THURSDAY, OCTOBER 24, 1878

THE CONSERVATION OF RIVERS

THE question of the control of rivers has during the last two years occupied more attention than had previously been bestowed upon it for a considerable period. The disastrous floods in South Wales and other parts of the country in the summer of 1875 caused a great outcry at the time, and this had hardly been forgotten when the evil recurred with still greater intensity, and in some cases more damaging effects in the winter of 1876-77. The immense amount of damage caused by floods in these two years, coupled with the fact that, in the opinion of a great many, they occurred at more frequent intervals than in former years, at length drew the attention of Government to the subject. Consequently in 1877 a Select Committee of the House of Lords was appointed to inquire into the operation of existing statutes in regard to the formation of, and proceedings by, Commissioners of Sewers, and Conservancy, Drainage, and River Navigation Boards; to consider by what means they could be more inexpensively constituted and their powers enlarged so as to provide more efficiently for the storage of water and the prevention of floods. At the same time two other committees of the House of Commons were sitting on the same subject, but with reference only to the River Thames, one dealing with the question of the prevention of floods within the metropolitan district and the other within the whole valley of the Thames. A vast amount of information was collected from the numerous witnesses examined by these committees. Considerable difference of opinion was, as might be expected, found to exist in respect of the causes and best means of prevention of the severe floods experienced of late years in our different river basins, but by far the greater majority of the witnesses agreed that the floods were yearly getting worse than formerly, that the river channels were getting into a worse and worse state of neglect, and, what is a most important point in the practical bearing of the question, that the damage caused was so great that the carrying out of extensive remedial measures could in most instances be made to pay. It would appear at first sight a comparatively simple matter, given the drainage area of the river basin, the intensity and duration of the maximum observed rainfall, and the hydraulic inclination of the river, to calculate the sectional area of channel requisite for the maximum discharge; this is doubtless the case, but unfortunately in the early history of the world the formation of rivers was left entirely to the forces of nature without the professional assistance of a competent engineer. If an engineer of suitable experience were called upon to design a river from source to the sea, he could doubtless successfully accomplish the work, but the problem the legislature is now called upon to deal with is of far greater complexity. Not only have the rivers themselves been doing all they could to make things difficult, meandering in graceful curves through plains where they ought to have gone in straight lines, and silting up where greater depth of channel was necessary, but the inhabitants of the country most interested have followed the same course now for some centuries by constituting themselves under Acts of Parliament into innumerable small drainage boards with certain definite powers within their own districts, but unable and unwilling to join together and act for their general good.

The Select Committee on the Prevention of Floods within the Metropolitan District had a comparatively simple question to deal with. Accurate and long-continued observations on the levels of high water were produced, showing the result of the various works of improvement that have been carried out since it was decided to remove old London Bridge. The tides in the Thames are the resultant of two tidal waves, one reaching the mouth of the river by the North Sea, the other by the English Channel, the former arriving at the river usually about three hours before the latter. But certain conditions of the wind on some occasions bring these two tidal waves together; thus a south-westerly gale accelerates the English Channel wave and retards the North Sea wave, while again the latter may be increased by a north-west wind off the coast of Scotland blowing at the same time. The highest tide on record in the Thames was that of November 15, 1875, which rose to the height of 4 feet 7 inches above Trinity high-water, or 3 feet 2 inches above the predicted height; that of January 2, 1877, exceeded the predicted height by 3 feet 4 inches, and reached a height of 4 feet above Trinity high-water. The conditions producing these results were nearly the same: in the south a south-westerly gale, in the north a north-westerly with an easterly wind blowing up the Thames, combined with a low barometric pressure over the river valley and continued heavy rains. Almost the worst possible concurrence of circumstances having on previous occasions occurred, it will not be too much to predict their recurrence at some future time, and possibly with much more disastrous effects; for whereas the highest tide on record, that on November 15, 1875, was only 3 feet 2 inches above its calculated height, that of December 12, 1845, rose to 5 feet 7 inches above its predicted height, showing that a suitable concurrence of conditions might produce a tidal wave upwards of 2 feet at least above the highest on record. In the face of these facts and the repeated inundations of low-lying parts of the metropolis, it is simply astounding that so little should be done not only to obviate the recurrence of a well-known evil, but to prevent a much worse one from happening. Bearing in mind the great and costly works carried out by the Metropolitan Board of Works in the main drainage of London, the Thames embankments and the numerous new streets, and, finally, also in their last great work of buying up and freeing the bridges, it would appear a small thing to raise the height of the river banks at the few places necessary to prevent the periodical inundations; but though there is no difference of opinion as to the character and extent of the works required, the Select Committee and the Board do not seem to have agreed on the question of how the improvements are to be paid for, and the matter appears again to have gone to sleep.

The general question of the control of the entire river channels is one of much greater complexity than the prevention of the periodic overflows of the Thames in the Metropolitan District. It was, therefore, with great pleasure that we saw that the President of the Mechanical Section of the British Association, Mr. Edward Easton, did so much to further the consideration of the question by making it the subject of his opening address at the recent Dublin meeting, and the number of papers by various well-known authorities that followed on the different branches of the same subject, with the discussions thereon, still more enhanced its value. The scope of the whole question involves, as well as the prevention of floods, the following considerations, as pointed out by the President:—the supply of pure and wholesome water for domestic and sanitary wants, the supply of water of proper quality and sufficient quantity for industrial purposes, the proper development of water power, land drainage, and irrigation, navigation, and the preservation of fish. It has long been found in most districts that many of these interests are mutually antagonistic, that the use of water for manufacturing purposes and sanitary arrangements interferes with the supply of pure water for domestic purposes in the places lower down the stream; that the utilisation of water-power by the erection of milldams and weirs impedes the passage of floods and renders efficient land drainage more difficult, while on most navigable rivers the navigation and drainage interests seem to be constantly in opposition. Before two of the Select Committees referred to much useful information was given by the different witnesses examined, but the absence of discussion left much useful work to be done at the Mechanical Section at Dublin.

The facts most prominently brought forward and the remedies advocated may now be considered. The passage to the sea of the water falling as rain may not only be too much retarded, causing loss to the producing power of the country by submerging large tracts of valuable land for a long period; but it may easily be too much accelerated, causing great loss and inconvenience from drought in summer. Notwithstanding the persistence of rainy weather, so much complained of in our climate, most of our rivers would sink to most insignificant dimensions were not some provision made for impounding the water in times of drought. In the fen country admirable provision for floods was made by the early Dutch engineers employed, who, finding the natural river channels, though adapted for the ordinary flow, quite incapable of containing the flood waters, raised banks a considerable distance back from the natural bed of the river. Long tracts of country were thus inclosed and formed into a channel for the passage of flood waters; and, had the works been completed to the outfalls of the river, or had those outfalls been artificially deepened and straightened in those days to the extent they have since, there is little doubt that the result would have been completely satisfactory. As it is, with the extension of works at the outfall of the rivers, rendered necessary by increasing quantity and size of shipping, the original works have been allowed to fall into decay, or have been so altered by the erection of dams and sluices as no longer to fulfil their original uses. What is required in these rivers, then, is to a great extent merely to restore them to the state they were in when left by their original improvers, continuing the improvement of the outfalls, and removing the shoals and other obstructions that have grown up since that time. To remove the whole of the weirs and sluices would be to take away almost the entire water supply, in time of drought, for agricultural purposes. The weirs will therefore have to be made movable, rendering it an easy matter to retain the water supply in summer, while, by lifting the sluices in good time, on the approach of floods, the channel will be freed of all obstructions. In the case of all the rivers considered—the Thames, the Severn, the Shannon, the Great Ouse, Nene, Witham, and others—it was shown that the channels had been suffering continued deterioration from the formation of shoals and the growth of weeds, and that the dams and weirs erected for the maintenance of the water-level in dry weather were not provided with sufficient sectional area for the flood discharge. The engineering difficulties in the way of a complete improvement of our principal rivers are not at all insurmountable, but the legislation necessary has proved abortive. Each river basin is cut up into a number of drainage districts, formed under Acts of Parliament obtained at various times, and wholly without reference to each other. One district is unable to obtain powers to make improvements in its portion of the river without encountering a determined opposition from the districts below, who find that their works would be imperilled by the alterations; and thus a great proportion of the cost of any improvements is spent in parliamentary contests. There is now an almost general agreement in the opinion that the difficulties in the management of rivers are due to divided authority, and that the question could be satisfactorily dealt with if entire river-basins were placed under the control of one body of conservators. The conclusion arrived at is that each river-basin must be placed under the care of a single Conservancy Board, who shall have to decide on and execute any general scheme for the improvement of the river; that this Board shall consist of members chosen from the various districts Boards, which would have the power of executing minor works in their own districts, not affecting the general *régime* of the river, but subject at all times to the control of the combined Board; that the powers of rating conferred on the combined Board shall extend over the whole river basins, but that a special additional rate shall be levied on those districts most directly benefited by the improvements.

It has been proposed, also, that a Central Board should be established in the metropolis, presided over by a Cabinet Minister, to which appeal from the decisions of the various Conservancy Boards can be made, and that this Central Board shall have powers analogous to the Local Government Board, of issuing provisional orders, to be subsequently confirmed by Act of Parliament, thus greatly diminishing the cost to the local ratepayers of the improvements they desire. At the conclusion of the Dublin meeting a recommendation was made by the Mechanical Section that a Committee of the British Association should be appointed to ascertain what steps should be urged on Government to bring about the undivided control of river basins in this country. As it appears very uncertain what action Government may take on the Reports of the Select Committees of both Houses on this question, the Council of the British Association may be able to do a work of great national importance by pointing out clearly and definitely what must be done, and by the publication of an annual report on the progress made preventing the subject again being allowed to drop.

STELLAR OBJECTS SEEN DURING THE ECLIPSE OF 1869

IT will be remembered by the reader who has interested himself in the published reports of observations of recent total eclipses of the sun, that during the totality on August 7, 1869, at a point in Iowa, called St. Paul's Junction, several observers attached to a party organised by Mr. W. S. Gilman, of New York, remarked below the sun what they termed "a little brilliant," and that one of the number using a small telescope, reported having seen just before the sun disappeared and as he came out again a minute crescent, in a similar direction from the moon. Commodore Sands, then Superintendent of the Naval Observatory, Washington, expressed his regret that these objects should not have been seen by Mr. Gilman himself, who had experience of the use of the telescope and was using a larger instrument than the others who had optical aid—but his "plan of operations" did not permit of it. The facts are thus stated :—A few moments after the corona formed, a small but exceedingly bright point, like a star, was noted independently by four of the party, two of whom it is mentioned were observing without telescopes; it appeared near the limits of the corona, below the moon's disc, and with one exception the observers located it a little to the right of an "anvil-shaped" prominence, or "at about 230° from the north point, reckoning by the east," and it is added that each of the observers felt quite positive that what he saw was truly a star. With respect to the small crescent Mr. Gilman reports that about half a minute preceding totality another member of the party, Mr. Vincent, came to him exclaiming that he saw a miniature-crescent-shaped star under the moon, and asking him to verify the observation, but, interested in his own work, he did not at the moment do so; on Mr. Vincent returning more urgent than ever, Mr. Gilman says he did look in a hurried manner but saw nothing in the few seconds he gave to the search; he afterwards states, however, that he does not think he looked so far away from the moon as the crescent was located in a drawing made immediately after the eclipse by Mr. Vincent; in this drawing it was placed "at one and a half times the moon's diameter from its limb, and to the left of a perpendicular down to the horizon." Mr. Gilman adds he could not connect this crescent with the small star of the other observers, indeed Mr. Vincent estimated the object seen by him at three times as far removed from the moon's limb as the small star, which would assign for the latter a distance of about half a degree, corresponding very well to the expression used by the four observers who noted it, that it was near the limits of the corona. Dr. B. A. Gould, now Director of the Observatory at Cordoba, who observed this eclipse at a different station, gave some attention to a search for any object near the sun which might be an intra-Mercurial planet, and he states he saw the star π Cancri, but did not meet with any other stellar body. This star being at the time in a similar direction from the moon's centre, to "the little brilliant" of the Iowa observers, there has been a pretty general opinion that it was the object remarked by them, and, in conversation with Dr. Gould several years since, I found him tolerably well satisfied that he had thus sufficiently explained their observations. But the discovery, or rather discoveries, of Prof. Watson, lend a new interest to them, and a more strict examination of the circumstances may not be out of place here. The position of St. Paul's Junction is stated to be in latitude 42° 47′ 30″ N., and longitude 19° 5′ 45″ W. of Washington. The totality was observed to commence at 5h. 48m. 4·6s., ending at 5h. 51m. 34s. M.T. at Washington, so that the middle occurred at 10h. 58m. 22s. M.T. at Greenwich, which agrees exactly with a calculation made with the *Nautical Almanac* elements. We will assume 10h. 59m. G.M.T. as the time to which the observations of the brilliant point apply. Correcting the moon's place for the effect of parallax, we find her apparent position at this time to be in right ascension, 9h. 11m. 26·7s., and north declination 16° 13′ 58″; her augmented semi-diameter was 16′ 37″. We must assume that both star-like object and crescent were on an angle of 230°, the latter one-and-a-half times the moon's diameter from her limb, and the former at one-third of this distance, whence, referring to the moon's centre, we have, for the crescent, $\Delta\alpha = -$ 3m. 32s., $\Delta\delta = -$ 42′·7, and for the bright little star, $\Delta\alpha = -$ 1m. 46s., $\Delta\delta = -$ 21′·4; and thus,

	R.A. h. m. s.	Decl. ° ′
Stellar object	9 9 41	+ 15 52·6
Crescent	9 7 55	+ 15 31·2

The former was therefore 28′ and the latter 56′ south of the ecliptic.

Now with regard to the star, the presence of which has been supposed to explain the observation of the four observers who noted "the little brilliant," there has been some slight confusion. In a note inserted in the last "Annual Report" of the Royal Astronomical Society it is stated that the object seen "has been satisfactorily identified as the star π^1 Cancri," which is assuredly a mistake. π^1, according to Argelander, is only a seventh magnitude, which is hardly to be glimpsed with the most acute sight in the darkest winter sky. For π^1 no doubt we must read π^2, or 82 Cancri. But this star, also, is of a degree of brightness wholly insufficient to allow of it being possible to discern it at all so near the sun's place without some optical aid in the still illuminated sky-ground, much less to be caught up as a brilliant point of light, with the naked eye; the "Durchmusterung" estimate is 5·8m., which is confirmed by the careful estimations of the second Radcliffe Catalogue, where we find it rated 5·9m., or, in round magnitudes, a sixth. It should be mentioned that the apparent place of 82 Cancri was in right ascension 9h. 7m. 59·5s., declination 15° 28′ 56″, agreeing nearly with that we have found for the minute crescent, but 33′ from the small star. It appears probable, in view of Prof. Watson's discovery, that Dr. Gould may have mistaken an intra-Mercurial planet for π^2 Cancri, and if the statements of the four observers at St. Paul's Junction (one of them, by the way, a lady) are accepted, it can hardly be doubted that they also were attracted by an unknown object, since in that part of the sky there is no star which could be visible as they describe it. It is significant that Regulus, upwards of 12° from the sun's place, was only noticed as "a glimpse-star" at St. Paul's Junction. J. R. HIND

LAKE DWELLINGS

The Lake Dwellings of Switzerland and other Parts of Europe. By Dr. Ferdinand Keller. Second edition, greatly enlarged. Translated and Arranged by John Edward Lee, F.S.A., F.G.S. Two vols. (London: Longmans. 1878.)

IT is ten years since the first edition of Dr. Keller's valuable work was published, and since that time vast additions have been made to a knowledge of the subject of which it treats. Mr. Lee, besides incorporating in the present edition the whole of Dr. Keller's Seventh Report, gives short accounts of every lake settlement that has been investigated; and an idea of the progress that has been made in this department may be learned from the fact that in the first edition the number of objects drawn and described numbered about 1,500, whereas in the present edition they number between two and three thousand.

The second volume, a thick one, is entirely occupied with illustrations of the portions of lake dwellings that have been found, of the situations in which the remains exist, and of the multitude of objects that have been collected *in situ*. As a frontispiece to the first volume is given an illustration of a restored lake dwelling, which nestling near the shore of a Swiss lake, in a picturesque situation, backed by trees and overtopped by lofty mountains, makes a very pleasant picture. Over the fence which surrounds the edge of the platform we see the sloping roofs of the huts built thereon, and out in the lake two boats fishing by means of nets. There is some difficulty, it seems, as to the question of windows, Mr. Lee contending that the huts must have contained these, as the inhabitants would often have to work at their flint implements by the side of the fire. But we scarcely think windows necessary on this account; we have frequently seen the peasants in Scotland, in the long winter evenings, carry on knitting and other even more delicate work by the light of the fire or at most with the addition of a lighted spill of resinous pine. On the whole, however, Mr. Lee's restoration is likely to be a pretty close approximation to reality, to judge from the mass of data collected in Dr. Keller's work.

