.C.B., F.R.S., and Sir John Lubbock, M.P., F.R.S., have been appointed trustees of the British Museum in the place of the late Right Hon. Sir David Dundas and the late Sir William Stirling Maxwell.

THE death is announced of Dr. Joseph Henry Corbett, of Dublin. The deceased was formerly Professor of Anatomy and Physiology, and an Examiner in the Queen's University in Ireland.

WE understand that the herbarium of the late eminent botanist, Alexander Braun, has been purchased by the German Government for the sum of 21,000 marks.

THE cryptogamic herbarium of the late Italian botanist, G. De Notaris, has been acquired by the Italian Minister of Public Instruction for the Botanic Garden at Rome.

WE are happy to state that a decree has established in Lyons, in Bordeaux, and in Besançon observatories for astronomical, meteorological, and horological purposes. For the two former towns, and especially for Lyons, this decree is merely an acknowledgment and regulation of former efforts, but the merit of this measure is not lessened by that consideration, as it puts an end to all local opposition.

EASTER being very late this year, the meeting of the delegates of the French learned societies will take place in the last days of April, only three or four days before the opening of the International Exhibition.

AT a meeting at the Mansion House last week an influential committee was formed to promote the holding of a great agricultural exhibition in London next year, under the auspices of the Royal Agricultural Society of England. Hyde Park was proposed as the place for holding the show.

A SHOCK of earthquake is reported to have been felt at Debenham, a few miles from Ipswich, on Saturday morning.

THOUGH the cultivation in India of the best quinine-yielding species of Cinchona (*C. officinalis*) has not proved a success, it is satisfactory to know that one species at least thrives most abundantly in the Sikkim plantations. From a paper read at the last meeting of the Pharmaceutical Society by Mr. Wood, the Government Quinologist in India, it seems that out of a total of about three million trees, comprising four or five species of Cinchona it is estimated that there are as many as 2,500,000 belonging to the species *succirubra*. It is from this bark that the now well-known "Cinchona febrifuge" is prepared. This substance, according to many well known medical practitioners in India, possesses to so very nearly the same extent the anti-periodic properties of quinine that it may be safely substituted for the latter in the treatment of ordinary fevers and ague. 5,000 lbs. of this febrifuge, we are told, has already been made and issued, and it is now being made at the rate of 4,000 lbs. a year; the demand, however, is so rapidly overtaking this scale of production that a further extension will shortly be necessary. For use it appears in the form of a fine white powder, which, however, becomes in a short time of a pale buff tint. It does not agglutinate even in the Indian climate. It is freely soluble in weak acids and is readily taken up by lemon-juice, which constitutes a pleasant vehicle for its administration.

THE Pharmaceutical Society of Great Britain has just issued an excellent catalogue of the fine collections of Materia Medica and chemical products in their museum in Bloomsbury Square. The catalogue is the work of the Society's Curator, Mr. E. M. Holmes, F.L.S., and includes a great deal of information regarding the several products mentioned. The alphabetical classification of the plants according to their genera in each order and the numerous references to figures in English, American, and foreign works will make this book valuable not only to students of the collection it illustrates, but also for handy reference on the subject generally.

THOSE who are interested in the subject of railway brakes will obtain much instruction and pleasure by a visit to the offices of the Westinghouse Brake Company, at St. Stephen's Palace Chambers, Westminster, where the Company's Automatic Brake may be seen at work. By an ingenious arrangement the brake-power sufficient for a train of ten carriages is represented. At one view the whole of the apparatus that would be brought into play to bring such a train to a stop is seen. A steam-engine compresses the air and distributes it through all the tubes and the ten reservoirs extending over the whole length of the train, and which, by simply turning a handle, acts upon the brakes, one of which is ready to clasp each wheel of the train. The brake can be applied by engine-driver or guard in little more than five seconds, and its action is so powerful that a train going at forty miles an hour can be brought to a dead stop in something like fifteen seconds and within a distance of about 500 yards. The essential principle of this system is the admission of compressed air into a cylinder attached underneath a carriage, and containing the ends of two pistons acting by leverage upon the brakes; the compressed air is stored in pipes attached to the cylinder, and is thus ready for instantaneous admission, which is effected by producing a reduction of pressure, and thus opening a set of valves that admit the air into the cylinder. The air thus admitted acts upon the pistons by pushing them out and causing the brakes to clasp the wheels and instantly stop their revolution. The distinctive feature of the automatic brake is that in case of the train breaking into one or more parts or in case of its meeting with any obstruction or leaving the rails, the brakes are at once applied automatically, and thus the risk of disaster is immensely diminished. Our examination of the apparatus has convinced us of its perfect efficiency, which we find is testified to by all the railway companies that have used it; and any one who has recently travelled north by the Midland Railway must admit that it would be difficult to improve upon a system that can bring a long train going at full speed to a stop within a few seconds. The brake can be applied with any strength, and thus is of great service in going down inclines and taking sharp curves. On the apparatus at St. Stephen's Chambers is a nozzle from which the compressed air may be allowed to escape, and with which some curious phenomena with a hollow elastic ball are shown. The ball is placed within the current of escaping air, and if the tap is kept upright the ball is sustained as if by a jet of water, but with little or no revolving motion. If the tap be brought to an angle of say thirty or forty degrees from the perpendicular, the ball is still sustained by the current, receding and advancing in the line of the tap and revolving rapidly outwards in the direction of the current, so rapidly as to produce a most marked flattening at the poles or sides at right-angles to the direction of motion. Ultimately it becomes almost a disc. Gradually the axis of rotation changes till it is at right-angles to its original position, when the speed of rotation diminishes and the ball gradually comes to rest. Again it begins to spin upon its new axis, going through the same changes again and again so long as it is kept within the action of the jet. In concluson we may say the brakes are comparatively simple in construction; it is almost impossible to put them out of order, and they may be effectually handled by ordinary railway officials.

THE method of coincidences has recently been applied by M. Szathmari, to determine the velocity of sound in free air, as follows:—A pendulum, whose rate was accurately known, closed, at each passage through the vertical position, a battery circuit, the line of which was 220 m. long, and included two electric bells. When both bells are placed before the observer, he hears them simultaneously. If one be moved a little way off this simultaneity ceases; and if the bell be moved still further a point is reached, at which both bells are heard simultaneously again. The distance is that through which the sound moves in the interval between two successive ringings of the bells. The pendulum, in the present case, had a period of 0·2961 seconds; the distances at which the sounds of the two bells were heard at once were directly measured, and the average value (from thirty measurements) was 99·25 m. From this the velocity of sound in free air = 335·19 m. Reducing the value to that for dry air at zero the number obtained is 331·57 m. This lies about midway between Regnault's value (330·7) and that of Moll and Van Beck (332·26).

AT a recent meeting of the Berlin Geographical Society, Prof. Karsten, of Kiel, read an interesting account of the activity of the Commission established in Schleswig-Holstein, which has for its object the exact and minute investigation of the climatological, physical, and chemical conditions of the Baltic and the German Ocean, as well as of the influence which these conditions exercise upon organic life. The commission has established a large number of stations for making observations of the currents existing in these seas, in order to obtain data for the understanding of the general laws governing marine currents. With regard to animal life, the commission has up to the present confined its labours to the most important inhabitant of the two seas, the common herring, and it has succeeded in determining with certainty the few zoological varieties of this fish, as well as in finding its spawning places, and as a result, the artificial cultivation of herrings has already been set on foot. The commission will now devote its attention to other species of fish.

A GERMAN Viticultural Society has just been formed at Cassel. For the present the Society intends to take up two important matters, viz., (1) discovering the best method for the destruction of phylloxera, and (2) the suppression of the secret manufacture of wines by artificial means.

IN NATURE (vol. xvii. p. 372) an account is given of the difficulty met with in Australia in getting bees to work after a few years. A correspondent calls attention to the fact that a similar difficulty occurred in California, where it has been obviated by a systematic abstraction of the honey as the bees collected it. If this were tried in Australia it might possibly meet the difficulty.

IN a recent communication to the Belgian Academy on digestion in insects, M. Plateau, after a careful examination of forty individuals of various types retires from his former position that the digestive juices (in the normal state) are *never acid.* In insects which feed wholly or partly on animal matters, they are slightly acid. He will not, however, concede a constant acidity for all insects (which some naturalists affirm); and in reply to the objection based on the characteristic acidity of the gastric juice of vertebrates, he contends that the digestive liquid in articulata, insecta, myriapoda, arachnida, and crustacea is not analogous to that juice, but rather to the pancreatic juice; the acidity is an accessory character and not the sign of a physiological property. The ferment present is evidently something quite different from the gastric pepsine of vertebrates. Thus, a very little hydrochloric acid, so far from promoting its action, retards or arrests it.

A NEW method, said to be more accurate in its results than that of Helmholtz, for determining the tones of the mouth-cavity which correspond to the vowels, is recommended by M. Auerbach in a recent number of the *Annalen der Physik.* It is based on percussion. Having made a long inspiration, you bring the mouth into the position corresponding to the particular vowel, and then strike the larynx after the manner of physicians, *i.e.*, place the middle finger of one hand firmly on it, and strike it with that of the other hand. A comparatively distinct tone is then heard, which varies with the position of the mouth, but for a given position is always the same. The effects are perceived more distinctly if the ears are previously stopped with wax. M. Auerbach describes results of observation by this method.

MR. A. W. BENNETT (Lecturer on Botany, St. Thomas's Hospital, London, S.E.) requests us to state that he is engaged on an introductory handbook of Cryptogamic Botany, to be published in the International Scientific Series, and that he will be extremely glad of any recent original memoirs, English or Foreign, bearing on any branch of the subject which the authors may incline to send him.

AN International Congress of Botany and Horticulture will be held in Paris on August 16 and following days, under the auspices of the Botanical Society and the Central Horticultural Society of France, in the rooms of the latter Society, 84, rue de Grenelle. A programme of subjects, botanical and horticultural, is announced, on which papers are especially invited, as well as the exhibition of illustrative specimens, collections, and apparatus. One of these subjects is the establishing and fitting up of botanical laboratories. The attendance and co-operation of foreign botanists are cordially invited.

IN the year 1877 no less than 8,000 new publications appeared in Italy. Amongst these there were 5,743 new books (1876 : 4,323), 1,880 pamphlets (1876 : 1,524), and 194 new journals (1876 : 256).

THE additions to the Zoological Society's Gardens during the past week include two Common Marmosets (*Hapale jacchus*) from South-East Brazil, presented by Mr. R. Donaldson; a Three-striped Paradoxure (*Paradoxurus trivirgatus*) from India, presented by Capt. Dalrymple; a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, presented by Messrs. W. Rigg and J. Curtis; a Green Glossy Starling (*Lamprocolius chalybeus*) from North-East Africa, a White-eared Bulbul (*Pycnonotus leucotis*) from India, a Californian Quail (*Callipepla californica*) from California, presented by Mrs. Arabin, F.Z.S.; a Common Kestrel (*Tinnunculus alaudarius*), European, presented by Mr. A. Blumenthal; a Lion (*Felis leo*) from Africa, a Variegated Sheldrake (*Tadorna variegata*) from New Zealand, received in exchange; two Common Swans (*Cygnus olor*), European, deposited; three Black Swans (*Cygnus atratus*), bred in the Gardens; a Zebu (*Bos indicus*), two Common Badgers (*Meles taxus*), born in the Gardens.

THE ANALOGIES OF PLANT AND ANIMAL LIFE[1]

II.

WE may find a kind of analogy for these cases of contradictory action—for they really strike one as contradictory.

The chameleon and the frog are both affected in a peculiar manner by light; they both change colour in accordance with variations in the intensity of the light. Moreover, the change of colour is produced by the same mechanism in the two cases; by a kind of contraction and expansion of certain coloured cells in their skin. But the curious fact is that chameleons[2] become darker in sunshine, while frogs[3] become pale in sunshine and darker in darkness. No doubt both these changes are in some way serviceable to the frog and the chameleon, and we may suppose that the whole phenomenon is really analogous to the opposite effects of light which occur in plants.

To quit the paths of science for those of another region of "Wonderland," it has been pointed out by Mr. Lewis Carrol that dogs wag their tails when they are pleased, whereas cats do so when angry. Seriously the principle is the same—given that emotion produces disturbance of the tail, it will depend on the surrounding circumstances in which the creatures live as to whether a given emotion shall produce a wagging or a rigid tail.