After an introduction describing the various forms of lake dwellings, the methods used in collecting the relics, on the original discovery of the dwellings, and a few sensible remarks on the ages of stone, bronze, and iron, each of the lakes in which dwellings have been found is treated of separately, the nature of the remains described, and an attempt made to realise the actual nature of the original work. Sections, for there are no chapters, are devoted to the discussion of special objects found and of special points and circumstances connected with the structures, the life and habits of the builders, and the environment generally. One of the most interesting sections is that on the Geographical Distribution of Lake Dwellings, from which we see that they have been found in many other places besides Switzerland—in Germany, Austria, France, Ireland, Scotland, and Wales. Mr. Lee rightly includes under the general head of Lake Dwellings the Crannoges of Ireland, Scotland, and Wales; for although those of Ireland at least were in several important respects different from the structures found on the Continent, still they have several strong points of resemblance. The reason for the choice of site was no doubt pretty much the same—security from sudden attack. Remains of lake-dwellings have even been found in the heart of London, in the peaty marsh where Finsbury now stands, and where, "in Romano-British times, some outcast natives lived." Gen. Lane Fox describes these remains in the *Anthropological Review* for April, 1867. Dr. Keller has always been adverse to the idea of lake-dwellings having been circular; but just when the English work was completed, Mr. Lee tells us that the author sent him word of remains of an undoubted circular dwelling having been found at Fang, in the Lake of Morat. Very interesting are the sections by Prof. Oswald Heer on the plants of the lake-dwellings, and by Prof. Rütimeyer on the animals.

From the mass of data which has been collected, Dr. Keller gives a very clear account of the general form of these lake settlements, and of the different varieties under which they may be classed. As to the substructure, first of all of pile dwellings, which are by far the most numerous in the lakes of Switzerland and Upper Italy. Piles of various kinds of wood sometimes split, but in general mere stems with the bark on, sharpened sometimes by fire, sometimes by stone hatchets or celts, and in later times by tools of bronze and probably of iron, were driven into the shallows of the lakes, provided they were not rocky, at various distances from the shores. Sometimes the piles were close together, sometimes wide apart. On the level tops of the piles were laid the beams, which were sometimes fastened by wooden pins and sometimes let into mortises cut in the heads of the piles. Sometimes the vertical piles were strengthened by cross timbers below the platform beams. Generally the platform itself consisted of one or two parallel layers, and was of very rude structure, though sometimes the stems were split and joined together with some approach to accuracy. The distance from shore seems to have varied considerably; but it is curious that when a lake dwelling had been inhabited both in the stone and bronze ages, that part evidently used in the bronze age is frequently further from the shore and deeper in the lake than that which belongs to the age of stone. Otherwise, nearly the same mode of construction prevailed in the pile-dwellings during the ages of stone, bronze, and iron. In some cases, at least, there is evidence that the dwellings were connected with the shore by a narrow platform or bridge, formed also of piles. In certain cases, also, it is seen that artificial elevations were made on the bed of the lake by piles of stones brought in boats; one of these boats, still loaded with stones, is to be seen at Peters Island, on the Lake of Bienne. The stones must have been put down after the piles had been driven more or less deeply into the mud.

Certain forms, known as frame-pile dwellings, have been found in the Lake of Zürich. In this form the piles, instead of having been driven into the mud of the lake, had been fixed by a mortise and tenon arrangement into split trunks, lying horizontally on the bottom of the lake, evidently when the mud was more than usually soft.

Another form of these ancient habitations has been designated fascine dwellings. Instead of a platform supported on a series of piles, Dr. Keller tells us these erections consisted of layers of sticks, or small stems of trees built up from the bottom of the lake, till the structure reached above the water-mark, and on this series of layers the main platform for the huts were placed. In these dwellings upright posts were used as stays or guides for the great mass of sticks reaching down to the bottom of the lake. Fascine dwellings occur chiefly in the smaller lakes, and belong to the stone age.

Another form of lake-dwelling which has been long known, are the Crannoges or "wooden islands," found in Ireland and Scotland; one has also been found in North Wales. "The crannoges, at least in Ireland, were frequently but not exclusively placed on natural islands, or on shallows which approached to this character; sometimes they were built up from the bottom of the lake on the soft mud, exactly in the manner of the fascine dwellings of Switzerland. They are surrounded by a stockade of piles driven into the bed of the lake, so as to inclose either a circle or an oval; the diameter varies from 60 to 130 feet. These piles are usually in a single row, but sometimes the rows are double and even treble. Occasionally the piles are boards, not round stems. The lowest bed within this inclosure is commonly a mass of ferns, branches, and other vegetable matter, generally covered over with a layer of round logs, cut into lengths of from four to six feet, over which is usually found a quantity of clay, gravel, and stones." Although it is probable that both these crannoges and the Swiss lake-dwellings, which it will be seen had much in common with regard to structure, were erected in lakes greatly for the sake of security, still the lake-dwellings were evidently places of permanent habitation, while the Scotch crannoges, at least, are believed by good authorities to have been chieftains' forts and fastnesses for occasional retreat. The crannoges were actually used far into the age of iron, while the Swiss lake-dwellings belong almost exclusively to the age of stone, and disappeared, Dr. Keller tells us, as far as we at present know, about the first century.

With regard to the superstructure of these pile-dwellings, it appears that on the platform was laid and beaten down firmly a bed of mud, loam, and gravel. The framework of the huts consisted of small piles or stakes, and sometimes of the upper or projecting parts of piles, longer than those on which the platform was built. Round the bottom, at least, of the hut a board or skirting was fitted, and the walls or sides were in a great measure made of a wattle or hurdle-work of small branches, woven in between the upright piles, and covered with a considerable thickness of loam or clay. The huts seem in nearly all cases to have been rectangular, though in at least one instance, referred to above, the circular form has been found. As to whether there were internal divisions in the huts no evidence has yet been found, though it seems certain they were thatched with straw or reeds. "Every hut had its hearth, consisting of three or four large slabs of stone; and it is probable from the almost universal prevalence of clay weights for weaving, that most, if not all, of them were furnished with a loom."

Such was, as far as can be gathered from the mine of information contained in Dr. Keller's volumes, the nature of these curious structures belonging to a remote age and a primitive people. But that the builders of these dwellings were considerably advanced beyond the lowest stage of civilisation is evident, not only from the structures themselves, but from the many articles found in connection with them, and which are so copiously figured in Dr. Keller's second volume. Implements, weapons, and ornaments, mostly in stone, but not infrequently in bronze and even in iron, have been found, of elaborate and finished structure. Beautifully wrought and ornamented textures, showing considerable skill not only in weaving, but in embroidery. Fishing-nets, fish-hooks, and boats, these lake-dwellers had, domestic animals and agricultural implements, all showing that, whoever they were, they were well on the way to a fairly high civilisation; they were fishers, hunters, shepherds and agriculturists, and to no small extent manufacturers. "The endeavours of the settlers to live together in permanent abodes and in a sociable manner, is a positive proof that they had long known the advantages of a settled mode of life, such as applies to the lake-dwellings, and that we have to look upon them not as wandering pastoral tribes, still less as a mere hunting and fishing people. A settled union of a great number of men in the same place, and of hundreds of families in the neighbouring bays, would never have taken place if there had not been a regular supply of provisions at all times of the year, and some beginning of social order."

To all interested in the progress of our race, the two fine volumes of Dr. Keller and Mr. Lee are well worthy careful study; they enable the student to put together with wonderful fulness a picture of a form of society that must have had an early beginning, and the dwellings, and implements, and manners and customs of which are full of interest. Considerable light is thrown on the subject of Dr. Keller's work by what we know of existing pile-dwellings in various parts of the world, not the least interesting of which are those found in Lake Mohyra, in Central Africa, by Commander Cameron.

OUR BOOK SHELF

Annual Record of Science and Industry for 1877. Edited by Spencer F. Baird. (New York: Harper Brothers. London: Trübner. 1878.)

THE high opinion which we have previously expressed concerning this excellent annual is sustained by the present volume, which, however, is smaller than its predecessors, owing to a change that has been made in its character. Hitherto the "Annual Record" has consisted of two distinct parts, a summary of scientific progress made during the year, and a series of abstracts of the more important papers and articles in the scientific journals. This dual character it has been found impossible to sustain, owing to the rapid increase in the number of scientific papers, and also probably to the larger range taken in by the contributors: hence the abstracts have been abolished and the summary alone retained. The change is a useful one, placing more space at the disposal of the editor and embarrassing the reader less. At the same time we regret the absence of references to the papers themselves, which might be added as footnotes, or incorporated in the text; and perhaps more distinction might be drawn between the longer researches, or more valuable memoirs of the year, and mere passing scientific observations. However, it is easier to criticise than to compile a work like the one before us. Our readers will form some idea of the comprehensive nature of this "annual record" by the following summary of its table of contents:—Astronomy, together with reports of the American observatories, contributed by Mr. Holden, of the United States Naval Observatory, Washington. Physics of the globe, followed by general physics, written by Prof. Barber, who also contributes the next section on chemistry. Mineralogy by Dr. Dana, and geology by Dr. Sterry Hunt. Hydrography and geography follow, the geography of North America being specially full. Microscopy, anthropology, zoology, and botany are contributed by able men in each department. Agriculture, engineering, technology, and industrial statistics are less full, and some of the abstracts given in technology would, we think, have found a better place under the head of physics, such, for example, as the telephone, phonograph, &c.

The observatory reports are a feature of the present volume, information being given concerning the *personnel* of each observatory, its principal instruments, the subjects of special observation during the past year, and those to be taken up during the coming year, and lastly the principal publications emanating from each observatory during the past year.

The bibliography at the end of the annual, giving the list of works on science published during 1877, seems most thoroughly and ably done, and so also is the index to the whole volume, and the concise and useful necrology of scientific workers. W. F. B.

Choice and Chance. An Elementary Treatise on Permutations, Combinations, and Probability. With 300 exercises. By W. A. Whitworth, M.A. Third edition, revised and enlarged. (Deighton, Bell and Co., Cambridge.)

WE have all three editions before us, and so are able to mark the growth of this work, which has been very considerable. The number of pages in the last edition is ten less than that of the second edition, but the volume is much thicker, and much of the matter is in smaller type. The work had already attained the position of a standard one on the subjects of which it treats, and it maintains and even improves its position in the present edition. Here, even in the elementary parts are to be found many propositions of great utility which are not to be met with, so far as we know, in any form elsewhere. We do not mean to say that they are not known to mathematicians, but writers have not introduced them into the text-books. Besides chapters on Permutations and Combinations, we have a chapter on *Distribution*, that is the separation of a series of elements into a series of classes, and one on *Derangements* (if a series of elements have been arranged, or if they have a proper order of their own, and we place them in some other order, we *derange* them). Under the head of *chance* we have a full treatment of that part of Probability which usually finds a place in algebraical treatises. Remarks "On the Disadvantages of Gambling," which formed an appendix to the last edition, here forms part of a chapter which also has a few paragraphs to show that insurance is the reverse of gambling, and discusses the effect of the repetition first of a fair wager, secondly of a wager at odds, thirdly of a fair wager on a scale proportioned to the speculator's means, the general case of a lottery with prizes of different value, and closes with a fairly exhaustive account of the Petersburg Problem. The novelty of this edition is a chapter on the geometrical representation of chances. We shall hope to see this chapter considerably enlarged in a future edition. The whole treatment may be said to assume nothing but what a well-primed algebraical student should be able to master. What is much wanted is a general treatise on the subject of Probability for English students. Mr. Todhunter's history of the theory down to the time of Laplace is a most interesting and able one, but it does not fill up the gap. In this branch, as in many others, we are dependent upon French writers, and still must have recourse to the works of Laplace, Poisson, and Liagre.

Pine Plantations on the Sand-Wastes of France. Compiled by John Croumbie Brown, LL.D., &c., &c. (Edinburgh: Oliver and Boyd. London: Simpkin Marshall and Co., 1878.)

THE subject of the reclamation of sand-wastes by the planting of coniferous trees or of grasses, shrubs, or other plants is one always of much importance. The extension of pine plantations has a two-fold interest over and above the primary cause of planting, namely, that arising from the general improvement in the appearance of the country, as the plants make growth and develop themselves into goodly forms, and that which is more utilitarian, but withal equally important—in the production of timber. Anything that can be done towards reducing the desolation of these French sand-wastes is a point gained not only, as Dr. Brown points out, for the benefit of France herself, but as indicating that what has been accomplished there may also legitimately be expected elsewhere, "not necessarily by the same means, but by means as appropriate, if they can be discovered." As will be seen from the title, the book does not claim originality, it professes to be a compilation, and the copious extracts, with the usual inverted commas, extending often over continuous pages makes this announcement unnecessary. Nevertheless a good work has been done in bringing together in a convenient form a great deal of valuable matter, scattered about in various books inaccessible for the most part to readers for whom the present work is intended, and amongst whom it will, no doubt, chiefly circulate; containing as it does detailed information on every branch of coniferous culture, from a consideration of the soils most suitable to satisfactory culture, to the collecting of the resin, and other economic products, and the diseases and injurious influences to which the plants are subject.

From the range of country under consideration, it will be understood that the pines treated of are limited to very few species, such as *Pinus sylvestris*, *P. maritima*, and *P. pinaster*. J. R. J.

La Morfologia vegetale. Esposta da T. Caruel. (Pisa, 1878.)

A NEW text-book of vegetable morphology, characterised by freshness both in the mode of treatment and in the illustrations, is an acquisition to botanical literature, even though written in a language which is unfortunately not familiar to most English readers. Prof. Caruel starts with the primary classification of all vegetable structures into the thallus, which displays no external differentiation, and the cormus, consisting of a central stipes (caulome), to which are attached appendages (phyllomes) more or less differing from the stipes. Under the head of the thallus he then discusses propaguli (of Muscineæ), conidia, sporidia (including zoospores), sporules (or spores, properly so-called), the pollen, and phytozoa (or spermatozoids). The general description of the cormus leads to an account of the various special forms which it assumes, viz., to the morphology of flowering plants and vascular cryptogams; and to the various modes of the reproduction of cormophytes by a process of impregnation, that is, the union of the contents of two dissimilar cells. Finally, Prof. Caruel discusses the various subjects connected with the genesis of species, and concludes with the system of classification of the vegetable kingdom, an outline of which we have already given to our readers (vol. xviii. p. 646). The author brings to his work a mind trained to great accuracy in the use of terms and in the perception of morphological homologies. Great advantage would ensue by the introduction into vegetable morphology in this country of a similar scientific terminology. A. W. B.

LETTERS TO THE EDITOR

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

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

American Exploration [1]

North-western Wyoming and Yellowstone Park

DURING a portion of the period 1870-4, the writer was engaged in service as military engineer of the staff of the troops serving in the geographical department of the Platte, U.S.A. This business involved the accumulation of local geographical information for the use of the troops who were constantly in contact with hostile Indians. The most troublesome of these were the Sioux, whose prowess in battle has since been shown to the world in the story of the battle of the Little Big Horn—the Custer massacre.

Within the limits of this department were several dark spots on the map marked "unexplored." One of these was the north-western corner of Wyoming territory—a region of vital interest to geographers, comprising, as it did, the crown of the North American continent. There lay, wrapped in impenetrable mystery, the trackless forest country where, in native lore, the Great Spirit evidenced his eternal anger by spouting great columns of water and smoke into the air far above the highest tree-tops, by filling the air with strange rumbling sounds, and Bad Medicine smells; and by flinging the waters of the great river into the bottomless depths of the Cañon of the Yellow Stone. There lay the Lake Beautiful high on the mountain side, from whose borders the Great Spirit puffed great clouds of smoke. There were the strange mountains that no man had ever entered, and whose existence was only indicated on the best maps by a hazy line of feeble *hachures*. Somewhere in that black and forbidding mass of the Unknown Mountains were hidden the secrets of the sources of the Yellowstone, the largest feeder of the Missouri, as well as those of the Columbia and the Snake. They were literally the "Unknown" Mountains. They had been looked at in awe from a few spots on the west and north, and from the south-east by a few travellers whom they had turned back from the glittering prize just as it seemed within their grasp. They were unknown to the Indians who lived on their border, with the exception of a handfull of outcasts from the Crows and Shoshonees, who, driven from all intercourse with their fellows, were obliged to live in the mountains, of which even they had acquired but a limited and uncertain knowledge. Along their eastern border spread out the hunting-grounds beyond compare of the Sioux, Arrapahoes, Cheyennes, and Crows, from whence no white man or peaceful Indian could ever hope to return unless prepared to cope with fearful odds. The mildest geologist on the planet could not have entered that happy hunting-ground without finding his own—without leaving his bones to whiten in a lonely vale and his scalp to decorate the evening entertainment of some untutored child of nature.

In the winter of 1872-73 General Ord, commanding the department, informed me of his desire that what remained of this dark spot in his field of operations should be cleared up, and, if possible, that a passage-way be discovered between the sources of Yellowstone and Wind Rivers. This would give easy access to the recently-discovered Yellowstone Park region, and very much simplify the question of the shipment of supplies to some of the posts in Montana. This was the sole origin and animus of the expedition.

At that time there had been published concerning the Yellowstone Park region the following:—Hayden's "Geological Report of 1871," Barlow and Heap's "Reconnaissance," and Doane's "Narrative." Of these, Hayden's work was a rapid geological reconnaissance not based upon any topographical work worthy of mention; Barlow and Heap were two officers of engineers who made a military reconnaissance, in which astronomical and topographical instruments were used by trained observers; while Doane, also an officer of the army, simply recounted what he saw. It was also known that Hayden had spent the season of 1872 in the immediate Park region, but that he had not examined the country to the southward and eastward of it. Acting upon this information, and such as had come to me through considerable hard service in the neighbouring country, I decided to carry what explorers call a preliminary triangulation from the surveyed region of the Union Pacific Railroad northward into the Yellowstone Park, there connecting with the work of previous explorers. This route would take me through the region infested by hostile Sioux, thence through the unknown mountains from the eastward into the Park, and thence recrossing somewhere in the neighbourhood of the sources of the Yellowstone. I felt satisfied that, with a thoroughly efficient pack-train, this could be accomplished before the early snows rendered the mountains impassable.