Let us once more consider what needs will arise in the life of an animal, and then see how the same needs are supplied by plants. An animal needs to be alert to changes going on in the world around it; it needs delicate sense-organs to perceive the approach of enemies or the whereabouts of its food. In fact it is evident that to prosper in the varying conditions of life an animal must be sensitive to these changes. By sensitiveness one

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[1] A Lecture delivered at the London Institution on March 11 by Francis Darwin, M.B. Continued from p. 391.

[2] Brücke, *Wien. Denkschrift*, 1851; v. Bedriaga, "Die Entstehung der Farben bei den Eidechsen," 1874.

[3] Lister, Cutaneous Pigmentary System of the Frog. (*Phil. Trans.*, 1858; v. Wittich, Müller's *Archiv*, 1854.

means that an animal must be capable of being affected by changes which, considered as mere physical agents, are insignificant. A fly living in the same room with an active-minded boy will depend for its safety on its power of rapidly appreciating the approaching shadow of the boy's hand. Now the changes produced in the arrangement of forces in the universe are not perceptibly affected by this shadow—it is utterly insignificant—yet what a violent effect it has on the fly. It is because the nervous system of the fly possesses the property of magnifying external changes so that apparently slight disturbance causes large results.

This power of being strongly affected by apparently slight changes is a very important character of living matter. The processes which occur within the fly have been likened to the explosion of a pistol, the force used in moving the trigger being utterly insignificant when compared with the result produced. I do not mean that this exploding power is a distinguishing mark of living matter, but it certainly is a well marked feature. Besides the power of magnifying or intensifying external changes, which we have described as the exploding power of irritable tissue, there is another, the power possessed by nerves of transmitting a stimulus wave from one part to another. We will first look for this transmitting power as it exists in plants.

The leaf of the sundew, or Drosera, consists of a shallow, slightly saucer-shaped disc covered over with short glands, and fringed all round with projecting tentacles which also terminate in glands. The glands secrete a sticky fluid, which hangs in drops on them, hence the name of sundew, because the leaves seem to be covered with dew in sunshine, when other plants are dry. Insects are caught by the sticky secretion, and are also embraced and held fast by the outer tentacles, which possess the power of moving. When the insect has been killed by being drowned in the sticky secretion, it is digested by the acid juice poured out by the glands and subsequently absorbed.

The external or movable tentacles may be made to bend inwards, either by insects alighting on the centre of the disc of the leaf, or on the sticky glands of the tentacles themselves. In the first case, when an insect is caught on the middle of the leaf, and the external tentacles bend in and surround it, we have a true transmission of stimulus, a message sent, like a message is sent along a nerve. The insect may be struggling to free itself, and will probably succeed in doing so, unless the external tentacles give their help. The external tentacles can be made to bend not only by insects or other objects placed on the centre of the leaf, but also by anything placed on the gland at the end of the tentacle itself. In this case the meaning of the movement is equally obvious. If a gnat or fly lights on one of the external glands, it will probably escape, unless carried to the centre of the leaf, where it will be also held by the small sticky glands. Here also there is a true transmission of stimulus. The message has to be sent from the gland at the top to the place where the tentacle bends; a message is sent from the gland to the bending part of the tentacle, just as a message goes through nerve tissue from our skins to our muscle.

In this case the tentacle always carries the fly it has caught to the actual centre of the leaf. But if a fly has been caught by the disc of the leaf, and not quite in the centre, then the messages are sent in accordance with the position of the fly, and all those tentacles within reach move to the point of irritation with marvellous precision. This transmission of messages is all the more wonderful, because, as far as our powers of observation go, there is no special structure to convey the stimulus. It is true that waves of stimulation do travel with special facility along the fibro-vascular bundles, or what are usually called the veins of the leaf. But in this case, where tentacles converge to a given point in the disc of the leaf, this mode of transmission is impossible, because the veins are few in number, and could not cause so nice an adaptation of movements. Moreover, stimuli can travel across a leaf of Drosera after the vascular bundles have been cut through.[1] So that we have the wonderful fact of a wave of stimulation travelling with great accuracy transversely through a number of cells with absolutely no structure like nerve-fibre to guide the course in which the stimulus-wave shall flow.

One other curious phenomenon may be alluded to as showing the extraordinary power of stimulus-transmission. If a piece of meat is placed on an external tentacle, the gland on which it rests sends forth an acid secretion; and if a piece of meat is placed on the centre of the leaf, the tentacles, as before said, bend in and ultimately touch it; but if the external glands are tested with litmus paper before they reach the meat in the centre, they will be found to be covered with acid secretion, proving that not only had a message been sent to the moving part of the tentacle, but also to the secreting cells in the gland.

One might find a parallel to this in the action of the human salivary glands. The gland nerves may be excited either by the stimulus of food placed in the mouth, or by the voluntary action of the muscles of mastication. Here the saliva is poured out, although there is no food to act on, just as the Drosera-gland secretes during the movement of the tentacle before there is anything for its secretion to digest.

Having briefly considered the transmission of stimulus-waves as shown in Drosera I will pass on to consider what manifestations may be found of the other general property of nerve tissue, the property which I have called exploding power. It is chiefly manifested in Drosera by the extreme sensitiveness of the glands on the external tentacles. It is found not to be necessary to place meat or insects on the gland, but that bits of glass, wood, paper, or anything will excite them. Smaller and smaller atoms were tried and still the glands were found to be sensitive to their presence.[1] At last a minute piece of a human hair, about one-hundredth of an inch in length, and weighing just over $\frac{1}{80000}$ of a grain, was placed on the gland of a tentacle and it caused unmistakable movement. The case is yet more wonderful than it sounds, because the piece of hair must be partly supported by the thick drop of secretion on the gland, so that it is probably no exaggeration to say that the gland can perceive a weight of one-millionth of a grain. This degree of sensitiveness is truly astonishing, it seems to us more like the sense of smell than that of touch, for to our most delicate tactile organ, the tongue, such atoms are quite imperceptible.

The power which Drosera has of perceiving the presence of ammonia is perhaps still more astonishing. A solution of phosphate of ammonia in pure distilled water in the proportion of one part to over two million of water, caused inflection of tentacles.[2] One may form an idea of this result by making a solution of a single grain of the phosphate and thirty gallons of distilled water, and then finding out that it is not pure water. Considering the water-supply which we at present enjoy, we may well be grateful that our senses are duller than those of a sundew.

As examples of simple sensitiveness these facts are sufficiently striking, but the powers of discriminating between different kinds of stimuli are equally curious. The tentacles having proved so extraordinarily sensitive to light bodies resting on them, one would expect that the slightest touch would make them bend. But it is not so; a single rapid touch, though it may be violent enough to bend the whole tentacle, does not cause inflection. The meaning of this is clear, for in windy weather the glands must be often touched by waving blades of grass, and it would be a useless labour to the plant if it had to bend and unbend its tentacles every time it was touched. It is not excited except by prolonged pressures or quickly repeated touches. This is also quite intelligible, for when an insect is caught on the sticky secretion of the gland it will give a somewhat prolonged pressure, or a number of kicks to the sensitive gland, unless indeed it flies away after a single struggle, and in that case the tentacle will be also saved from uselessly bending.

In another carnivorous plant, Dionæa, the specialisation of sensitiveness is exactly the reverse; thick and comparatively heavy bits of hair can be cautiously placed on the sensitive organs without causing any movement, but the delicate blow received from a cotton thread swinging against the hair causes the leaf to close.[3] Dionæa catches its prey by snapping on it like a rat-trap—there is no sticky secretion to retain the insect as in Drosera till the slowly moving tentacles can close on it. Its only chance of catching an insect is to close instantly on the slightest touch. The specialisation of sensitiveness in Dionæa is therefore just what it requires to perfect its method of capture.

In describing the sensitiveness of Drosera and Dionæa I wish rather to insist on a wide and general similarity to the action of nerves. There may be said to be an analogy between the specialisation of extreme sensitiveness in Drosera and Dionæa and the nervous tissues of animals, because these properties play the same part in the economy of the plant that is supplied through some kind of nerve machinery in the higher animals. Closer analogies could be pointed out. There are, for instance, the

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[1] See Batalin, "Flora," 1877, who has correctly pointed out the importance of the fibro-vascular bundles as conveying stimulus-waves.

[1] "Insectivorous Plants," p. 32.

[2] "Insectivorous Plants," p. 170.

[3] "Insectivorous Plants," p. 289.

well-known researches of Dr. Burdon Sanderson, in which he compares the electrical disturbances which occur in the leaf of Dionæa to those which take place in nerve and muscle. Again Mr. Romanes has, in a recent lecture in this place, compared the peculiar sensitiveness of Drosera to repeated touches with the phenomenon known in animal physiology as the summation of stimuli. But I have merely sought to show that we find in Drosera a power of conduction of stimuli, an extreme sensitiveness to minute disturbances, and a power of discriminating between different kinds of stimuli which we are accustomed to associate with nervous action. To establish this analogy I believe that the examples already mentioned may suffice.

We will now inquire whether among plants anything similar to memory or habit, as it exists among animals, may be found.

The most fruitful ground for this inquiry will be the phenomenon known as the sleep of plants. The sleep of plants consists in the leaves taking up one position by day and another at night; the two positions for night and day following each other alternately. The common sentitive plant (Mimosa) is a good example of a sleeping plant. The leaf consists of a main stalk from which two or more secondary stalks branch off; and on these secondary stalks are borne a series of leaflets growing in pairs. The most marked character of the night or sleeping position is that these leaflets, instead of being spread out flat as they are in the day, rise up and meet together, touching each other by their upper surfaces. At the same time the secondary stalks approach each other and ultimately bring the rows of closed-up leaflets (two rows on each stalk) into contact. Besides this well-marked change the main stalk alters its position. In the afternoon it sinks rapidly, and in the evening it begins to rise, and goes on rising all night, and does not begin to sink until daylight. From that time it sinks again till evening, when it again rises, and so on for every day and night. In reality the movement is more complicated, but the essential features are as I have described them.

In comparing the sleep of plants with anything that occurs in animal physiology, we must first give up the idea of there being any resemblance between this phenomenon and the sleep of animals. In animals, sleep is not necessarily connected with the alternation of light and darkness, with day and night. We can imagine an animal which by always keeping its nutrition at an equal level with its waste would require no period of rest. The heart which beats day and night shows us that continuous work may go on side by side with continuous nutrition.[1] Mr. Herbert Spencer has suggested that since most animals are unable to lead a life of even ordinary activity during the night because of the darkness, therefore it answers best to lead an extremely active life in day when they can see, and recover the waste of tissue by complete rest at night. On the other hand, certain animals find it more to their profit to sleep in the day and rest at night. But there is nothing of this kind in plants; their sleep movements are not connected with resting. Although the leaflets close up, yet the main stalk is at work all the night through.[2] Moreover, owing to the closing up of the secondary stalks of the leaf, the length of the whole organ is increased, and therefore the work done by the main stalk is also increased. So that, far from resting at night, the main stalk is actually doing more work than in the day. Besides this, instead of being more or less insensible, as a sleeping animal is, the primary petiole of the Mimosa remains fully sensitive at night, and displays the same property which it shows by day, viz., that of falling suddenly through a large angle on its irritable joint being touched. Besides these points of difference, there is the important distinction that the movements of sleeping plants are strictly governed by light and darkness without any reference to other circumstances.

In Norway,[3] in the region of continual day, the sensitive plant remains continually in the daylight position—although no animals probably remain continually awake.

There is one—but only a fanciful resemblance—between the sleeping plants and animals, namely, that both have the power of dreaming. I have been sitting quietly in the hot-house at night waiting to make an observation at a given hour, when suddenly the leaf of a sensitive plant has been seen to drop rapidly to its fullest extent and slowly rise to its old position. Now in this action the plant is behaving exactly as if it had been touched on its sensitive joint; thus some internal process produces the same impression on the plant as a real external stimulus. In the same way a dog dreaming by the fire will yelp and move his legs as if he were hunting a real instead of an imaginary rabbit.[1]

I said that in the regions of perpetual light the sensitive plant remains constantly in the day position. We might fairly expect, therefore, that we should be able to produce the same effect by artificial light constantly maintained. This experiment has, in fact, been made by A. de Candolle,[2] Pfeffer, and others with perfect success. But before the leaves come to rest a remarkable thing takes place. In spite of the continuous illumination, the sleeping movements are executed for a few days exactly as if the plant were still exposed to the alternation of day and night. The plant wakes in the morning at the right time and goes to sleep in the evening; the only difference between these movements and those of a plant under ordinary circumstances is that under constant illumination the movements become gradually smaller and smaller, until at last they cease altogether. When the plant has been brought to rest it can be made to sleep and wake by artificial alternations of darkness and light. This fact seems to me extremely remarkable, and one which, in the domain of animal physiology, can only be paralleled by facts connected with habit. The following case is given me by a friend and is probably a common experience with many people:—Having to be at work at a certain time every day, he has to get up at an early hour, and wakes with great regularity at the proper time. When he goes away for his holiday he continues for a time waking at the proper hour to go to work, but at last the body breaks through the habit, and learns to accommodate itself to holiday hours.