The event proved that if those pack mules had not been handled with the utmost skill by the men in charge of them, and had they not had the agility of squirrels, we should have been turned back into a hornet's nest of redskins.

I had no particular intention of reduplicating anybody's work, but if such happened I am very glad of it. In the cause of science a little duplication and reduplication are things not to be sneered at. Dr. Hayden has been at work this very season reduplicating his own work in the Park and mine too, and I do hope and pray, if there be anything erroneous or incomplete in my work, that he may find and point it out. I am not afraid of truth and right, even though it lay me prone in the dust. It would be a pity indeed if, with the sum of $75,000 and upwards at his disposal, with an outfit that has been the growth of so many years of his own and other people's experience, and with the only dangerous Indians in the whole region completely quiescent and humbled to the dust—it would be a pity indeed if the sum of our knowledge of that wonderful region were not very largely increased and many former errors discovered.

Exploring is at best imperfect work, so far as the survey, which is its foundation feature, is concerned. Observations for longitude with any known portable instruments are painfully erratic unless there be abundant time; angles taken with a light shaky transit in a gale of wind from the summit of one mountain to the most pointed aspects of the summits of others in sight must make some very "holey" triangles; and yet this is the best that has been done or can be done unless there be time and money for a regular survey.

With such an expedition as mine it would have been a sad pity not to give trained scientists an opportunity to gather some of the treasures in our path, and so after careful selection and the advice of one of the most competent scientists in the country (Prof. O. C. Marsh), I took with me some specialist observers. They were excellent hard-working men, and have every reason for being proud of their work. The sum of money placed at my disposal for the work was $8,000.

Prof. Geikie has, I fear, been misled by the one-sided Report of a Congressional Committee.[1] This Report does not afford a fair idea of the issues with which it deals. It conveys the impression that the Engineer Department of the army had been making efforts to absorb the Hayden survey. I was at that time in a position to know that such was not the case.

It may be well to add that both by law and long-continued practice, a portion of the duties of the engineers of the American army comprises public explorations and surveys, and they have always given the greatest possible assistance to specialist observers, who can always do very much more and better work when they have no cares other than those of observation and reflection.

Of Dr. Hayden I would like to say that few men deserve more commendation for successful labour than he. Where others had always failed, he had succeeded in securing from Congress

[1] See NATURE, vol. xviii. p. 315.

[1] House Doc. Report 612, 43rd Cong. 1st Session.

annual appropriations of about $75,000. I know him to be an indomitable worker in the field, and well remember the day when his annual arrival in our department was hailed with the greatest interest, and was the signal for every possible act of kindness and assistance from one end of the command to the other.

Prof. Geikie's quotation, that the presence of an armed escort needlessly irritated the hostile Indians, is out of the pale of decent characterisation. In those days army men were of the opinion that no party having less than 100 long-range breech-loading rifles could safely pass into certain portions of the Sioux country, and that minimum-sized parties could just about take care of themselves on the defensive. That was the basis upon which my party was organised. That there was some error in this judgment was shown by the Custer massacre not long after. To the other portion of the quotation, that the geologists of the Interior Department were never molested by Indians, I will state, from personal knowledge, that they have always taken the most precious care not to operate in the neighbourhood of dangerous Indians, a very sensible proceeding for parties without armed escort. Through carelessness and lack of knowledge of the system of guarding camps, they have been stampeded once or twice by thieving Indians who were after plunder, but did not dare to kill anybody. This misfortune has recently befallen them in Yellowstone Park, where the commonest precautions would have made it impossible. Their presence alone, without armed escort, seems to have been "irritating to the Indians."

W. A. Jones

Geological Climate and Geological Time

I have been much interested in Prof. Haughton's communication to Nature, vol. xviii. p. 266, on the subject of geological climate and geological time. I fully agree with him that geological climates cannot be explained by any change in the position of the poles, even supposing such change possible, and for the reason assigned by him, viz., that we have no palæontological evidence of an arctic climate in any portion of the earth in any geological period previous to the glacial. But I have some objections to make to the data on which he bases his estimates of time, and therefore to his views as to the *cause* of geological climates.

I. He supposes aqueous agencies to commence operation, and therefore the archæan (azoic) era to commence when the earth surface had cooled to 212° F., evidently because, as he thinks, water could not exist as a liquid on the earth's surface at a higher temperature. But the writer forgets that with all the water of the ocean in the air as vapour, and the large quantity of carbonic acid now existing in the form of carbon and the carbonates also in the air, the pressure of the primeval atmosphere must have been many times—perhaps several hundred times—greater than now, and the boiling, or rather precipitating, point of water very much higher than 212°.

II. Again: Even with a surface temperature from internal causes of 212°, the crust of the earth must have been *very thin*, not more than 40-50 ft. (for increased atmospheric pressure, though greatly affecting the boiling-point of water, would not sensibly affect the fusing-point of rocks). Under these conditions—by the law of equilibrium—the inequalities constituting land-surfaces and ocean-bottoms could not possibly exist; the ocean would be universal, and therefore there would be no erosion and sedimentation. Therefore when dry land first appeared and erosive agencies commenced to act at the beginning of the azoic era, the surface temperature from internal causes must have been much less than 212°. For my part I believe that this temperature had already become very small, the surface had become substantially cool, and the crust very thick before land could exist, and the history recorded in stratified rocks could commence.

III. Therefore, though I agree with Prof. Haughton that all the evidence we have indicates uniform climates in early geological times, I would not, like him, attribute this to warm decrease of surface temperature from *internal* causes alone. I would attribute it almost wholly to *external* causes. Among these are:—1. The *constitution of the atmosphere*. The greater amount of carbonic acid and water in the atmosphere would shut in and accumulate the sun's heat on the earth surface according to the principle discovered by Tyndall, and applied to the explanation of geological climates by Sterry Hunt. 2. It is probable that the *heat received from the sun* was much greater then than now; for the sun is now cooling, and has been cooling throughout all geological times much faster than the earth. 3. The idea of Poisson, that in the journey of our system through the stellar universe it may be *now* in a region in which the *heat received from space* is exceptionally small, has been, perhaps, too much neglected in these speculations concerning geological climates. 4. The more *uniform distribution* of this greater surface-temperature from any or all these causes, would of course still farther increase the temperature of *high latitudes*. This more uniform distribution might be due to the position and shape of land masses, or to the less area and the less height of the then lands.

IV. Lastly: I think that a little reflection will show that while it may be allowable to roughly estimate the *relative lengths* of different *eras* by the *relative extreme thickness* of their strata; it will not at all do to estimate the *absolute length of geological times by the extreme thickness of all the strata*. For as the *measuring rod* is not the rate at which sediments are now accumulating at any one place, but the *average rate* over the whole bottom of the sea, so *the thing to be measured* is not the extreme thickness of the strata at any one place, much less the extreme thicknesses of different formations in different places piled one atop the other, but the *average thickness of the strata* over the whole earth surface.

Most of the points brought out here have already been discussed by me in my recently published "Elements of Geology."

Joseph Le Conte

University of California, October 2

The Magnetic Storm of May 14, 1878

I was much interested in Mr. Perry's note inserted in Nature, vol. xviii. p. 617, showing the simultaneity of the magnetic storm of May 14, 1878, in different parts of the earth's surface. As these magnetic disturbances are always accompanied by electric disturbances (earth currents) in telegraph wires, I was anxious to find out what effects were observed upon our wires in England on the same day, viz., May 14. I append an extract from the diary of the Relay Station at Haverfordwest, a very important station on the wires running from London to Valentia, and where very careful observations are made of all interferences with the regularity of the working of the wires:—

May 14.
P.M.

6.40.—First appearance of relays not closing automatic switch well on down side of 202.

7.10.—London finds some difficulty in reading on 199; no cause visible here.

7.40.—Up side of automatic switch on 202 rather unsteady.

9.0. —Variations in London's current on 200.

9.10.—Strong positive deflections (earth currents) on Cork wires.

9.15.—Cork complains of marks missing and running; no doubt the result of deflections.

9.30.—Great difficulty with automatic switches on Cork wires owing to continuous strong positive deflections which tend to opening of switches when battery currents are in opposite directions, and to close them when in same direction. Probably earth-currents influenced them earlier in evening.

9.40.—Deflections diminishing; wires going better.

9.45.—Deflections ceased.

10.0. —All wires going well; weather wet.

10.10.—*Aurora Borealis visible about this time.*

11.25.—Earth currents very strong again on all wires, causing much trouble with automatic switches. Almost full deflection on up side of 201 and 202.

10.40.—Deflection on 202 reversed, and not so strong as before.

10.45.—Full deflection on up side of 202.

10.48.—Deflection on 199 causes up automatic switch to remain depressed.

Midn.—Earth currents disappearing.

May 15.
A.M.

12.40.—Electric storm seems to have spent itself. Weather fine; clear moonlit sky.

May 15.
A.M.
1.15.—Weather wet. High winds coming on.
7.0. —Nearly six hours' rain and wind.

The numbers 199, 200, 201, and 202 are those of the wires.

Mr. Ellis has also told us (p. 641) of what was observed at Greenwich. Although the magnetic disturbance commenced about 6 P.M. at Greenwich, it only reached a maximum at 9 P.M., when the electric disturbances were observed at Haverfordwest, though indifferent working, most probably due to them, commenced at 6.40. At 11.45 P.M. the north end of the needle at Greenwich moved sharply westward, and about the same time the currents were reversed at Haverfordwest. From midnight to 12.40 A.M. the currents gradually disappeared. Earth currents were also active at Greenwich, as indeed they were everywhere. Unfortunately the wires at the post-office were so fully occupied with press work during these hours, that no observations could be taken. It will be noticed that the aurora borealis was observed. W. H. PREECE

October 21

Giddiness

A TRUE theory of the cause of giddiness ought to explain the following extreme experience, which deserves record in print. The method was first told to me by a friend; I once tried it myself successfully in a mitigated form, and will assuredly not repeat the experiment, and I persuaded a philosophical friend to try it also, with much the same result. Stand in the middle of a soft field where you can't hurt yourself by tumbling on the ground or against anything; avoid having your best clothes on, and secure appreciative spectators. Then put both hands one above the other on the top of your umbrella or walking-stick, and bend down until your forehead rests on the back of your hands. Thus your legs will be vertical, your body will be more or less horizontal, and the umbrella will be vertical. Shut your eyes. Then get a friend, by touching your hips, so to guide you that you shall circle three times, with a sidelong gait, round the vertical umbrella as an axis. Finally raise your head quickly, and try to walk straight as though nothing particular had happened. What will occur is a frightful giddiness and feeling of sickness, a sense of the ground rising up tumultuously on all sides, a wild rush to save yourself, and a headlong tumble.

F. G.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SATELLITE HYPERION.—In a letter from Prof. Asaph Hall it is remarked that the ephemeris for September last, given in NATURE, requires correction by nearly two days, although it was deduced from the elements which he showed to closely represent the Washington observations in 1875 and 1876 (*Astron. Nach.*, No. 2,137). There appear to be great difficulties attending the satisfactory determination of the orbit of this satellite, doubtless arising in the main from the magnitude of the perturbations with which its motion is affected, but for this reason it is the more necessary that it should be regularly observed, and a rough indication of the position of so extremely faint an object is better than none.

If we take for a peri-saturnium passage September 24·8393 G.M.T. with Prof. Hall's other elements, the calculated and observed distances on September 27 agree, and the computed angle is one degree in excess of observation. On the same system the following angles and distances are found for 10h. G.M.T.:—

	Angle. °	Distance. "		Angle. °	Distance. "
Oct. 25	271	137	Nov. 1	95	217
,, 26	268	82	,, 2	94	225
,, 27	250	23	,, 3	94	211
,, 28	107	41	,, 4	93	175
,, 29	99	99	,, 5	92	119
,, 30	97	150	,, 6	87	49
,, 31	96	191	,, 7	287	29

THE MEAN PARALLAX OF A STAR OF FIRST MAGNITUDE.—Prof. Gylden, director of the Observatory at Stockholm, has reported the result of a preliminary calculation bearing upon the mean distance of a star of the first magnitude. Remarking that in the actual state of our knowledge, when a general result is to be deduced from the parallaxes so far measured, we must not only take into account the apparent brightness of the stars concerned, but also their apparent proper motions, since the magnitude of the proper motion is to be viewed as at least as sure a criterion of a measurable parallax as the apparent brightness; as a hypothesis, it is then assumed that the actual parallax p of a star of nth magnitude with the apparent motion s, will be given by the formula

$$p = P \frac{s}{\sigma_n M_n}$$

where σ_n signifies the mean apparent motion of a star of nth magnitude and M_n the distance estimated according to its brightness. P is a constant, which for M = 1 indicates the mean parallax of a star of the first magnitude.

Prof. Gylden takes the following data, depending upon observation, for sixteen stars, of which the parallaxes are supposed to be known with the greatest degree of approximation:—

	mag.	p "	s "
α Centauri ...	1	0·900	3·674
61 Cygni ...	5	0·511	5·221
L. 21185 ...	7	0·501	4·734
34 Groombr. ...	8	0·307	2·801
L. 21258 ...	8·5	0·260	4·403
Oelt. 17415 ...	9·5	0·247	1·200
σ Draconis ...	5	0·222	1·925
Sirius	1	0·193	1·252
70 Ophiuchi ...	4	0·162	1·108
α Lyræ	1	0·153	0·349
1830 Gr. ...	7	0·147	7·053
ι Urs. maj. ...	3	0·133	0·525
α Bootis	1	0·127	2·258
γ Draconis ...	2	0·092	0·063
α Aurigæ ...	1	0·046	0·438
α Urs. min. ...	2	0·046	0·045

From the adopted values of p, s, together with the products $\sigma_n M_n$, 16 equations of condition can be formed, the solution of which by the method of least squares will furnish the value of P. But Prof. Gylden points out that this mode of treatment will not be found to answer the object in view, since the determination of the weights of the different equations, which can in no wise be considered equal, is attended with great difficulties. On the assumption of equal weight, the value of P comes out, 0″·048. As another mode of treatment, normal equations may be formed in various ways, each containing the unknown quantity P, and consequently each serving for a determination of the quantity sought. The sum of all the equations thus obtained gave P = 0″·062.

This value, however, is greatly influenced by several stars of the first magnitude with large proper motion. Omitting α Centauri, α Bootis, and Sirius, the remainder give P = 0″·086, or if all stars of the first magnitude are omitted, P = 0″·083. Again, if all stars with extreme motions are neglected, and a value of P derived from the nine stars which remain, with proper motions less than 2″ annually, it is found to be 0″·084. Prof. Gylden considers that the near agreement of values obtained from these two calculations, in which the extreme case of brightness and motion enter, affords some support to the inference that the relation indicated by the above formula between parallax, apparent motion, and apparent brightness may be taken as an approximation to the truth. It may be remarked that Prof. Peters found for the mean parallax of a first-magnitude star, 0″·102 ± 0″·026; the new value is within the limit of his probable error.

ON THE TIDES OF THE SOUTHERN HEMISPHERE AND OF THE MEDITERRANEAN[1]

ON the coasts of the British Islands and generally on the European coasts of the North Atlantic and throughout the North Sea, the tides present in their main features an exceptional simplicity, two almost equally high high-waters and two almost equally low low-waters in the twenty-four hours, with the *regular* fortnightly inequality of spring tides and neap tides due to the alternately conspiring and opposing actions of the moon and sun, and with large *irregular* variations produced by wind. Careful observation detects a small "diurnal" inequality, (so called because it is due to tidal constituents having periods approximately equal to twenty-four hours lunar or solar) of which the most obvious manifestation is a difference at certain times of the month and of the year between the heights of the two high-waters of the twenty-four hours, and at intermediate times a difference between the heights of the two low-waters.

In the western part of the North Atlantic and in the North Sea, this diurnal inequality is so small in comparison with the familiar twelve-hourly or "semi-diurnal" tides that it is practically disregarded, and its very existence is scarcely a part of practical knowledge of the subject; but it is not so in other seas. There is probably no other *great* area of sea throughout which the diurnal tides are practically imperceptible and the semi-diurnal tides alone practically perceptible. In some places in the Pacific and in the China Sea it has long been remarked that there is but one high water in the twenty-four hours at certain times of the month, and in the Pacific, the China Sea, the Indian Ocean, the West Indies, and very generally wherever tides are known at all practically, except on the ocean coasts of Europe, they are known to be not "regular" according to the simple European rule, but to be complicated by large differences between the heights of consecutive high-waters and of consecutive low-waters, and by marked inequalities of the successive intervals of time between high-water and low-water.

On the coasts of the Mediterranean generally the tides are so small as to be not perceptible to ordinary observation, and nothing therefore has been hitherto generally known regarding their character. But a first case of application of the harmonic analysis to the accurate continuous register of a self-recording tide-gauge (published in the 1876 Report of the B.A. Tidal Committee) has shown for Toulon a diurnal tide amounting on an average of ordinary midsummer and mid-winter full and new moons to nearly $\frac{4}{5}$ of the semi-diurnal tides; and the present communication contains the results of analysis showing a similar result for Marseilles; but on the other hand for Malta, a diurnal tide (similarly reckoned), amounting to only $\frac{1}{4\frac{1}{2}}$ of the semi-diurnal tide. The semi-diurnal tide is nearly the same amount in the three places, being at full and new moon, about seven inches rise and fall.