It seems to me that this case may fairly be likened to that of the sensitive plant in constant illumination. There is the same continuance of the periodic movement on the first removal of a stimulus, and the same gradual loss of periodicity consequent on the *continued* absence of the stimulus.

From this kind of habitual action there is but a small step to those actions in which we say that memory comes into play. Dr. Carpenter[3] relates the case of a boy who, in consequence of an injury to his brain, never acquired the power of speech or of recognising in any way the minds of other people. In spite of this mental incapacity he had an extraordinary sense of order or regularity. Thus although he disliked personal interference, his hair having been one day cut at ten minutes past eleven, the next day and every following day he presented himself at ten minutes past eleven, as if by fate, and brought comb, towel, and scissors, and it was necessary to cut a snip of hair before he would be satisfied. Yet he had no knowledge whatever of clocks or watches, and was no less minutely punctual when placed beyond the reach of these aids.

It is hard to say whether this boy actually remembered at ten minutes past eleven that now was the time to have his hair cut, or whether it was an unconscious impulse that made him do so. But whether we call it habit or memory, there is the same knowledge of the lapse of time, the internal chronometry, as Dr. Carpenter calls it, which exists in the sensitive plant, and the same tendency to perform an action because it has been done previously. There is, in fact, hardly any distinction between habit and memory; if a man neglects to wind up his watch at night, he says that he forgot it, and this implies that memory normally impels him to wind it; but how little memory has to do with the process is proved by the fact that we have often to examine our watches again to see that they are wound up. It is the old problem of conscious and unconscious action. If a friend, in order to test our powers of self-control,[4] moves his hand rapidly near the face, we cannot help winking, though we know he will not hurt us; and when we are breaking through a hedge or thicket, we close our eyes voluntarily to keep twigs out. Here are two actions performed with the same object by the same muscles under command of the same nerves, yet one is said to be directed by the will and the other by instinct, and a great distinction is drawn between them. It seems to me that the presence of what Mr. Lewes calls "thought consciousness" is not the crucial point, and that if it is allowed that the sensitive plant is subject to habit (and this cannot be denied), it must, in fact, possess the germ of what, as it occurs in man, forms the groundwork of all mental physiology.

I am far from wishing to make a paradoxical or exaggerated statement of this resemblance between the periodic movements of plants and memory of the human mind. But the groundwork

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[1] Leaving out of the question the repose during diastole.

[2] In Mimosa at least.

[3] Schübler, quoted by Pfeffer ("Die periodische Bewegungen der Blattorgane," 1875, p. 36).

[1] This curious phenomenon was first observed by Millardet, who describes it as of rare occurrence. (Millardet, *loc. cit.*, p. 29.)

[2] Quoted by Pfeffer ("Periodische Bewegungen," p. 31).

[3] "Mental Physiology," p. 349.

[4] See "Physiology of Common Life," vol. ii. p. 200.

of both phenomena seems to be the repetition of a series of acts, or the recalling of a series of impressions, in a certain order at a certain time, because they have been repeated in that order and at that time on many previous occasions.

I will mention one more fact in connection with the movements of Mimosa, in which the formation of habit is illustrated. Every one knows that a noise regularly repeated ceases to disturb us; that one becomes habituated to it, and almost ceases to hear it. A boy fast asleep inside an iron boiler while riveting is going on, is an example of this power of habituation. The same thing occurs with the Sensitive Plant. A single violent shake causes the main stalk to drop, and the leaflets to shut up; in a minute or two the leaf recovers, and will again react on being disturbed. In order to test the power of habituation, I fastened one end of a thread to the leaf of a sensitive plant, and the other to the pendulum of a metronome, and placed the plant just at such a distance from the instrument that it received a pull at every beat. The first shock caused the leaf to shut up, but after a few repetitions it became accustomed to it, and I had the curious sight of a highly-sensitive plant unaffected by a series of blows. In nature this power no doubt enables the plant to withstand the constant shaking of the wind.

In spite of the amount of time which has been spent on the study of sensitive and sleeping plants, no satisfactory explanation of the use which the movements are to the plant has ever been given. In the case of the carnivorous plants, we saw that the movements of plants may be offensive, and like the movements of animals in securing its prey. In the case of certain flowers which we will now consider, the movements are *de*fensive, like the closing of a sea anemone. I shall describe these movements with a view to showing the existence of periodicity or habit, and some other general resemblances to animal physiology.

The crocus is perhaps the best example of a flower which opens and shuts in accordance with changes of external circumstances. The crocus is especially sensitive to changes of temperature. If a light index is fastened into one of the petals or divisions of the flower, very small movements are made visible, and in this way it has been shown that the crocus actually appreciates a difference of temperature of one degree Fahrenheit.[1] I have seen a crocus distinctly open when a hot coal was brought near it. The use of this power of movement is connected with the fertilisation of the flower. In the warm sunshine the flower opens wide, and the bees are soon hard at work, and carry pollen from one flower to another. If, now, a cloud hides the sun, the temperature falls, and the crocus begins to close, and by the time the sky has become overcast and the first drops of rain fall, the precious pollen is housed safe beneath the roof of petals. The crocus is warned of the coming danger by the shadow of the cloud just as the fly is warned by the shadow of the approaching hand. The crocus is sensitive to changes of light and darkness as well as to changes of temperature, and the sum of these influences alternately acting by night and day produce a periodic opening and shutting which resembles the periodic movement or sleep of the Sensitive Plant. Corresponding to the regular repetition of the stimulus of light and heat, an internal periodicity has arisen in the flower which shows itself in a curious manner. This phenomenon is best shown by certain flowers which are not so sensitive to temporary changes, but which open and close regularly by day and night. Raising the temperature in the evening does not produce nearly the same amount of divergence of the petals as a similar rise in the morning. With the white waterlily, *Oxalis rosea*, and some other flowers, the same thing is well seen.[2] If the flowers have been allowed to close at the natural hour in the evening it is hardly possible to perceive the least opening of the petals even when the temperature is raised from 50° to 82°. On the other hand a considerable lowering of temperature does not produce so much effect in the morning as it does towards evening. In all biological problems it is necessary to consider the internal condition of the organism quite as much as the other element, viz., the external condition. It is a familiar fact that similar external causes do not produce like results. A man may fall ill after exposure to wet and cold at different times of his life and the kind of illness may be very different. Once it may be rheumatic fever, another time pleurisy, or some other malady, so that in the case of the flowers which, under a given change of temperature, behave differently at different times of day, we see the variability in the internal condition or receptive state of the organism exemplified, the most interesting fact being that the receptiveness varies not capricously but with periodicity.