The present investigation commenced in the Tidal Department of the Hydrographic Office, under the charge of Staff-Commander Harris, R.N., with an examination and careful practical analysis of a case greatly complicated by the diurnal inequality presented by tidal observations which had been made at Fremantle, Western Australia, in 1873-74, chiefly by Staff-Commander Archdeacon, R.N., the officer in charge of the Admiralty Survey of that Colony. The results disclosed very remarkable complications, the diurnal tides predominating over the semi-diurnal tides at some seasons of month and year, and at others almost disappearing and leaving only a small semi-diurnal tide of less than a foot rise and fall. These observations were also very interesting in respect to the great differences of mean level which they showed for different times of year, so great that the low-waters in March and April were generally higher than the high-waters in September and October. The observations were afterwards, under the direction of Capt. Evans and Sir William Thomson, submitted to a complete harmonic analysis worked out by Mr. E. Roberts. Not only on account of the interesting features presented by this first case of analysis of tides of the southern hemisphere, but because the south circumpolar ocean has been looked to on theoretical grounds as the origin of the tides, or of a large part of the tides, of the rest of the world, it seemed desirable to extend the investigation to other places of the southern hemisphere for which there are available data. Accordingly the records in the Hydrographic Office of tidal observations from all parts of the world were searched, but besides those of Fremantle, nothing from the southern hemisphere was found sufficiently complete for the harmonic analysis except a year's observations of self-registering tide-gauge at Port Louis, Mauritius, and personal observations made at regular hourly, and sometimes half-hourly, intervals for about six months (May to December) of 1842, at Port Louis, Berkeley Sound, East Falkland, under the direction of Sir James Clark Ross. These have been subjected to complete analysis.

So also have twelve months' observations by a self-registering tide-gauge during 1871-2 at Malta, contributed by Admiral Sir A. Cooper Key, K.C.B., F.R.S.

Tide-curves for two more years of Toulon (1847 and 1848) in addition to the one (1853) previously analysed, and for Marseilles for a twelvemonth of 1850-51, supplied by the French Hydrographic Office, have also been subjected to the harmonic analysis.

These results, both for the southern hemishere and the Mediterranean, will form the subject of a paper which Capt. Evans and Sir William Thomson hope to communicate to the Royal Society in the course of the coming session. In the meantime the numbers resulting from the harmonic analysis are submitted without further comments to the British Association for comparison with those for other places in previous Reports of the Tidal Committee. Those of them which represent the most important of the diurnal and semi-diurnal tides are shown in the following table, which includes also for immediate comparison the results for Toulon, 1853.

R in every case denotes, as in previous tables of the British Association Committee, the range of the particular tidal constituent on *either side of mean level;* so that $2R$ is the whole rise *from lowest to highest of the individual constituent.* (In comparing results with those shown in the Admiralty Tide Tables, it must be borne in mind that in the latter it is the rise above the level of ordinary low water spring tides that is given as "heights.")

ϵ (technically called the epoch) is the angle, reckoned in degrees, through which an arm, revolving uniformly in the period of the particular tide, has to turn till high water of this constituent, from a certain instant or era of reckoning defined for each constituent as follows:—

Definition of ϵ.[1]

To explain the meaning of the values of ϵ given in the following table of results, it is convenient to use Laplace's "astres fictifs," or ideal stars. Let them be as follows:—

M the "mean moon."

[1] Abstract of paper by Capt. Evans, R.N., F.R.S., and Sir William Thomson, LL.D., F.R.S., read in Section E of the Dublin meeting of the British Association.

[1] This definition for the several cases of K diurnal, and O, P, Q, and L differs by 90°, or 180°, or 270° from the definition given in the British Association 1876 Report for a reason obvious on inspection of Tables I. and II., pp. 304 and 305 of that report, which (except in respect to the longitudes of perigee and perihelion) show ϵ as previously reckoned for the several constituents.

S the "mean sun."

K for diurnal tide, a star whose right ascension is 90°.

K for semi-diurnal tide, the "first point of Aries," or ♈.

O a point moving with angular velocity 2σ, and having 270° of right ascension when *M* is in ♈.

Q a point moving with angular velocity $2\sigma - \varpi$, and 270° before *M* in right ascension when the longitude of *M* is half the longitude of the perigee.

P a point moving with angular velocity, 2η having 270° of right ascension when *S* is in ♈.

N a point moving with angular velocity, $\frac{3}{2}\sigma - \frac{1}{2}\varpi$, and passing alternately through the perigee and apogee of the moon's orbit when *M* is in perigee.

L a point moving with angular velocity, $\frac{1}{2}\sigma + \frac{1}{2}\varpi$, and passing alternately through 90° on either side of the perigee of the moon's orbit when *M* is in perigee.

			SOUTHERN HEMISPHERE.			MEDITERRANEAN.				
			Fremantle, Western Australia. Lat. 32° 3′ S., Long. 115° 45′ E. Year 1873-74. I = 27°·8; ν = + 6°·5.	Port Louis, Mauritius, Lat. 20° 9′ S., Long. 57° 11′ E. Year 1838-39. I = 28°·6; ν = − 1°·5.	Port Louis, Berkeley Sound, East Falkland. Lat. 51° 29′ S., Long. 58° 0′ W. Year 1842, from May 10 to September 8, and from November 14 to December 15. I = 25°·6; ν = − 11°·3.	Toulon, Lat. 43° 7′ N., Long. 5° 55′ E. Year 1847. I = 18°·6; ν = − 4°·6.	Toulon, Year 1848. I = 18°·5; ν = 0°·7.	Toulon, Year 1853. I = 24°·8; ν = + 12°·1.	Marseilles, Lat. 43° 18′ N.; Long. 5° 22′·5 E. Year 1850-51. I = 20°·1; ν = + 10°·2.	Malta, Year 1871-72. Lat. 35° 55′ N.; Long. 14° 30′ E. I = 24°·6; ν = + 12°·2.
S Speed of semi-diurnal $2(\gamma - \eta)$ = 30° per hour.	Mean solar	Diurnal	R_1=0·039 ft. ϵ_1=59°·7	0·013 ft. 31°·8	0·289 ft. 25°·1	0·42 cm. 39°·3	0·28 cm. 14°·9	0·29 cm. 5°·6	0·57 cm. 48°·1	0·10 in. 161°·6
		Semi-diurnal ...	R_2=0·145 ft. ϵ_2=291°·9	0·331 ft. 26°·0	0·492 ft. 195°·3	2·70 cm. 254°·3	2·74 cm. 246°·3	2·74 cm 249°·8	2·37 cm. 246°·6	1·44 in. 100°·2
		Quarter-diurnal.	R_4=0·004 ft. ϵ_4=71°·6	0·003 ft. 115°·6	0·007 ft. 64°·2	0·05 cm. 306°·1	0·05 cm. 259°·9	0·06 cm. 297°·7	0·08 cm. 276°·9	0·01 in. 36°·7
M Speed of semi-diurnal $2(\gamma - \sigma)$ = 28°·984 per hour.	Mean lunar ...	Diurnal	R_1=0·059 ft. ϵ_1=349°·2	0·008 ft. 174°·8	0·052 ft. 347°·7	0·11 cm. 223°·0	0·09 cm. 303°·7	0·47 cm. 12°·3	0·16 cm. 83°·1	0·07 in. 268°·4
		Semi-diurnal ...	R_2=0·154 ft. ϵ_2=287°·2	0·417 ft. 22°·8	1·530 ft. 155°·4	5·45 cm. 253°·9	7·04 cm. 244°·8	5·75 cm. 242°·4	6·87 cm. 229°·9	2·36 in. 94°·8
		Ter-diurnal ...	R_3=0·008 ft. ϵ_3=219°·1	0·016 ft. 166°·9	0·018 ft. 339°·7	0·15 cm. 166°·3	0·08 cm. 183°·4	0·13 cm. 174°·0	0·15 cm. 187°·7	0·02 in. 207°·7
		Quarter-diurnal.	R_4=0·009 ft. ϵ_4=262°·4	0·004 ft. 295°·2	0·066 ft. 352°·7	0·40 cm. 347°·5	0·61 cm. 24°·1	0·33 cm. 329°·0	0 62 cm. 3°·0	0·03 in. 354°·5
K Speeds γ and 2γ = 15°·041 and 30°·082 per hour.	Luni-solar declinational	Diurnal	R_1=0·611 ft. ϵ_1=304°·8	0·236 ft. 119°·7	0·350 ft. 29°·2	2·98 cm. 185°·3	3·23 cm. 185°·8	3·67 cm. 191°·9	3·29 cm. 187°·6	0·41 in. 51°·9
		Semi-diurnal ...	R_2=0·051 ft. ϵ_2=296°·6	0·124 ft. 21°·2	0·160 ft. 189°·4	0·68 cm. 251°·4	0·37 cm. 250°·6	0·80 cm. 272°·5	0·52 cm. 267°·0	0·38 in. 127°·3
O Speed $(\gamma - 2\sigma)$ = 13°·943 per hour.	Lunar-declinational	Diurnal	R_1=0·430 ft. ϵ_1=286°·0	0·165 ft. 99°·4	0·481 ft. 13°·7	1·26 cm. 129°·8	1·68 cm. 124°·2	1·88 cm. 99°·0	1·85 cm. 97°·1	0·30 in. 72°·4
P Speed $(\gamma - 2\eta)$ = 14°·959 per hour.	Solar-declinational	Diurnal	R_1=0·156 ft. ϵ_1=296°·7	0·056 ft. 131°·7	0·141 ft. 86°·7	1·25 cm. 178°·6	1·29 cm. 175°·8	1·25 cm. 179°·4	1·19 cm. 182°·4	0·13 in. 57°·9
L Speed $(2\gamma - \sigma - \varpi)$ = 29°·533 per hour.	Smaller lunar-elliptic	Semi-diurnal ..	R_2=0·011 ft. ϵ_2=250°·3	0·024 ft. 18°·7	0·060 ft. 132°·8	0·21 cm. 254°·1	0·33 cm. 232°·5	0·21 cm. 235°·3	0·22 cm. 274°·5	0·25 in. 116°·0
N Speed $(2\gamma - 3\sigma + \varpi)$ = 28°·435 per hour.	Greater lunar-elliptic	Semi-diurnal ..	R_2=0·040 ft. ϵ_2=341°·1	0·132 ft. 31°·9	0·332 ft. 128°·3	1·53 cm. 223°·4	1·61 cm. 234°·3	1·39 cm. 223°·1	1·36 cm. 222°·7	0·37 in. 116°·0
Q Speed $(\gamma - 3\sigma + \varpi)$ = 13°·394 per hour.	Greater lunar-elliptic declinational	Diurnal	R_1=0·114 ft. ϵ_1=284°·9	0·028 ft. 79°·2	— —	0·38 cm. 42°·0	0·17 cm. 48°·8	0·19 cm. 32°·7	0·32 cm. 18°·4	0·08 in. 58°·5

The value of ϵ in each case above means the number of 360ths of its period which the corresponding tidal constituent has still to execute till its high-water from the instant when the ideal star crosses the meridian of the place. Thus if n denote the periodic speed of the particular tide in degrees per mean solar hour, its time of high-water is $\frac{\epsilon}{n}$, reckoned in mean solar hours after the transit of the ideal star.

In this definition, and in the table of results, the following notation is employed[1]:—

I to denote the mean inclination of the moon's orbit to the earth's equator during the time of the series of tidal observations included in each instance.

ν ,, ,, the mean right ascension of the ascending node of the moon's orbit on the earth's equator during the same time.

γ ,, ,, the angular velocity of the earth's rotation.

σ ,, ,, the mean angular velocity of the moon's revolution round the earth.

η ,, ,, the mean angular velocity of the earth round the sun.

ϖ ,, ,, the angular velocity of the progression of the moon's perigee.

"Speed" means the angular velocity of an arm revolving uniformly in the period of any particular tidal constituent; each angular velocity being reckoned in degrees per mean solar hour.

THE PHYSICAL FUNCTIONS OF LEAVES

AN elaborate study on the above subject has lately been published by Prof. J. Boussingault, of Paris, in the *Annales de Chimie et de Physique* (vol. xiii. pp. 289-394); in which the phenomena of absorption and transpiration by leaves are treated at great length. Since the memorable experiments of Hales in 1727, recounted in his work on "Vegetable Statics," this branch of vegetable physiology has been rarely touched, and the carefully recorded observations of Boussingault, carried out with the best of modern scientific appliances, possess an unusual value.

The first point studied was the loss of water by transpiration from the leaves of plants under normal circumstances. For this purpose a healthy Jerusalem artichoke (*Helianthus tuberosus*) in a roomy flower-pot was chosen. The top of the pot was covered with a sheet of india-rubber, tightly inclosing the stem of the plant, and provided with an opening for the admission of water. The whole was then weighed, and the loss noted which ensued under various circumstances, by evaporation of water from the leaves, the plant receiving during the experiment weighed normal amounts of water. The total surface of the leaves of the plant (both upper and lower sides) was carefully estimated, and the result reckoned on the square metre. The averages of fourteen experiments showed that the artichoke lost hourly, for every square metre of foliage, the following amounts of water:—in the sunshine sixty-five grammes, in the shade eight grammes, during the night three grammes.

In the next place the question was investigated whether the absorption of water by plants, and the ascent of the sap is due to the force resulting from the transpiration on the surface of the leaves, or whether the roots exercise also a certain amount of force to this end. For this purpose experiments similar to the above were carried out with various plants, firstly under normal circumstances, secondly with the stem minus the roots immersed in water. As an instance we can take mint. The plant with roots showed an hourly evaporation per metre, of eighty-two grammes in the sunshine, and thirty-six in the shade. Under the same condition, without roots, the evaporation was sixteen and fifteen grammes respectively.

[1] The values of I and ν are given to facilitate comparison with the equilibrium values of the several tidal constituents, according to Tables I. and II. of the British Association Tidal Committee's Report of 1876.

The results show that the absorption of water by plants is determined in a great measure by the transpiration occurring in the leaves, that this is maintained for a certain length of time without the assistance of the roots, but cannot continue long, being dependent on the injective power possessed by the roots. The effects of pressure on the absorption was next examined, and it was found possible by this means for a time in certain cases to even more than replace the water lost by transpiration. For example: a chestnut branch dipped in water was found to transpire hourly per metre of foliage, 16 grammes. It was then inserted into a tube of water, and subjected to the pressure of a column of water $2\frac{1}{2}$ metres high. Under these conditions the evaporation mounted to 55 grammes per hour, and the branch at the end of five hours weighed more than at the commencement.

The general result of these experiments shows the mutual working of the various parts of the plant with reference to the phenomena of transpiration. The roots absorbing water from the soil by endosmose, direct it towards the stem. Whether the motive force here is injection by the roots or absorption resulting from the transpiration in the green parts of the plant, or a union of both, is a question still unsettled. The stem serves not only as a passage for the water to reach the leaves, but also as a reservoir to be drawn on during rapid evaporation. In the leaves the sap is concentrated by the transpiration, and the matters in solution enter into the cell formation, or, changed by the action of light, are distributed throughout the plant by the descending sap. The circulation would be quite similar to that in an animal, were it not for the irregularity. While the supply of water from the roots varies but slightly, the loss by evaporation from the leaves is subject to the greatest fluctuations, according to the temperature and hygroscopic condition of the surrounding air. During these periods the leaves draw on their stock of constitution water and the supply in the stem; and when both fail, the phenomenon of wilting ensues.

Numerous experiments were made on the difference in *evaporation during the day and during the night.* Those carried out with leaves of the grape vine gave the following hourly averages per square metre of foliage; in sunshine, 35 grammes; in shade, 11; during the night, 0·5. The trellis on which the vine was trained was 1 metre high and 38 metres long, and presented a surface of 138 square metres of foliage. In sunny weather this would lose by evaporation in the course of 24 hours, 48 kilogrammes of water, and nearly half of that amount during cloudy weather. To give an idea of the enormous amount of aqueous vapour dissipated by plants in the sunshine, calculation showed that an acre of beets could lose in the course of 24 hours between 8,000 and 9,000 kilogrammes. Another experiment made with a chestnut-tree 35 years old showed that it lost over 60 litres of water in the course of 24 hours. The structure of the leaf, however, containing 70-80 per cent. of water, and possessing a thickness frequently of but $\frac{1}{10}$th of a millimetre, would suggest the question why the evaporation is not much more rapid. The answer to this is found in the peculiar structure of the tissue forming the epidermis, designed especially to moderate the transpiration. In order to see the remarkable retentive power exercised by this epidermis, one can expose for a few hours to the sun two cactus leaves of the same superficies, one of which has been deprived of its epidermis. The evaporation in the latter case will be about fifteen times as rapid as in the other. It is the presence of a similar tissue forming the skin of fruits which prevents an otherwise rapid evaporation. For instance, an apple deprived of its skin loses 55 times as much water as a whole specimen in the same time. Losses by rapid evaporation lessen notably the physiological energy of leaves. Thus an oleander leaf containing 60 per cent. of water, when introduced into an atmosphere containing carbonic acid, decomposed 16 c.c. of this gas; one containing 36 per cent. decomposed 11 c.c.; and one containing but 29 per cent. was without action.

A series of observations was made on the relative powers of *evaporation on the upper and lower sides of leaves*. They consisted in plucking two leaves of the same kind at the same moment, covering on the one the upper, on the other the lower side with melted tallow, and then noticing the loss of weight by evaporation in a given time. The average of the results showed that the proportion between the amounts of water evaporated on the upper and lower side of a dozen varieties of leaves was 1 : 4·3. In all cases the amount evaporated from the two exposed sides of two equal leaves was greater than from the entire surface of a similar leaf under the same circumstances.

A point of no small interest with regard to the physical function of leaves is that of their ability to replace the roots of a plant in serving as the agent of absorption. A variety of tests were undertaken to settle this question; among them the following:—A forked branch of lilac (Fig. 1) was so disposed that the one branch was immersed in water while the other was exposed to the ordinary atmospheric conditions. The superficies of foliage was the same on both branches. The transpira-

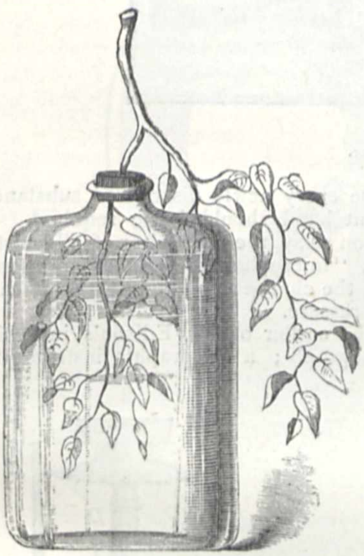

Fig. 1.

tion from the surface of the leaves on the latter branch was the same as under normal circumstances, and after the lapse of two weeks the foliage was as fresh as at the commencement, showing that the submerged leaves were fully able to replace the roots in one of their functions. In an experiment with a beet in which one-half of the leaves were in water and one-half in the air, communication being maintained by means of the root, the free portion of the leaves wilted in the course of a day, the neck of the root apparently not offering a sufficient means of communication with the submerged leaves. A grapevine shoot half plunged in water (Fig. 2) maintained a normal evaporation in the free foliage, and remained fresh for over a month. An oleander shoot under similar conditions maintained its normal appearance for four months. With the artichoke it was found necessary that the surface of the leaves beneath the water should be four times that of the leaves above.

Closely bordering on this question is another which has excited much dispute, viz., the ability of leaves to draw water from the surrounding air or by immersion, after having suffered losses by transpiration. Prof. Boussingault's numerous experiments show that leaves, after having been exposed to influences causing a rapid evaporation, are able to absorb water rapidly on immersion, and even from an atmosphere saturated with aqueous vapour. There is, however, in both cases no absorption unless the leaves have lost a portion of their water of constitution, *i.e.*, that which is essential to their normal existence. Thus, a wilted branch of periwinkle weighing 4·0 grammes, after remaining in an atmosphere saturated with aqueous vapour for a day and a half, weighed 4·2 grammes, and after twelve hours' immersion in water 9·4 grammes.

The last function of leaves studied by Prof. Bous-

Fig. 2

singault is their ability to absorb solutions of mineral matter, *i.e.*, perform another of the ordinary duties of the roots. For this purpose a solution of gypsum containing $\frac{2}{1000}$ of solid matter was used. Drops of this solution were placed on the leaves of a great variety of plants—under conditions favouring absorption, as in the experiments just described—and protected from evaporation by superincumbent watch-glasses with greased edges (Fig. 3).

In most instances the drops were absorbed entirely, leaving no traces of the mineral matter; in some cases a slight residue was left, which the addition of a minute

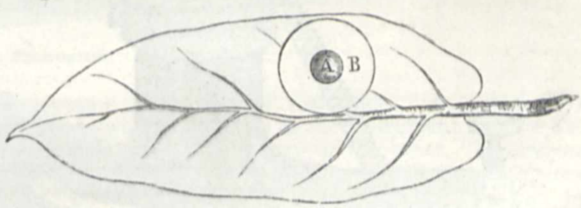

Fig. 3.—A, drop of solution; B, watch glass.

quantity of water caused to disappear. As in the case of pure water, the under side of the leaves absorbed much more rapidly than the upper side. Solutions of sulphate and nitrate of potassium gave quite similar results; the absorption of solutions of chloride of sodium and nitrate of ammonium was not so perfect. These results would tend to show that the foliage of a plant is able to supply it with perhaps no small portion of its saline constituents by means of the ammoniacal salts formed in the air, and the alkaline and earthy salts suspended there which are deposited on the surface of the leaves by rain and dew. T. H. N.

EDISON'S INVENTIONS

THE fertility of Mr. Edison's inventive genius has frequently been referred to recently, though the attractive and popular nature of the phonograph has had the effect of throwing some almost equally important inventions into the shade. We propose, with the aid of the *Scientific American*, copies of which have been sent us by Mr. Edison, to draw attention to a few of these other inventions; the illustrations which we are able to give have also been kindly sent us by Mr. Edison himself.

Mr. Edison's laboratory, in size and external appearance, resembles a country church. The interior, however, is not so church-like. The first apartment is a reception room, on the right of which is the private office, containing a large library of scientific works. Beyond these there is a large room containing materials and a number of glass cases filled with physical and chemical apparatus.

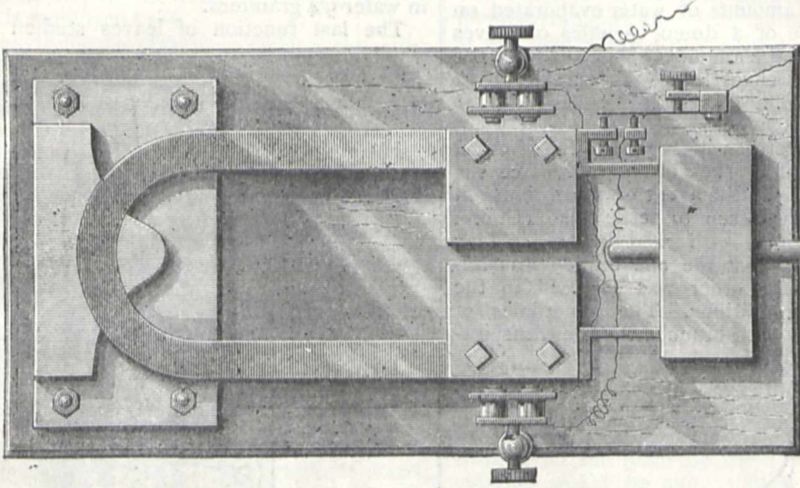

FIG. 1.—Edison's Harmonic Engine.

The machine shop at the rear is furnished with the best of machinery and tools, and is kept constantly in operation in carrying out the plans of Mr. Edison. On the second floor there is a single spacious room, which is the laboratory proper. Here, upon the walls, are shelves which are thickly studded with bottles, jars, and boxes, containing a multitude of substances, both common and rare. It is said to be a chronic habit of Mr. Edison to purchase every newly discovered substance, so that it will be at hand should it be required. Here also is the carbon relay, the progenitor of all existing carbon telephones, "microphones," and other instruments dependent on the changeable conductivity of carbon under a varying pressure.

One of the earlier of Mr. Edison's inventions is the electro-motograph; a telegraphic instrument in which

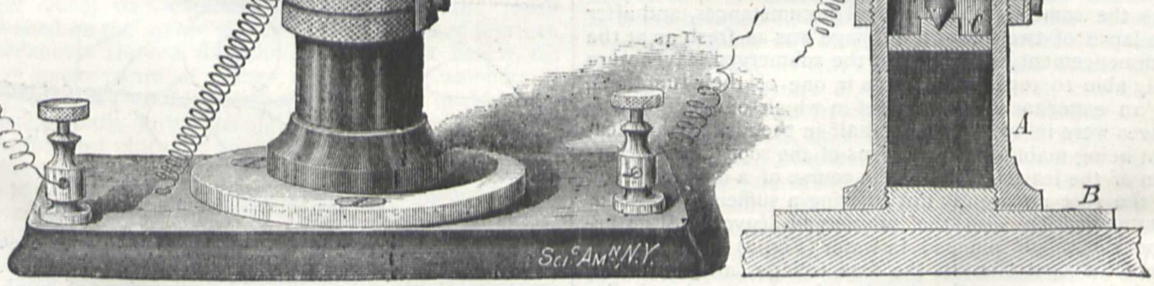

FIG. 2.—Edison's New Carbon Rheostat.

the sounder is operated without magnets. A strip of chemically prepared paper is laid upon a metallic surface, which is connected with one of the battery wires, and a platinum faced spring which is attached to the other battery wire is taken in the hand and pressed firmly on the paper strip; at the same time force is applied in the direction of the length of the strip. A telegraph key is placed in the electric circuit, and when the current passes through the paper the salt contained by it is instantly decomposed, so that it acts as a lubricant, permitting the spring to slide easily on the paper while the current passes, but immediately the current is broken the friction is sufficient to stop the spring.

The best solution for saturating the paper is made by dissolving 1 lb. of sulph. soda in 1 gallon of water. Any of the sodium salts will answer.

Electricity as a motive power, until now, has been a comparative failure, as 90 per cent. of the battery has been wasted. Mr. Edison has devised a novel electrical machine which he calls the harmonic engine, in which 90 per cent. of the power is realised. With two small electro-magnets and three or four small battery cells, sufficient power is generated to drive a sewing machine or pump water for household purposes. This engine, which is represented in Fig. 1, consists of a fork $2\frac{1}{2}$ feet long, made of 2-inch square steel. The curved part of the fork is firmly keyed in a solid casting which is bolted to a suitable foundation, and to each arm of the fork is secured a 35 lb. weight. Outside of and near the end of each arm is placed a very small electro-magnet. These magnets are connected with each other, and with a commutator that is operated by one of the arms. The arms make thirty-five vibrations per second, the amplitude of which is $\frac{1}{8}$ inch. Small arms extend from the fork arms into a box containing a miniature pump having two pistons, one piston being attached to each arm. Each stroke of the pump raises a very small quantity of water, but this is compensated for by the rapidity of the strokes. Mr. Edison proposes to compress air with the harmonic engine, and use it as a motive agent for propelling sewing machines and other light machinery. The power must be taken from the fork arms so as not to affect the synchronism of their vibrations, otherwise the engine will not operate.

In quadruplex telegraphy it is vital to the working of the system to perfectly balance the electrical current. The common method of doing this is to employ a rheostat containing a great length of resistance wire, more or less of which may be thrown into or cut out of the electrical circuit by inserting or withdrawing plugs or keys. This operation often requires thirty minutes or more of time that is or might be very valuable. To remedy this difficulty

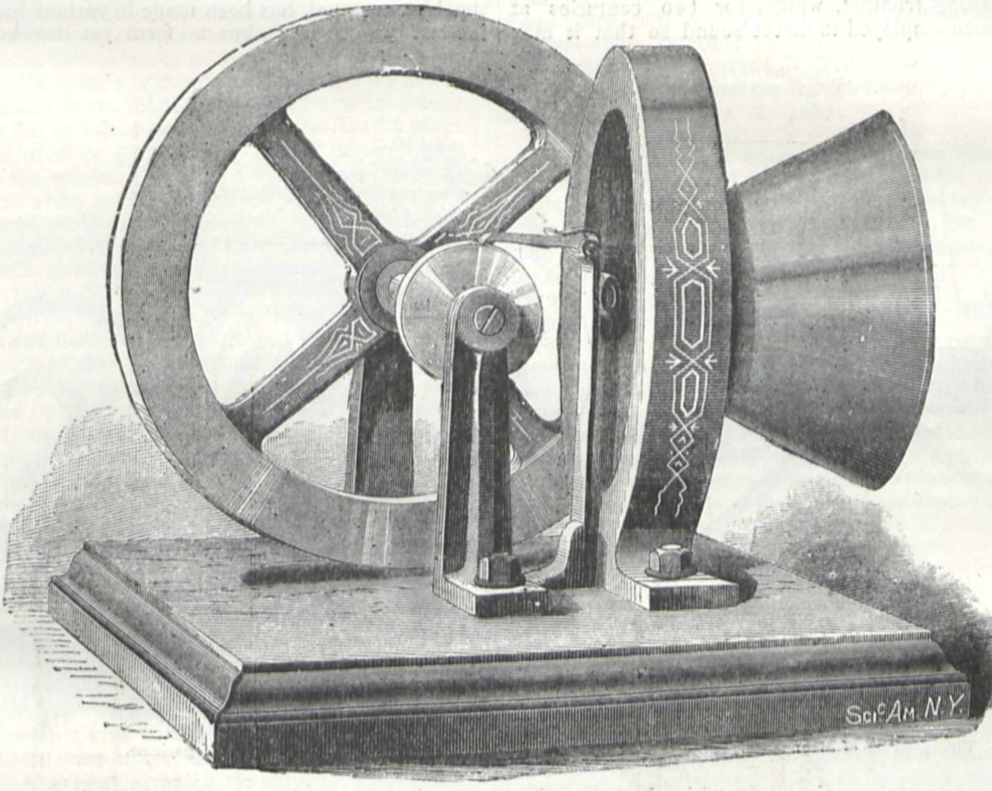

Fig. 3.—Edison's Phonometer.

Mr. Edison has devised the instrument represented in Fig. 2, 1 being a perspective view and 2 a vertical section. A hollow vulcanite cylinder A is screwed on a boss on the brass plate B. Fifty disks—cut from a piece of silk that has been saturated with sizing and well filled with fine plumbago and dried—are placed upon the boss of the plate B, and are surmounted by a plate C, having a central conical cavity in its upper surface. A pointed screw D passes through the cap E at the top of the cylinder A, and projects into the conical cavity in the plate C. The screw is provided with a disk F, having a knife edge periphery which extends to the scale G, and serves as an index to show the degree of compression to which the silk disks are subjected. The instrument is placed in the circuit by connecting the cap E with one end of the battery wire and the plate B with the other end.

The principle of the instrument is identical with that of Mr. Edison's carbon telephone. The compression of the series of disks increases conductivity; a diminution of pressure increases the resistance. Any degree of resistance within the scope of the instrument may be had by turning the screw one way or the other. In this instrument the resistance may be varied from 400 to 6,000 ohms, and any amount of resistance may be had by increasing the number of silk disks.

The thermo-telephone, although at present without special practical value, is certainly a novelty. It consists of a thermopile having placed in its collecting funnel a hard rubber disc. A sound made in front of this disc is heard in a receiving telephone connected with the thermopile.

The *rationale* of this is at once apparent when a strip of hard rubber is placed against the lips and bent, so that the strip will be alternately concave and convex. The difference in temperature is very perceptible, the convex surface being cold and the concave surface warm, and, however rapid the vibrations which render the surfaces alternately convex and concave, the result is the same.

Mr. Edison, in his telephone and phonograph experiments, discovered that the vibrations of the vocal chords were capable of producing considerable mechanical effect. Acting on this hint, he began experiments on a phonometer, or instrument for measuring the mechanical force of sound-waves produced by the human voice. In the course of these experiments he constructed the machine shown in Fig. 3, which exhibits the dynamic force of the voice. The machine has a diaphragm and mouth-piece similar to a phonograph. A spring which is secured to the bed piece rests on a piece of rubber tubing placed against the diaphragm. This spring carries a pawl that acts on a ratchet or roughened wheel on the fly-wheel shaft. A sound made in the mouth-piece creates vibrations in the diaphragm, which are sufficient to propel the fly-wheel with considerable velocity. It requires a surprising amount of pressure on the fly-wheel shaft to stop the machine while a continuous sound is made in the mouth-piece.

The speaking trumpet, which, for two centuries at least, has been employed to direct sound so that it may be heard over a long distance, is much used at sea, and is often employed on land to direct vocal sounds so that they may be heard above other sounds. It is tolerably certain that the speaking trumpet is of modern origin, and that it is the invention of Samuel Moreland, 1670.

Kircher, in his "Ars Magna et Umbra" and in his "Phonurgia," mentions a kind of gigantic speaking-trumpet, described as the horn of Alexander. According to Kircher, this horn enabled Alexander the Great to call his soldiers from a distance of ten miles. The diameter of the ring must have been eight feet, and Kircher conjectures that it was mounted on three poles.

Late in the last century Prof. Huth, a German, made a model of the horn, and found that it served as a powerful speaking-trumpet, but we are considerably in doubt as to the distance through which sounds can be projected through such an instrument.

The ear-trumpet, which is the counterpart of the speaking-trumpet, has been made in various forms during the last two centuries, but no form yet devised has any

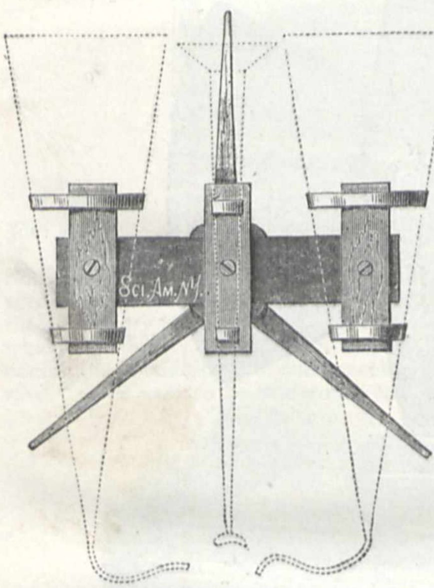

FIG. 4.—Plan of Megaphone.

FIG. 5.—Edison's Megaphone.

advantage over a plain conical tube with a bell-shaped or flaring mouth.

Mr. Edison, in his researches on sound, has made many curious experiments, one of the most interesting of which is that of conversing through a distance of 1½ to 2 miles with no other apparatus than a few paper funnels. These funnels constitute the megaphone, an instrument wonderful both for its simplicity and effectiveness. In the plan, Fig. 4, the details of construction are clearly shown, and Fig. 5 represents the instrument as it stands on the balcony of Mr. Edison's laboratory. A mile and a half distant there is another instrument exactly like the one in Fig. 5.