The same phenomenon may also be seen when the cycle is a yearly and not a daily one. A German physiologist has lately made a long and patient research on the yearly periodicity in the growth of buds.[1] The method consisted in ascertaining the weight of 100 cherry buds gathered at frequently repeated intervals throughout the year. In order to discover whether the growth of buds would be equally increased in rapidity at all times by a given increase of temperature, branches were cut and kept in a greenhouse at a temperature of 60 to 70 at various times of the year. This experiment showed that branches thus treated in the beginning of December were hardly at all hurried on in growth, while the rise of temperature at once produced energetic growth in buds in the middle of January. If this fact is to be classed with the very similar effects of temperature on the daily periodic changes in flowers—and I can hardly doubt that it ought to be so classed—a difficulty arises. The buds being new growths, have never experienced a previous winter or spring, so that the periodicity cannot originate in their tissues; it must, therefore, depend on some property common to all the branches, some periodicity common to the nutrition of the tree. Askenasy describes the case as the occurrence of some chemical change which goes on in the buds, rendering them sensitive to rise of temperature at a certain period. The case bears a resemblance to the hybernation of animals. Thus, Berthold[2] says that when the dormouse, *Myoxus avellanarius* first goes to sleep in the autumn, it can be partly awakened, and then sent into deep sleep by alternations of temperature, answering, like the crocus, to alternations of heat and cold; but when the winter sleep has fairly set in, no effect could be produced by raising the temperature,—just as the oxalis and water lily when once shut for the night could not be made to open.

I have no doubt that many closer analogies will some day be shown to exist between the behaviour of plants and animals, as regards nerve-physiology. The after-effect of stimuli seems to be represented in the movements of plants. If a stimulus is suddenly applied and then removed, the nerves acted on do not cease to be disturbed the instant the stimulus ceases. The molecular change, whatever it is, which goes on in the nerve, cannot leave off directly the stimulus ceases. The molecular action goes on like the vibration of a bell after it has been struck. When a wheel is turned round rapidly before our eyes the image of a new spoke strikes the retina before the image of the old one has died away, so that we cannot distinguish one from another. In the same way a burning stick whirled round looks like a circle of fire. This after effect of stimuli is represented in plants by heliotropism and geotropism. I have myself observed it in the latter. I took a young growing shoot and put it through a hole in a cork, so that it was firmly fixed into a bottle of water. I then put the bottle on its side in a vessel filled with wet sand, and fixed it firmly by piling wet sand over it. The shoot thus projected horizontally from the vessel of sand. It now began to straighten itself by geotropism, that is to say, the tip of the shoot began to curve upwards. I applied a delicate means of measuring this upward movement, and allowed it to continue for some time. I then turned the bottle round on its axis, so as to rest on what had been its upper surface, and the action of gravity being now reversed as far as the shoot went, the tip ought to have reversed its direction of growth, and curved upwards, but instead of this it went on curving towards the earth in consequence of the after-effect of the old stimulus. And it was more than an hour before it could reverse its movement, and again grow upwards.

With this case I conclude my comparison of plants and animals. Some of the points of resemblance which I have attempted to point out are purely analogical. Nevertheless, I have tried to show that a true relationship exists between the physiology of the two kingdoms. Until a man begins to work at plants, he is apt to grant to them the word "alive" in rather a meagre sense. But the more he works, the more vivid does the sense of their vitality become. The plant physiologist has much to learn from the worker who confines himself to animals. Possibly, however, the process may be partly reversed—it may be that from the study of plant-physiology we can learn something about the machinery of our own lives.

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[1] Pfeffer, "Physiologische Unters.," 1873, p. 183.

[2] Pfeffer, "Physiologische Unters.," p. 195.

[1] Askenasy, *Bot. Zeitung*, 1877, No. 50, 51, 52; abstract *Naturforscher*, 1878, p. 44.

[2] Berthold, *Müller's Archiv*, 1837, p. 63.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Vice-Chancellor has published, for the information of the Senate, a statement received from the University Commission. There appears to the Commissioners to be sufficient evidence of needs which will ultimately require a contribution equivalent to, at least, ten per cent. of the net income of the Colleges. The Commissioners think it will be sufficient to specify in general among the purposes for which provision should be made :—

"1. Additional buildings for museums, laboratories, libraries, lecture-rooms, and other rooms for University business.

"2. The maintenance and furnishing of such buildings, including the provision of instruments and apparatus, together with the employment of curators, assistants, skilled workmen, and servants.

"3. Additional teaching power by the institution of new permanent or temporary professorships, and the employment of lecturers and readers, including the increase of the stipends of some of the existing professorships and the provision of retiring pensions.

"4. Grants for special work in the way of research, or for investigations conducted in any branch of learning or science connected with the sudies of the University.

"The sources from which funds for the purposes described should be obtained appear to be clearly pointed out by the Act itself, when it empowers the Commisioners to enable or require the several Colleges, or any of them, to make contributions out of their revenues for University purposes, regard being first had to the wants of the several colleges in themselves for educational and other collegiate purposes.