The two larger funnels are 6 feet 8 inches long and 27½ inches in diameter at the larger end. These funnels are each provided with a flexible ear-tube, the end of which is placed in the ear. The speaking-trumpet in the middle does not differ materially from the ordinary ones. It is a little longer and has a larger bell mouth. With this instrument conversation can be readily carried on through a distance of 1½ to 2 miles. A low whisper, uttered without using the speaking-trumpet, is distinctly audible at a thousand feet, and walking through grass and weeds may be heard at a much greater distance.

These statements, it must be understood, are given on the authority of the *Scientific American*, but some experiments lately made with a paper megaphone by Prof. Barrett lend them strong support

COLOUR BLINDNESS IN RELATION TO THE HOMERIC EXPRESSIONS FOR COLOUR

IN an article on "The Colour Sense" in the number of the *Nineteenth Century* for October last, Mr. Gladstone points out certain peculiarities, very remarkable and very difficult to account for, in the expressions for colour used by Homer. "Although," he says, "this writer has used light in its various forms for his purposes with perhaps greater splendour and effect than any other poet, yet the colour adjectives and colour descriptions of the poems are not only imperfect but highly ambiguous and confused." And again—"We find that his sense of colour was not only narrow, but also vague, and wanting in discrimination."

The article is an expansion of a chapter in the same author's "Studies on Homer and the Homeric Age," published in 1858 (vol. iii. page 457), from which the proposition is quoted; "That Homer's perception of the prismatic colours, or colours of the rainbow, and *à fortiori* of their compounds, were, as a general rule, vague and indeterminate." Mr. Gladstone gives many examples illustrating these opinions, and by powerful and ingenious reasoning, he endeavours to establish from them the general conclusion that "the organ of colour was but partially developed among the Greeks of the heroic age."

I have no intention of disputing this conclusion, in favour of which no doubt much may be said, but I think it may be worth while, on scientific grounds, to point out how remarkably the anomalies and imperfections in question correspond with those that might be expected to arise if the writer were assumed to be *colour blind*.

Mr. Gladstone makes some allusion to the possibility of a defect in the poet's organisation; but it appears to me that, probably from the facts connected with colour blindness not being fully known to him, he hardly gives this point the attention it deserves. In his earlier essay he expresses the opinion that such a supposition "cannot be resorted to, when we bear in mind Homer's intense feeling for form, and when we observe his effective and powerful handling of the ideas of light and dark." From this remark it is clear that Mr. Gladstone was unaware of the fact that colour blindness can, and usually does, co-exist with a perfect feeling for form, and with as vivid ideas of light and dark as are possessed by the normal-eyed. In the later article he mentions the defect more specifically, and refers to Prof. Wilson's book on the subject (published in 1855), but he does not add anything to the argument, and appears to leave the point still open to discussion, when further data can be supplied.

In 1856 I presented to the Royal Society a paper on Colour Blindness, which was afterwards published in the *Philosophical Transactions*, vol. 149, p. 323. Its object was to state my own case (which happens to be one of the most decided on record) and to show that the general phenomena attending this defect of vision were more simple, uniform, and consistent than was generally supposed.

Before I wrote that paper the general impression was that, although there were certain broad particulars in which the sensations of different colour-blind patients agreed, yet there were many varieties of the defect, differing much in character as well as in severity, each being denoted by its own peculiar symptoms, and each, therefore, requiring special classification. Prof. Elie Wartmann, of Lausanne, whose paper on the subject was published in England in 1846, held the opinion that there were as many varieties of the defect as of individuals affected with it, so that no classification was possible. Dr. Wilson did not go so far as this, but he considered the cases as varying much in degree, and he inclined strongly to the opinion that the most severe form of the defect was very rare.

To illustrate the great variety of mistakes made by the colour blind, and to show the confusion resulting therefrom, I gave the following list of "symptoms" which had been observed in various patients, and which were all combined in my own case:—

Blue and yellow are always perfectly distinguished, even in their lighter or darker tones, and are never confounded with each other.

Only these two colours are seen in the solar spectrum, the blue corresponding to the more and the yellow to the less refrangible rays. The red space is seen as yellow.

Red, though frequently identified in certain cases, is often confounded with black, white, or grey, with orange, with yellow, with green, with brown, with blue, and with violet. Crimson and pink have no relation to the red of vermilion.

Green is a colour most perplexing to the patient, who cannot be said generally to manifest any definite sensation about it at all. It is confounded not only with red, but also with black, white, or grey, with orange, with yellow, with blue, with violet, and with brown.

Orange is confounded with yellow; violet is confounded with black or grey, and with blue.

No wonder that philosophers should have despaired of finding any reasonably simple diagnosis for such a heterogeneous mass of symptoms; it was, however, my object to show this could be done. By a long and careful study of my own sensations, aided by a masterly suggestion of Sir John Herschel's that had been published shortly before, I found, in the first place, that notwithstanding the apparent variety of the symptoms in different persons, the defect was uniform, or nearly so, in all; and in the second place, that in spite of the apparent complexity of the phenomena, this defect was of a very simple character. I believe the explanations I gave have been generally accepted, and subsequent experience has amply confirmed them.

As few people have a clear understanding what Colour Blindness really means, and as without such an understanding it would be impossible to make my remarks intelligible, I must ask leave to describe the defect as briefly as I can, referring to the *Philosophical Transactions* for fuller details and demonstrations.

In the first place we see white and black, and their intermediate or compound grey (provided they are free from alloy with other colours), precisely as others do.

Secondly, there are two colours properly so called, namely, yellow and blue, which also, if unalloyed, we see, so far as can be ascertained, in the normal manner.

But these two are the *only* colours of which we have any sensation; and hence the defect has been given by Sir John Herschel the scientific name of *dichromic vision*.

But now comes the difficulty of the explanation. It may naturally be asked: Do we not *see* objects of other colours, such as roses, grass, violets, oranges, and so on? And if we do see them, what do they look like? The answer is that we do see all such things, but that they do not give us the colour sensations correctly belonging to them; their colours appear to us varieties of the other colour sensations which we are able to receive.

This will be best explained by examples. Take first the colour red. A soldier's coat or a stick of red sealing-wax conveys to me a very positive sensation of colour, by which I am perfectly able to identify, in a great number of instances, bodies of this hue. If, therefore, the investigation of my experience ended here, there would be no reason to consider me blind to red, or as having any grave defect in my vision regarding it. But when I examine more closely what I really do see, I am obliged to come to the conclusion that the sensation I perceive is not one that I can identify separately, but is simply a modification of one of my other sensations, namely, *yellow*. It is, in fact, a yellow shaded with black or grey—a darkened yellow, or what I may call yellow brown. I find that all the most common hues of red correspond with this description, and in proportion as they are more scarlet or more tending towards orange, the yellow I see is more vivid. The explanation, I suppose, is, that none of such reds are pure, they are combinations of red with yellow; so that I see the yellow element of the combination, while the true red element is invisible to me as a colour, and acts only as a darkening shade.

I obtain a further proof of this by the change of sensation when the hue of red is altered. I find that as the colour approaches crimson the yellow element becomes fainter and the darkening shade more powerful, until very soon the yellow disappears, and nothing but a grey or colourless hue is presented to my eye, although the colour is still a positive and powerful red to the normal-eyed. So that there is a hue of red which as a colour is absolutely invisible to the colour-blind.

If I go on beyond this point and take reds that pass from crimson towards the hue called lake, I see my other colour come in, a faint blue, which increases till violet is reached, when it becomes more decided.

Violet is understood, I believe, to be a compound of blue with red, and accordingly, the red element being invisible to the colour-blind, violet hues generally appear to them only as darkened blue. There are, however, examples where, from the red being very strong, the blue appears to lose its effect, and the impression given is colourless, black, or grey. They correspond, in fact, with the neutral red before described, although still called violet or purple by the normal-eyed. This latter effect is much enhanced under the artificial light of gas or candles.

A similar explanation will apply to orange, a combination of red and yellow, in which the yellow only is perceived.

The appearance of green to the colour-blind corresponds exactly to that of red; green in its true aspect is invisible to them, and consequently when neutral, *i.e.*, unmixed with any other colour, it presents to their eyes he appearance of grey. When, however, it is mixed with yellow (and most of the greens in nature are yellow greens) they see the yellow only, but diluted or darkened by the invisible green element. And in the less frequent cases where the green is mixed with blue, they see the blue only, in like manner.

It may now easily be understood how it is that so simple a defect of vision gives rise to so complex a series of symptoms as those already described.

Take first the colour red. If it is a scarlet variety, as the majority of reds are, presenting the appearance of yellow to the colour blind, they may naturally confound it with the latter colour, as well as with orange, with yellow green, and with brown, all which cause to them the same sensation. If, on the other hand, the red contains a predominance of blue, it may be confounded, on the same principle, with blue or violet. If it is a neutral red, lying between the two, it will be confounded with black or grey. A pale pink, though very distinctly coloured to the normal-eyed, often offers so little colour to the colour-blind as to be mistaken for white, or very light grey.

The same explanation will apply to green. Its yellow varieties may be confounded with red, orange, yellow, and brown, its blue varieties with blue and violet, and its neutral hue with black or grey, or if very pale, with white.

The confusion of orange with yellow, and of violet with blue, black, and grey, have been already sufficiently explained.

I must now go on to show how the hypothesis of Colour Blindness may serve to explain or account for the anomalies in Homer's descriptions of colour. It is out of my province to meddle with any questions of classical scholarship, I adopt all Mr. Gladstone's critical nterpretations, and I suppose I need not desire a higher authority. It will be convenient to refer to his two essays indiscriminately, using the letter N. for the article in the *Nineteenth Century*, and H. for the chapter in the Studies on Homer.

Before going into any detail I may notice the general classification which Mr. Gladstone (H. 458, &c.) has given of the Homeric peculiarities, and it is impossible not to see, at a glance, how exactly this corresponds with what might be expected from the colour-blind.

I. The paucity of Homer's colours. Excluding black and white, Mr. Gladstone reduces them to four, intimating, however, in the following sentence, that even this number is too many.

The colour-blind list is limited to two.

II. The use of the same word to denote not only different hues or tints of the same colour, but colours which, according to the normal-eyed, are essentially different.

This is the *shibboleth* of the colour-blind defect.

III. The description of the same object under epithets of colour fundamentally disagreeing one from the other.

Mr. Gladstone only names three instances, referring to iron, to the dragon, and to a thunderbolt, none of which appear to me to be very conclusive; but since a colour-blind person may, with perfect correctness according to his own sensations, describe grass as either green, red, orange, or yellow, the defect will amply account for this peculiarity.

IV. The vast predominance of black and white; and

V. The slight use of colour, as compared with other elements of beauty for the purpose of poetic effect, and its absence in certain cases where we might confidently expect to find it.

Nothing can be more natural than this, in the case of a writer to whom the great mass of colours in nature are invisible.

When we go into detail, and review the instances Mr. Gladstone has given of Homer's particular applications of colour adjectives, the correspondence with the colour-blind hypothesis becomes much closer and more conclusive.

As a general preliminary, let us ask what such a writer, if colour-blind, might be expected to do? How would he be likely to use his epithets of colour?

In the first place he would be certain to use them incorrectly, that is, in a way not consistent with the ideas ordinarily attached to them. He must adopt words in ordinary use; but he can form no proper idea of their meaning, and, as the objects they apply to appear under totally different aspects to him, his use of the words must necessarily be confused and often inappropriate. This may be particularly looked for in regard to red and green; terms which, although conveying ideas so positive and unmistakable to the normal-eyed, have to the colour-blind no definite signification at all.

But secondly, there ought to be a certain consistency and intelligibility in his use of the terms when viewed in regard to his own sensations; and if my view of the simple and uniform character of the disease be correct, we ought to be able, knowing what these sensations are, to form a tolerable idea how colour epithets would be applied so as to accord with them.

Omitting all considerations of white, black, or grey, and confining ourselves to colour proper, we know that every coloured object in nature presents to the colour-blind person one of two sensations, either that of yellow or that of blue, modified in tone or shade, as I have described. These are positively distinct from each other, and are never confounded. We therefore ought to expect that the colour-epithets used by such a person should be found capable of being arranged in two groups or classes, one corresponding to the yellow sensation, the other to the blue sensation. The various words in either group may have very different meanings to the normal-eyed, but if they all convey the same sensation to the colour-blind person, he may be expected to use them indiscriminately. And, moreover, he ought never to apply a word belonging to one class or group, to an object belonging to the other group; if he did he would fail in the consistency to his own sensations which I am now insisting on. For example, if a person applied the word "orange," a word belonging to the yellow group, to lapis lazuli, or the violet flower, which, on the colour-blind hypothesis ought to convey to him the idea of blue, the error, although not appearing worse to the normal-eyed than calling grass red, would be altogether inconsistent with the proper colour-blind sensations, and would prove that such a person had not dichromic vision in the sense here intended.[1]

It may further be remarked that, as the colour-blind person finds the yellow sensation much predominating in what he sees, and as he will have observed that it corresponds to a larger number of ordinary colour-words than the blue sensation, his vocabulary for this group will be naturally more copious than for the opposite one.

WILLIAM POLE

(*To be continued.*)

[1] Some errors might, however, legitimately arise in the use of the words for red and green, from the fact that some hues of these colours give yellow sensations, while others give blue sensations.

CHEMICAL NOTES

ESTIMATION OF MERCURY.—Prof. Clark, of Cincinnati, describes (*Ber. d. deutsch. chem. Gesell.* xi. 1,409) an interesting application of electrolytic decomposition for the purposes of analytical chemistry, viz., in the separation and estimation of mercury. The solution of the mercury salt, acidulated with sulphuric acid, is placed in a platinum vessel, connected with the zinc pole of a Bunsen bichromate battery of six cells. A piece of platinum foil in connection with the carbon pole is dipped into the liquid, and the decomposition commences at once. At first a mercurous salt is precipitated. This is reduced gradually, until, in the course of an hour, it is completely changed into the metal, which requires simply to be separated from the solution, washed, dried, and weighed. Similar methods for the estimation of zinc, nickel, and copper have for some years been in use.

SEPARATION OF ANTIMONY AND ARSENIC.—One of the problems in analytical chemistry awaiting solution is a satisfactory separation of arsenic from antimony. In the last number of Liebig's *Annalen* (vol. 192) Prof. Bunsen presents a new method intended to supersede that hitherto employed, which was discovered by him a number of years since, depending on the treatment of the combined sulphides with sulphurous acid. In the new process the sulphides are dissolved in potash and subjected to the action of chlorine. A quantity of a saturated aqueous solution of sulphuretted hydrogen, sufficient to precipitate the antimony, as Sb_2S_5, is then added, and in the filtrate the arsenic acid is precipitated on heating as As_2S_5 by a long-continued stream of H_2S.

SPECIFIC HEATS OF MERCURY AND IRON.—O. Pettersson and E. Hedelius have recently made careful determinations of the specific heat of mercury and iron in the following manner (*Ofvers. f. Vetensk. Förhandl.*, 37, p. 35):—A piece of wrought iron was heated in an air bath to 26°, and then plunged in baths containing weighed quantities of mercury and water at 0°. The resultant temperatures gave the specific heat of iron as referred, firstly to water, and secondly to mercury, and the division of the first value by the second yielded the specific heat of mercury referred to water. The averages derived from twenty experiments give for the average specific heat of wrought iron between 4° and 27°, 0·10808; and for the specific heat of mercury between 0° and 5°, 0·033266. The authors find that the specific heat of mercury suffers but slight alterations between 0° and 100°.

LATENT HEAT OF WATER AT TEMPERATURES BELOW 0° C.—O. Pettersson (*Ofvers. f. Vetensk. Förhandl.*, 37, p. 53) has lately determined the latent heat of water at temperatures below 0°. For this purpose thin tubes containing water were placed in a mercury calorimeter, cooled to certain temperatures below 0°, and congelation was induced by the insertion of a snow crystal. The latent heat of water at 0° according to Regnault is 79·25. The results obtained by Pettersson at lower temperatures are as follows: − 2·80°, 77·71; − 4·995°, 76·60; − 6·28°, 75·94; − 6·50°, 76·03; − 6·62°, 75·99; all of them coinciding closely with the estimations of the theoretical formula $\frac{\delta r}{\delta T} = c - h$, where r represents the latent heat of fusion, T the absolute temperature, and $c - h$ the difference between the specific heats of the solid and liquid body. Experiments were likewise made with sea water containing 3·536 per cent. of solid matter, and freezing at − 9°. At this temperature pure water would possess a latent heat of 75; the sea water possessed on the contrary but 54, showing that the above proportion of saline matter was sufficient to cause a diminution of 28 per cent. in the latent heat.

PREPARATION OF SALTS OF NITROUS OXIDE.—In the *Journal* of the Chemical Society (clxxxix.) Mr. A. E. Menké describes some of the above salts. In analysing a sample of cast iron an experiment was made attempting the conversion of the phosphorus contained in it by fusion with nitre and sodium carbonate, into an alkaline phosphate. During the operation a bulky yellow precipitate was obtained which proved to be, not a phosphate, but identical with the body obtained by Dr. Divers in the action of sodium amalgam on sodium nitrate. The analysis of the silver salt gave a mean percentage of 78·09 Ag, agreeing therefore with the formula AgNO, which requires 78·26 per cent. Ag. The salt may also be obtained by the simple fusion of iron filings with nitre, the best heat to employ being that of a charcoal furnace. The analysis of the sodium salt obtained by the fusion of iron filings with sodium nitrate gave numbers closely agreeing with the formula $NaNO + 3H_2O$. The substitution of zinc for iron filings failed to produce the body. On acting on the silver salt with ethyl iodide the silver is converted into iodide, and on fractionating the distillate evidence of the formation of an ethereal salt of low boiling point is obtained.

ON MANGANESE TETRACHLORIDE ($MnCl_4$).—Some doubt still existing with regard to the decomposition of manganese oxides higher than the dioxide MnO_2, Mr. W. Fisher has recently made experiments bearing upon this point. The oxides employed are the sesquioxide, Mn_2O_3, and the red oxide of manganese, Mn_3O_4. The analyses of the liquids obtained by the action of the acid on the different oxides were made by decomposing the freshly-prepared solutions with potassium iodide, and then titrating the amount of iodine liberated in each case with sodium hyposulphite. From his experiments Mr. Fisher finds that the higher oxides when treated with excess of acid give a brown liquid containing a highly chlorinated manganese compound easily resolved into manganous chloride and free chlorine, and on dilution with water yielding manganese binoxide in both instances. The solutions appear to be identical, probably containing $MnCl_4$ in each. Under the conditions of the experiment the corresponding chlorides, Mn_2Cl_6 and Mn_2Cl_8, do not appear to be formed from their corresponding oxides, nor do they appear as products of the partial dechlorination of the tetrachloride. The action of the acid on the two oxides the author considers may be represented by the formulæ—

$$Mn_2O_3 + 6HCl = MnCl_2 + MnCl_4 + 3H_2O,$$
$$Mn_3O_4 + 8HCl = 2MnCl_2 + MnCl_4 + 4H_2O,$$

and as a large excess of acid or alkaline chloride renders $MnCl_4$ more stable, he thinks it probable that this body may exist in a form analogous to chloroplatinic acid.

SPONTANEOUS IGNITION OF HYDROGEN BY FINELY-DIVIDED ZINC.—In dissolving zinc in hydrochloric acid P. W. Hofmann has observed explosions on the surface of the liquid in the vessels employed. These phenomena he describes in a paper in the *Chem. Centr.*, 1878, 351, and explains them by the supposition that the gas in its evolution throws up small portions of zinc, rendered porous by the action of the acid, and that these finely-divided particles coming in contact with the air act like spongy platinum, causing the gaseous mixture to explode. The spontaneous ignition of hydrogen has been observed by others, but no satisfactory explanation has been given of the action.

METEOROLOGICAL NOTES

CAPT. HOFFMEYER has made an original and highly important contribution to our knowledge of the distribution of atmospheric pressure in winter over the North Atlantic, and its influence on the climate of Europe, in the last published number of the *Journal of the Meteorological Society of Austria* (October 15). The contribution takes the form of a rectification of Buchan's isobaric charts for this part of the globe, and, by a most ingenious and able method of investigation, entirely his own, Hoffmeyer conclusively shows that Greenland and Iceland exert a powerful influence on the distribution of atmospheric pressure not hitherto properly recognised, resulting in the mean minimum of pressure being localised distinctly to the south-west of Iceland—a minimum accompanied with two subordinate minima, one in Davis Straits and the other in the Arctic Ocean, mid-way between Jan Mayen and the Lofoden Isles. Four typical charts are also given, showing the actual mean pressure of as many individual winter months, from which it is plain that one or other of these three minima plays the chief roll, the other two being, for the time, subordinate; and that, according as the one or the other of these minima of pressure predominates, so is the character of the weather, as regards its mildness or severity, of the winter of the regions surrounding the North Atlantic, determined.

THE *Report of the Royal Meteorological Institute of Prussia for* 1877 has been received. It is the thirtieth Report, and like all the foregoing Reports, is published by the Royal Statistical Bureau, Berlin, with which the Institute, since its establishment in 1848, has stood in close and uninterrupted connection. Important changes are in contemplation, the most vital of which are the severance of the connection between the Institute and the Statistical Bureau, and the establishment of an independent central direction for meteorology. The Bureau has done a graceful act in presenting with the Report a highly characteristic portrait of the veteran meteorologist and physicist Dove, who has directed the affairs of the Institute since December 9, 1848, and who, by the number and thoroughness of his writings and their breadth of view, deserves of all men to be styled the father of meteorology.

AMONG the separate papers incorporated in this Report is a discussion by Dr. Hellmann of the observations of cloud at Crefeld, being in continuation of the author's researches into the cloud-covering of the sky as influenced by the hour of the day, the season of the year, and geographical situation. The daily maximum occurs at Crefeld, about, or a little before sunrise, from September to April, whereas, from May to August, the maximum is from about 11 A.M. to 3 P.M. The monthly maximum, which holds also for all hours of the day, is December, whilst the month with clearest skies is September. The barometric observations at Berlin for the past thirty years are carefully discussed by Prof. Arndt, from the general results of which it appears that the great summer depression of the barometer which is so characteristic a feature of the climatology of the Europeo-Asiatic Continent, is not shown at Berlin, it being a little to eastwards of Berlin, to which the limits of the western outskirts of this wide-spread barometric depression extend.

THE Dutch Meteorological Institute has issued Wind Charts of the North Atlantic, Series I., including the six months from December to May. The region covered by the charts lies between 51—30° N. lat. and 4—52° W. long., and between 30—8° N. lat., and 13—39° W. long. The frequency of the different winds is graphically shown by radii, the length of each being proportional to the frequency of the particular wind it represents. Instead of grouping the observations into 5° squares and into seasons as has been generally done, Dr. Buys Ballot has presented the facts on the charts for each 1° square and for each month, the object being to lay down the geographical position of the winds of this region, so important to navigators as well as men of science, with the closest approach to truth and least possible admixture of hypothesis.

IN a circular letter addressed to the Permanent Committee on Meteorology, Prof. Hildberandsson invites the co-operation of all meteorologists to the carrying out of a more systematic observation of the upper currents of the atmosphere than has yet been attempted. Hitherto the observation of the upper clouds and the directions in which they march, has been confined to isolated observers whose services were enlisted through the enthusiasm of individual meteorologists. But fragmentary and scattered though the observations have necessarily been, the results fairly deduced from them are of so important a nature from their bearings on the great problem of atmospheric circulation, that we have no hesitation in giving our hearty support to Prof. Hildebrandsson's proposal that the meteorological societies and observatories make observations of the movements of clouds, chiefly of the upper clouds, part and parcel of their regular observations, and that the results regularly appear in their publications.

THE great storm of September 15-16, so widely and so severely felt, deserves to be specially noticed on account of the low barometers accompanying it, which were not only exceptionally low for the season but even exceptionally low for any season of the year. From the observations made at the stations of the Scottish Meteorological Society in the north and north-west it is seen that at Thorshavn, Farö, the barometer at 32° and sea-level fell at 9 P.M. of the 15th to 28·058 inches, being the lowest point to which it fell, and about that time the wind shifted from south-east to north-west. At Stornway the barometer fell to its lowest, 28·400 inches at 7 P.M., or two hours earlier than in Farö; at the same hour it fell to the lowest point, 28·457 inches, at Monach lighthouse, the wind at this time attaining its maximum violence during the storm; at Sandwick to 28·404 at midnight; and at North Unst lighthouse it fell during the night to 28·305 inches. Heavy showers with thunder and lightning and heavy continued rain occurred in the North-west Highlands, nearly an inch of rain falling in less than an hour at Portree on the morning of the 15th, and 10·57 inches at Glenquoich during the six days beginning with the 14th.

GEOGRAPHICAL NOTES

THE Gothenburg *Handels Tidning*, of the 16th inst., contains a telegram from Irkutsk, addressed to Mr. Oscar Dickson by Prof. Nordenskjöld, announcing that he had reached the mouth of the Lena on August 27, after having passed Cape Chelyuskin, without meeting with any noteworthy obstacle from ice, and that the voyage would be continued towards Behring's Straits with the highest hopes of success. It is probable that Prof. Nordenskjöld's anticipations have been by this time realised, that the *Vega* has reached Behring's Straits, and thus successfully accomplished the North-East Passage. News has also arrived that the *Lena*, a small steamer which accompanied the *Vega*, has ascended the river of the same name, having arrived at the town of Yakutsk on September 22.

DR. GERHARD ROHLFS had finally fixed his departure from Malta for the 20th instant. He will be accompanied by two Austrian travellers, Dr. Hecker, and Herr von Csillagh. The party will first go to Tripolis, and direct their principal efforts to the investigation of the Shari River, and of the sources of the Binue and Congo Rivers.

CAPT. TYSON, having arrived at St. John's, Newfoundland, has sent a telegram to Washington stating that his voyage has been quite successful, and every part of the task imposed upon him has been accomplished. Capt. Tyson learns with deep regret that all has been rendered useless by the postponement of the definitive expedition.

ON reference to a map of China lately published by Mr. Stanford for the China Inland Mission, it will be seen that the missionaries of that body have for some years past been emulating their Roman Catholic brethren in the energy with which they have pushed their way into various parts of the empire. One of the most remarkable journeys, an account of which has but lately become available, was performed principally on foot, by Mr. John McCarthy, who left Shanghai in December, 1876, and reached Bhamô on August 26, 1877, having travelled a distance, including detours, of about 3,000 miles. Mr. McCarthy, though taking a somewhat different course, made the same journey as the Grosvenor Mission, and he claims to be the first non-official traveller who has thus traversed the entire width of the empire, and crossed the Kah-chen hills to Bhamô. Wearing the Chinese dress, and having nothing strange or novel with him, he was able to move along without any difficulty through the various towns and cities, and it is certainly worthy of note that throughout the whole of his long and hazardous journey he was not once obliged to appeal to an officer for help of any kind, and in no case did any officer put an obstacle in his way. The country, as far as the great commercial mart of Chungking, in Szechuen, is now comparatively so well known, that that part of Mr. McCarthy's journey was tolerably easy, but after leaving Chungking the case is different. Circumstances induced him to make for Kweiyung-fu, the capital of Kweichow; he found that the country due south of Chungking was not at all to be compared with the eastern portion of Szechuen, large tracts of land being uncultivated, towns fewer, the people more scattered, and worse housed and clothed. It would be difficult, he says, to picture the desolation of a great part of the Kweichow province; in consequence of the many years' internal strife, whole districts having been entirely depopulated. After a fortnight's stay in Kweiyang-fu Mr. McCarthy decided to walk westward, as far, at least, as Yünnan-fu, being anxious to test the feelings of the people towards foreigners. The people everywhere continued civil, and no more difficulties were met with in Yünnan than in previous portions of the journey. On the road between Yünnan-fu and Tali-fu Mr. McCarthy remarks that "the people generally are in a deplorable condition: the women compelled to do manual labour, which in other places is confined entirely to men. Men and women—but especially the latter—suffer from the formation of goitre, some of immense size." From Tali-fu to Têng-yüeh, or Momien, Mr. McCarthy says, is really the most fertile part of the country. Yungchang-fu, between these places, has been a fine city, and even now the southern part is well built over, and a good deal of business is done there. Mr. McCarthy found that the fame of the medical work at Bhamô had spread even to Momien, and during the four days' walk to Manwyne he met many Shans and Chinese who spoke approvingly of the wonderful cures effected by the foreign teachers. Having secured the services of a chieftain he crossed the hills in two days, and arrived at Bhamô in safety. This Kah-chen chief and his followers professed the greatest friendship for the English, and treated Mr. McCarthy so well that he agreed to return with him in a fortnight, in order to continue his journeys in Yünnan. This plan, however, he was obliged to give up, as he was informed by our political agent at Bhamô that he could not be allowed to re-enter China from Burmah, that being forbidden by the Indian government!

THE Wesleyan Missionary Society have recently received some very satisfactory intelligence in regard to the attitude of the natives towards foreigners in a part of Central China where they had probably never been seen before. Writing from Kwang Chi, Hankow, under date of June 7, the Rev. Thos. Bramfit says, in describing a missionary tour, that, "as Lo Tien, Ma Tsien, and the other towns have not been visited before, the people came out in crowds to see the foreigner, and to hear his doctrine; and it is to be recorded to their credit that without exception they treated us kindly, and seem inclined to give the truth a fair hearing. It may be that the Chefoo Convention has something to do with the change in the temper of the people, as compared with that in other places when first visited; but it struck us that the change is to be accounted for chiefly by the increased intercourse between the people and foreigners."

THE French Government have sent M. Léon Cahun, well known from his researches in Eastern Europe and in Central Asia, to Cyprus, on a special mission, in order to investigate the island in an anthropological and archæological direction.

NOTES

THE death is announced, on the 13th inst., of M. Delafosse, Professor of Mineralogy in the Paris Museum of Natural History and the Faculty of Science.

WE have received a "first proof" of the list of awards made to British exhibitors, from which we cull the following items:—A Grand Prix and Diplôme d'honneur have been awarded, in Class 8, Organisation, Methods and Appliances for Superior Instruction, to South Kensington; in Class 15, Mathematics and Philosophical Instruments, gold medals have been awarded to Mr. J. H. G. Dallmeyer, Mr. Howard Grubb, Messrs. A. Léqé and Co., Messrs. Negretti and Zambra, Messrs. Ross and Co., and Sir William Thomson; in Class 16, Maps and Geographical and Cosmographical Apparatus, a gold medal has been awarded to Mr. Edward Stanford; in Class 65, Telegraphic Apparatus and Processes, a Grand Prix is awarded to Prof. A. Graham Bell, for his magneto-electric telephone, without electric current; in Class 67, Navigation and Life Saving, a gold medal to Sir William Thomson, for his compass.

THE Council of the Meteorological Society have arranged for a course of six lectures on meteorology to be given at the Institution of Civil Engineers, 25, Great George Street, Westminster, on successive Thursday evenings, commencing on the 31st instant at eight o'clock. The first lecture will be by Dr. R. J. Mann, on the "Physical Properties of the Atmosphere." The other lectures will be by J. K. Laughton, F.R.A.S., R. Strachan, F.M.S., Rev. W. Clement Ley, M.A., F.M.S., G. J. Symons, F.R.S., and R. H. Scott, F.R.S. Admission to the lectures will be by ticket only, which may be obtained free on application to the Assistant Secretary at the office of the Society, 30, Great George Street.

IN a lately-issued number of the *Proceedings* of the American Philosophical Society, Prof. Cope has given an account of the collection of fishes made by Prof. Orton at various points on the head-waters of the Amazon. Species of the genera *Belone* and

Tetrodon—characteristically marine forms—are here recorded as having been obtained in these districts 2,500 miles from the mouth of the river—thus showing how far marine animals will penetrate into, and become ultimately acclimatised in, fresh waters.

THE existence of the true heath plant in North America was for a long time considered very doubtful, and its detection in New England some years ago is a matter of much interest. The published localities hitherto are Newfoundland, Nova Scotia, and Massachusetts, but, according to the *Bulletin* of the Torrey Botanical Club, Dr. Hexamer, of Newcastle, has lately found a few plants of it near Egg Harbour, New Jersey.

PROF. MORSE, since his return to Japan, has been diligently engaged in prosecuting investigations into the natural history and archæology of the coast region. During his summer's stay at Yezzo he brought together a large material of the most interesting character, the transmission of a portion of which to American museums, it is hoped, he will be able to bring about.

THE operations of the United States Fish Commission a Gloucester, Massachusetts, were brought to a close, so far as the deep-sea research was concerned, on September 26, on which day the last trip of the United States steamer *Speedwell* was made. This vessel, under the command of Capt. L. A. Beardslee, of the navy, has been diligently occupied since the middle of July in her work, and has made trips of greater or less extent, varying from five to fifty miles, nearly every suitable day during the summer. With an efficient corps of naturalists, consisting of Prof. A. E. Verrill, Mr. Richard Rathbun, and Prof. Sanderson Smith for the marine invertebrates, Dr. W. G. Farlow for the algæ, Prof. G. Brown Goode, Dr. T. H. Bean, and Mr. Earll for the fishes, and Mr. Asaph Hall, Jun., in charge of the temperature observations, very important results have been secured, the location and extent of important fishing banks have been ascertained, and existence established, of many new and important fishes and invertebrates. A full account of these will be published in the annual report of the commission. The existence of species of shark, chimæras, and other strange fishes in the deep water off the coast, has been established by numerous specimens, while the corals, gorgonians, star-fishes, and other invertebrates brought in are of the most interesting character. A portion of the commission has also been engaged during the season in collecting numerous facts in regard to the fisheries of Gloucester, especially those relating to the cod, halibut, and mackerel, the report upon which, when published, will doubtless be considered the first reliable statement of the history of this great industry.