"The principles on which payments from the Colleges should be contributed are, in the opinion of the Commissioners, as follows :—

"That such contributions should be made by the several colleges as nearly as possible on a uniform scale throughout, whether by annual payments to the proposed common University fund, or by a capital sum to be provided by the college out of money belonging to it in lieu of such annual payments ; or by annexing any college emolument to any office in the University, with specified conditions of residence, study, and duty ; or by assigning a portion of the revenue or property of the college as a contribution to the common fund, or otherwise, for encouragement of instruction in the University in any art, or science, or other branch of learning, or for the maintenance and benefit of persons of known ability and learning, studying, or making researches in any art or science, or other branch of learning in the University ; or by providing out of the revenue of the college for payments to be made, under the supervision of the University, for work done or investigations conducted in any branch of learning or inquiry connected with the studies of the University within the University.

"The Commissioners think it probable that over and above the contributions to be required from the college on a uniform basis, some colleges may be willing, following in this respect the example of Trinity College, and in consideration of prospective additions to their revenues, or for other reasons, to contribute to the wants of the University by founding professorships or otherwise."

OXFORD.—The vacant Burdett Coutts Scholarship has been awarded to Mr. Edward B. Poulton, B.A., Scholar of Jesus College. The examiners have also announced that Mr. Francis H. Butler, B.A., Worcester College, distinguished himself in the examination and is worthy of honourable mention.

GLASGOW.—At a private meeting of the members of the University Council to consider who should fill the vacancy in the Chancellorship caused by the death of Sir William Stirling-Maxwell, fifty members voted for the Duke of Buccleugh, and thirty-one for Sir Joseph Hooker. A committee was appointed to endeavour to concentrate the vote upon the duke.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 7.—"Experimental Researches on he Temperature of the Head," by J. S. Lombard, M.D., formerly Assistant-Professor of Physiology in Harvard University, U.S. Communicated by H. Charlton Bastian, M.D., F.R.S., Professor of Pathological Anatomy in University College, London.

"Addition to Memoir on the Transformation of Elliptic Functions," by A. Cayley, F.R.S., Sadlerian Professor of Pure Mathematics in the University of Cambridge.

March 14.—"On the Function of the Sides of the Vessel in maintaining the State of Supersaturation," by Charles Tomlinson, F.R.S.

Anthropological Institute, February 26.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—The following new Members were announced :—Mr. W. Cohen and Mr. Gabriel.—A weapon from New Zealand was exhibited by Mr. Hyde Clarke.—Mr. J. Sanderson exhibited some stone implements and fragments of pottery from Natal, and read a paper on the subject of the present native inhabitants and their legends. The President remarked that the great bulk of the implements exhibited were extremely rude ; and in respect to the pottery, observed that it presented remarkable similarity in pattern to pottery found in this country, a statement confirmed by the Rev. Canon Greenwell, who remarked that the pottery was hard and well-baked, and probably made for use in the household.—Mr. W. St. Chad Boscawen read a paper on the primitive culture of Babylonia, in which he referred to the rudely pictorial character of early Babylonian writing, and to its gradual development into a syllabic character, as shown in the syllabaries of Assur-banipal, which he illustrated by reference to the growth of pronominal ideas and the change of the archaic forms through hieratic into a court, or script hand. Treating the earlier forms as pictorial, he suggested that they gave evidence that the original form of dwelling was a cave, which then gave place to a construction of wattle and daub, and that to a structure supported by wooden beams on columns, and having doors and windows. To these were probably attached gardens about the entrance. The honour in which women were held by their children is indicated by the ideograph for mother, which signifies "home-divinity." Mr. Boscawen then stated, as his opinion, that the early Babylonians used the fire-stick to kindle their fires. The ideograph for "prison" is "dark-hole." In these early cities there were policemen who patrolled day and night. A vast number of other curious illustrations of the manners of ancient Babylon were deduced by Mr. Boscawen from the ideographs and syllabaries, and his lecture was listened to with great interest.

Physical Society, March 2.—Prof. W. G. Adams, president, in the chair.—The following candidates were elected Members of the Society :—Mr. J. P. Kirkman and Dr. W. J. Russell, F.R.S.—Mr. Sedley Taylor exhibited the colours produced in thin films by sonorous vibrations. A piece of thin brass perforated with a triangular, circular, or rectangular aperture, and bearing a thin film of soap solution, was placed horizontally on one end of an ⌊-shaped tube ; the beam of the electric lamp, after reflection from it, was received on a screen. It was shown that when a sound is emitted in the neighbourhood of the open end of the tube, the film takes up a regular form which is indicated by the different colours of the reflected light, and each note has its own particular colour figure ; and further, with different instruments we have different figures. Thus when a square film was employed a kind of coloured grating was the result, which was modified by changing the note, and with a circular film concentric rings traversed by two bars at right-angles were observed.—Mr. W. H. Preece exhibited and described the phonograph. After referring to the manner in which the preceding communication bore on the subject of the telephone, he went on to explain the construction of the two instruments exhibited, which have been made in accordance with the published accounts of the apparatus and details received from the inventor, Mr. T. A. Edison, by Mr. Pidgeon and Mr. Stroh respectively. In the first of these the receiving and emitting discs are distinct, the former being of ferrotype iron, and the latter of paper, whereas, in the second form of apparatus, both these functions are performed by one and the same disc of iron. They also differ in that in Mr. Pidgeon's apparatus the drum receives its motion by hand, and in that of Mr. Stroh a descending weight is caused to communicate motion by a suitable train of wheels, which motion can be controlled and regulated by an adjustable pair of vanes. In both cases the drum is of brass traced over by a spiral groove, and the whole is mounted on a screw of the same pitch. The manner of using the phonograph is extremely simple. The drum having been covered with tinfoil, a uniform movement of rotation is given to it, and a fine metal point, firmly fixed to the centre of the receiving plate, is brought in contact with it, care being taken to place the point accurately over the groove. If now this plate be sung or spoken to, the tinfoil will be indented in accordance with the vibrations communicated to the plate. The emitting plate having been provided with a resonator, its point is now brought into the position initially occupied by the point of the receiving plate, and on rotating the drum, with the same velocity, fairly identical sounds are given out. It will be seen that Mr. Stroh's apparatus has an advantage over that of Mr. Pidgeon, in that it secures a constant rate of rotation; but on the other hand, the sounds emitted by the paper disc appeared to be more distinct than those from the iron. A number of experiments were performed with the instruments. The sounds were reproduced at times with remarkable distinctness, and when Mr. Spagnoletti and Mr. Sedley Taylor sang "God Save the Queen," as a duet, through a double mouthpiece, the two voices could be clearly distinguished on its being reproduced. It was shown that even when an indented sheet of tinfoil has been employed to emit sounds, it retains its form with such perfectness that the sounds can be reproduced by means of it a second, and even a third time, with nearly equal distinctness. Prof. Graham Bell pointed out that the articulation of the instruments was very similar to what he had observed in the earlier forms of telephone, and he had no doubt, judging from his own experience of that instrument, that the phonograph will ere long be so adjusted as to articulate much more perfectly. He anticipated that the *quality* of the sound would be found to vary as the rate of rotation was altered, as well as the pitch, and this proved on experiment to be the case.

Royal Microscopical Society, March 6.—Mr. H. J. Slack, president, in the chair.—Mr. Chas. Stewart described a new species of coral said to have been obtained from an island in the vicinity of Tahiti, and which was referred to the genus *Stylaster*. The characteristics of the genus and the distinctive features of the new species were explained and illustrated by black board drawings, and specimens of the coral were exhibited under the microscope.—A paper on a new operculated infusorian from New Zealand, by Mr. Hutton, of Otago, was read by the president.—A paper by Mr. Adolf Schulze on a new and simple method of resolving the finest balsam-mounted diatom tests, was read by the secretary, and described the success which had attended the examination of this class of objects by means of the reflex-illuminator, and the immersion paraboloid, moistened with castor oil in place of water. The lines on *Amphipleura pellucida* were shown in this manner by Dr. Dickson, in illustration of the paper.—Lissajous curves drawn microscopically upon glass by Mr. West, were exhibited by Mr. Curties.

Institution of Civil Engineers, February 26.—Mr. W. H. Barlow, vice-president, in the chair.—The paper read was on liquid fuels, by Mr. H. Aydon.

Victoria (Philosophical) Institute, March 4.—A paper was read by the Rev. Dr. Rule, in reference to ancient Oriental monuments.

CAMBRIDGE

Philosophical Society, February 11.—Mr. J. W. L. Glaisher made a communication on the mode of formation of the factor table for the fourth million, now in course of construction.

PARIS

Academy of Sciences, March 11.—M. Fizeau in the chair.—The following papers were read:—On the phenomena connected with vision of coloured objects in motion, by M. Chevreul. He is able to show on a circle, one-half of which is black, the other half coloured, the complement of this colour, and prove that it is due to the arrangement of the two surfaces with regard to circular motion.—On some applications of elliptical functions (continued), by M. Hermite.—On the relative affinities and reciprocal displacements of oxygen and halogen elements combined with metallic substances, by M. Berthelot. The comparative reactions of the halogens and oxygen on various metals, and specially the reciprocal displacement between iodine and oxygen, depend neither on type nor on atomic or other formulæ of the combinations, but on the quantities of heat liberated by direct combination of the metals with each of the antagonistic elements taken in equivalent weights.—Influence of M. Pasteur's discoveries on the progress of surgery, by M. Sedillot. He shows the relation (to those discoveries) of Lister's treatment of wounds and its results; also Guerin's (with wadding, &c.). M. D'Abbadie stated that on the shores of the Red Sea the natives have a maxim that a wound, to be healed, should remain in contact with air; and he found this was the case. He thinks the air may there be free from microbes.—The vibrations of matter and the waves of the ether in chemical combinations, by M. Favé.—On Mr. Edison's phonograph, by M. du Moncel.—On the industrial applications of electricity, by M. Du Moncel. This is a short summary of vol. v. of his "Exposé des Applications de l'Électricité" (third edition).—M. Cialdi was elected correspondent for the section of Geography and Navigation, in room of the Emperor of Brazil, elected Foreign Associate.—On elliptic polarisation by reflection at the surface of transparent bodies, by M. Cornu.—Note on the vibrations of liquids, by M. Barthélemy. A claim of priority.—Discovery of a small planet at the Observatory of Pola, by M. Palisa.—Observations of small planets, by M. Palisa.—On the fundamental points of the system of surfaces defined by an equation with partial derivatives of the first algebraic order, linear with regard to these derivatives, by M. Fouret.—On a class of transcendant functions, by M. Picard.—On the variations of terrestrial magnetism, by M. Quet. He examines, with the aid of calculation, the theory which attributes to the sun a direct action on the magnetic and electric fluids of the earth.—On the precise orientation of the principal section of Nicols, in apparatus of polarisation, by M. Laurent. For this purpose he places between polariser and analyser a diaphragm, one-half of which only is covered with a thin plate of quartz parallel to the axis, having the thickness of half a wave. When the Nicol, *e.g.*, has to be placed at a determinate angle to certain reticular wires, the border of the plate is brought into the position, then the Nicols are placed accordingly.—Study of chloride of sulphur, by M. Isambert. There is only one chloride of sulphur in which the chloride is dissolved in considerable proportion at a low temperature.—On the substitution of sulphur for oxygen in the fatty series, by M. Dupré.—On the catechines (third note). Catechines of gambirs, by M. Gautier.—Action of fluoride of boron on organic matters (benzylic aldehyde, ethylene), by M. Landolph.—On a new pyrogenous derivative of tartaric acid, dipyrotartaric acetone, by M. Bourgoin.—On the acid of gastric juice, by M. Richet. The hydrochloric acid of gastric juice is in combination with tyrosine, leucine, and perhaps other similar substances.—Experimental researches on the inequality of the corresponding regions of the brain, by M. Le Bon. He examined 287 skulls in the Museum of Anthropology, and found 125 with predominance of the right side over the left, 111 with predominance of the left side, and 51 in which the bones were unequal but compensated each other, making the right side nearly equal to the left.—Classification of Stellerides, by M. Viguier.—On Garnierite, by M. Garnier.—Artificial production of brochantite, by M. Meunier. This was done by keeping fragments of galena about eleven months in a moderately concentrated solution of sulphate of copper.—The Silurian Tigillites, by M. Crié. He attributes those in the west of France to ancient plants, of calamitoid aspect, that lived in shallow water.—On the *rôle* of the retina in vision of near or distant objects, by M. Fano.

CONTENTS

PAGE

OUR BOOK SHELF:—

LETTERS TO THE EDITOR:—

OUR ASTRONOMICAL COLUMN:—

GEOGRAPHICAL NOTES:—