IT is desired to enlist the co-operation of botanists in general, and more especially of bryologists, in a scheme set on foot by the Botanical Locality Record Club for investigating the geographical distribution of mosses in the British Isles. The Botanical Locality Record Club was founded in 1873 for the purpose of working out the distribution of British plants, records, accompanied by specimens as vouchers, being sent in by the members and embodied by the recorder in an annual report on the plan of "topographical botany." The club, which commenced with fifty-four members, now contains nearly 100, including some of our most eminent botanists. A large amount of work has been done by the club during the five years that it has been in existence, the floras of several counties previously almost unexplored have been worked out, and a very large number of additions have been made to the flora of many others. Up to the present time the reports have dealt only with the flowering plants and vascular acrogens. In 1875, however, a suggestion was made that the club should include in its field the other orders of cryptogamia, and it is considered desirable that, if possible, this should be carried into effect. It is proposed to start with the mosses, for which order Mr. C. P. Hobkirk, F.L.S., and Mr. H. Boswell have consented to act as recorders. A list of the mosses hitherto recorded in Great Britain, entitled "The London Catalogue of British Mosses," has been drawn up by Messrs. H. Boswell and C. P. Hobkirk, as an aid to collectors, and to secure uniformity of nomenclature. A number of specimens have already been sent in by several members. At present, however, the funds in hand are not sufficient to allow of the publication of a report on mosses without seriously curtailing the report on the flowering plants, which it is not considered desirable to do, especially seeing that bryologists constitute but a comparatively small proportion of the members of the club. If more botanists interested in mosses (say thirty) could be induced to join the club, the additional subscriptions (5*s*. each per annum) would suffice for the publication of a report on mosses. Botanists wishing to join the club are requested to send their names either to Dr. H. F. Parsons, Goole, or C. P. Hobkirk, Huddersfield.

WE are glad to see that the Metropolitan Board of Works have decided to give the electric light a fair trial by making a large and continued experiment along the Victoria Embankment and perhaps the recently freed Waterloo Bridge. The Commission of Sewers have resolved to try similar experiments on the Holborn Viaduct and in the open space in front of the Royal Exchange and Mansion House. We trust proper discrimination will be exercised in making arrangements, and if the interests of the public are alone considered, we can hardly doubt what will be the result.

Engineering has been publishing an interesting series of articles on physical science at the Paris Exhibition. In an article in the last number on the Jablochkoff system of electric lighting, some figures are given as to the total cost of the light from sixteen Jablochkoff candles, which shows it to amount to 8*s*. 6½*d*. per hour. The light of the sixteen candles is estimated by the Jablochkoff Company as equal to that of 1,600 gas-burners, each consuming 3¾ cubic feet per hour, or about 6,000 cubic feet altogether. The price of gas in Paris being 6*s*. 10*d*. per thousand cubic feet to the public and 3*s*. 5*d*. to the Administration of the Ville de Paris, it follows that the cost of illuminating by gas, equal in power to that produced by the Jablochkoff system for 8*s*. 6½*d*., would be 2*l*. 1*s*. to the public and 20*s*. 6*d*. to the Ville de Paris, while in London, taking gas at 3*s*. per thousand, its hourly cost would be 18*s*.

CARRIER pigeons, it would seem, are being turned to useful account in a new direction in Germany, for Consul Ward writes to the Foreign Office that the successful results attained by the establishment of communication between the two Eider lightships and the port of Tönning, in Schleswig, by these means has led to the organisation of a similar arrangement between the light-vessel stationed off the Island of Borkum, at the mouth of the Ems and the island itself, whence any news brought by the pigeons can at once be forwarded by telegraph to the mainland.

SERGEANT JENNINGS, of the Signal Corps of the United States, has established a temporary station in the American section of the International Exhibition, and is practising weather-warning according to the rules of the service, as far as it is possible with his limited knowledge of the peculiarities of the Parisian climate and atmospheric conditions. This has attracted the attention of the public and scientific authorities.

MR. A. CRAIG-CHRISTIE, of Edinburgh, writes to us to say that it occurred to him some little time ago that our common grass, *Molinia cærulea*, might form a good material for paper-making, on account of its tenacity of fibre and the comparatively small quantity of silica in its composition—two characters which distinguish it from all our native grasses. He sent a small quantity of the grass to Mr. Thomas Routledge, of Sunderland, who, after experiment, concludes that, taken as dried and put up carefully in bundles, free from weeds and dirt, its value would be equal to esparto at 5*l*. per ton dry. "I, however," Mr. Routledge states, "must refrain from reporting *positively* as to its value for paper-making from the result of so small an experiment. I should require at least one ton (more would be better) to test it practically and make paper from it. . . It may be worth more than the value I mention, but only a practical working trial into paper can properly test this point." Mr. Christie writes in the hope that some of our landed proprietors may be sufficiently interested in the matter to send Mr. Routledge a quantity of the grass, so as to repeat his experiment on the large scale. The grass grows in the open parts of woods and on moorlands all over Scotland, and could be cultivated where nothing else of any value will grow. As the plant lasts for several years, the only expense after the first outlay would be that of gathering in the crop.

A DESPATCH from Poughkeepsie, dated October 4, gives the particulars of a severe earthquake shock along both sides of the Hudson from Marlborough to Peekskill, a distance of twenty-five miles. The shock was first felt at 2.30 o'clock A.M. at West Point. The shock seemed to come from the north and to pass south. For several seconds the earth seemed to rock, and houses were shaken and windows rattled. The rumbling and shock together lasted half a minute.

IN reference to the article in vol. xviii. p. 620, on the balloon experiments at Woolwich, Mr. Percy Smith writes to remind us of the fact that the first aerial voyage made in England took place on September 14, 1784, when Lunardi ascended from London in a balloon thirty-three feet in diameter, and filled with hydrogen.

M. AMÉDÉE GUILLEMIN, the well-known author of "Le Ciel" and other works on popular astronomy, has been selected by the Liberal-Republican Committee to stand as a candidate in the next elections for the French Senate, for the Department of Saone et Loire. It is stated that a number of scientific men will contend for other vacant seats.

A TELEGRAM from Sydney states that it has now been definitively decided to hold the International Exhibition in August, 1879, as gazetted last February. The Exhibition is being organised under the auspices of the Agricultural Society of New South Wales.

IN connection with the Bristol Museum and Library we have received a syllabus of a course of ten lectures, on literary and scientific subjects, to be delivered in the lecture theatre of the Museum during the winter. The lectures are mostly scientific, and the lecturers men of established eminence in their own departments.

AUSTRIA, Spain, Egypt, China, Morocco, Portugal, Russia, and England, with all her colonies, have presented the French government with all the objects which have been exhibited by them in the ethnographical and pedagogical departments of the exhibition. These invaluable collections will be exhibited in the Ethnographical and Pedagogical Museum, which the French government intends to establish, according to the announcement made by M. Bardoux in one of his last speeches.

THE *Journal Officiel* of the French republic published, on October 19, a decree of the President, appointing a general commission to investigate the means of making the best use of running waters all over France. A systematic inspection will take place. The commission has been divided into the following sections:—1. Irrigation; president, M. Andral. 2. Supply of cities; president, M. Magnin. 3. Creation of reservoirs; president, M. Cocheris. Any person wishing to suggest improvements or useful works is requested to write to the president of the section which his communication concerns. The letters are to be directed to the Ministry of Public Works.

THE number of aeronautical ascents in France is increasing in a most remarkable manner, owing to the splendid working of the Giffard captive balloon. Every Thursday and Sunday two free balloons, inflated with pure hydrogen, have been sent up from the Cour des Tuileries during several weeks. The number is to be enlarged progressively, so that three, four, and at last five mounted balloons will be sent up.

TWO volumes of the *Memoirs* of the Geneva Society of Physics and Natural History have just appeared. The first, forming the second part of vol. xxv. of these *Memoirs*, is occupied entirely by the sixth fascicule of the "Mélanges Orthoptérologiques" of Henri de Saussure, and contains the monograph on the Gryllidæ. The second volume, forming the first part of vol. xxvi. of the *Memoirs*, contains (1) a paper by M. J. E. Duby on new or imperfectly known exotic mosses; (2) a stratigraphical study of the south-west part of the Crimea, by M. Ernest Favre; (3) researches on fecundation among various animals, by M. Hermann Fol.

A FINE elephant tusk was found in the month of August last in a locality near Geneva on a hill to the south-west of the confluence of the Arve and the Rhone. It was taken from a gallery in a very compact sand along with beds of hard and tenacious gravels formed of pebbles bound together by calcareous cement. The part of the tusk which has been extracted is about eighty centimetres long; it is the anterior portion, but the fragments left behind lead to the presumption that its total length exceeded 1·50 m. The bed in which it was found belongs to the old alluvium, several metres below the glacial earth. Prof. Alph. Favre assigns it to the *Elephas antiquus*, of which *débris* were met with in 1786 by H. B. de Saussure in two places in the southern part of the valley of Geneva Lake. A portion of the parenchymatous matter contained in the interior of the tusk has been analysed by Prof. Brun, of the University of Geneva, who, having dissolved it in hydrochloric acid, obtained a residuum of organic particles—charcoal, grains of fecula, spores of algæ and of mushrooms, four species of diatoms still living in the waters of the country, and lastly a polycistina, a silicious form not well determined, and discovered previously in the mud of the Lake of Geneva. From the presence of these Prof. Brun concludes that the elephant's tusk must have been a long time in fluviatile waters.

A THIRD mathematical tract (Invariants) for American students is now being written by Dr. W. J. Wright, recently Professor of Mathematics at Wilson College, Pa. The previous tracts, which we have noticed in these columns, bore the titles of Determinants, Trilinear Co-ordinates.

ON August 29, 1879, a century will have passed since Johann Jakob von Berzelius, the celebrated chemist, was born at Westerlösa, in Sweden. The Swedish papers draw attention to this fact, and request that preparations for a dignified celebration of that day should be made in good time.

WE have received three parts (containing the concluding chapters) of the second edition of Herr F. von Hauer's work, "Die Geologie und ihre Anwendung auf die Kenntniss der Bodenbeschaffenheit der oesterr. ungar. Monarchie" (Vienna, Hölder); also a German work, by Prof. F. Lorber, "On the Exactness of Measurements of Length."

THE investigations which have been carried on for more than ten years at the Hague, in order to find out the house which Spinoza inhabited from the year 1652 until the day of his death, on February 21, 1678, have at last been crowned with success.

It is now proved that the great philosopher occupied an attic in the house, No. 28, Paveljoens-gracht in Doublet Straat, opposite to the Holy Ghost House (hoffje). The house belonged to a Heer van der Spyk. Shortly a marble tablet with a fitting inscription will be placed over the entrance.

THE German Geological Society met at Göttingen in the last week of September. The first lecture was delivered by Prof. Credner, of Leipzig, who spoke on the granite of Geyer. Then Prof. Klein, of Göttingen, spoke on a collection of thin sections of minerals forming rocks.—Herr Levin presented a petrified starfish (*Asteria cilicia*) found by him in the upper Muschelkalk of the Hainberg. This specimen is particularly interesting, being the first starfish which has ever been found in the North German limestone.—A communication was read from Prof. Martin, of Leyden, on the tertiary fauna of Java.—Dr. Hornstein (Cassel) reported on a new treatise on Eozoon by Prof. Möbius (Kiel), which will be published in Parts 5 and 6 of the "Palæontographica." Prof. Möbius arrives at the conclusion, from long-continued investigations of numerous specimens of Eozoon, that the latter is of inorganic nature.—Then followed some minor communications from Herr von Groddeck, Prof. Streng, and Prof. Weiss (Berlin), the latter pointing to a recent discovery of coal in the so-called "Eherne Kammer," some few miles to the south of Eisenach. The other speakers at the meeting were Prof. von Seebach (Göttingen), Herren Grotrian (Brunswick), Römer (Breslau), Schmid (Jena), and Prof. vom Rath (Bonn). The Society will meet at Baden Baden in 1879.

ACCORDING to a communication made at the Berlin meeting of ornithologists by Dr. Brehm, the Crown Prince Rudolf of Austria is about to publish a work on Eagles, in conjunction with Drs. Brehm and von Homeyer.

WE have on our table the following works:—"Commercial Products of the Sea," P. L. Simmonds (Griffith and Farran); "Talks about Plants," Mrs. Lankester (Griffith and Farran); "Notes on a Tour in America," H. Hussey Vivian (E. Stanford); "Philosophical Fragments," Dr. Morell (Longmans); "Geological Survey of Canada: Report of Progress for 1876 and 1877," "The Germ Theories of Infectious Diseases," J. Drysdale, M.D. (Baillière); "Sedimentary Formation of New South Wales," Rev. W. B. Clarke (Trübner); "Annual Report of the Department of Mines of New South Wales for 1877" (Trübner); "Australian Orchids," Parts 3 and 4, R. D. Fitzgerald (Trübner); "Geology of Ireland," G. H. Kinahan (Kegan Paul, and Co.); "Animal Chemistry," C. H. Kingzett (Longmans); "Manuel du Voyageur," D. Kaltbrunner (Würster and Co., Zurich); "Report on the Geological Survey of the United States," Dr. Hayden.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Saimaris sciurea*), from Guiana, presented by Mr. Edward Calthrop; an Emu (*Dromæus novæ-hollandiæ*), from Australia, presented by Mr. C. Hampden Wigram; two Radiated Tortoises (*Testudo radiata*), from Madagascar, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Water Rail (*Rallus aquaticus*), British Isles, presented by Capt. F. H. Salvin; a Michie's Tufted Deer (*Elaphodus cephalophus*), from China; a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*); three Blue-bearded Jays (*Cyanocorax cyanopogon*); a Dark-winged Buzzard (*Leucopternis scotopterus*), from Bahia; a Saturnine Mocking Bird (*Mimus saturninus*); two Lined Finches (*Spermophila lineola*); two Gutteral Finches (*Spermophila gutteralis*), from Pernambuco; a Pileated Song Sparrow (*Zonotrichia pileata*), from Rio de Janeiro; a Palm Tanager (*Tanagra palmarum*), from Monte Video, deposited; a Patas Monkey (*Cercopithecus ruber*), from West Africa; two Ruddy Sheldrakes (*Tadorna rutila*), European, purchased.

ON A NEW METHOD OF STUDYING THE OPTICAL CHARACTERS OF MINERALS[1]

AS is well known, the optical characters of minerals furnish us with a most valuable means for identifying the various species. The practical application of these phenomena has, however, been much restricted by the difficulty of obtaining crystals sufficiently large and transparent to be cut into appropriate sections, so that the properties of some of the commonest minerals were very imperfectly known. By the methods hitherto employed it was almost impossible to study the black or imperfectly transparent minerals constituting the chief part of rock masses, and in fact little could be learned unless the specimens were so large and perfect that the individual species could be identified by other means. What we want is a method which will enable us to ascertain the approximate value of the principal optical constants, when we have at our disposal only detached, small, and imperfect crystals in their natural state, or those scattered about in thin sections of rocks, cut into plates which are inclined at every varying angle to the optic axes.

The method now to be described satisfies these requirements sufficiently well. Time would not permit me to give a full description of the apparatus, the manner of using it, and the conclusions to be drawn from the observed data. I must therefore avoid all unnecessary detail, and confine myself to such an outline as will serve to indicate the general character of the method. I may here say that I have received most valuable assistance from Prof. Stokes in the mathematical part of the subject.

When, many years ago, I first commenced to apply the microscope to the study of minerals, I was told by a well-known professor of mineralogy that it would never be possible to learn much by the use of that instrument. If we merely magnify a portion of a pure transparent crystal, we do, indeed learn little or nothing; but if, instead of viewing the crystal itself, we look through it with a suitable magnifying power at some appropriate object, we can learn more facts of interest and importance than by any other single method whatever. The property possessed by the object-glass of collecting divergent rays to form an image gives rise to an entirely new class of phenomena, and converts the microscope into a most valuable apparatus for optical research. The object examined through the crystals is the image of a small circular hole, or of rectangular lines ruled on a piece of glass, formed at the focal point of a well-corrected achromatic condenser fixed below the stage, and so arranged that the image is placed either just below or just above the lower surface of the crystal. The divergent rays passing through it to the object-glass are bent so that the focal length is, as it were, increased by an amount depending on the thickness of the crystal and its refractive power. In order to see the lines in focus, it is therefore necessary to move back the body of the microscope. If we know the thickness (T) and the amount of the displacement of the focal length (d), we can calculate the value of the index of refraction (μ) from the equation

$$\mu = \frac{T}{T-d}.$$

These values are measured by means of a scale and vernier attached to the body of the microscope; and, with care, there ought to be no error greater than $\frac{1}{2000}$th of an inch. The thickness of the specimen (T) is determined by measuring the difference in the focal points for particles of dust on the surface of the supporting glass and on the upper surface of the mineral. In a similar manner the value of d is determined by the difference in the focal length for the lines of the grating seen through the supporting glass with or without the specimen under examination. From the value of the index thus determined a small amount must be deducted, depending upon the aperture and correction of the object-glass, and, when great accuracy is desired, several precautions must be taken to avoid a number of possible small errors, which it would be tedious to explain in detail.

In the equation, $\mu = \frac{T}{T-d}$, it is assumed that the substance possesses no double refraction, as in the case of glass or crystals belonging to the regular system. When viewed through such a substance, only one simple and undistorted image of the circular hole can be seen, and both sets of lines are in focus at the same

[1] Address by the Chairman, H. C. Sorby, F.R.S., Pres. G.S., &c., at the meeting of the Yorkshire Geological and Polytechnic Society, held in Selby on March 13.

adjustment, no matter what may be their azimuth to the axes of the crystal. We obtain by measurements and calculation one single index of refraction, but this may vary so much in different minerals as to clearly point out what they are. Thus, for example, it varies from 1·43 in fluor to 2·34 in blende. If, however, the crystal possesses strong double refraction, the phenomena are far more complex, and vary according to the direction in which the section is cut, its azimuth to the lines of the grating, and also according as it has one or two optic axes.

If we look through a parallel plate of a uniaxial crystal with powerful double refraction, like calcite, cut perpendicular to the principal axis, we see two undistorted images of the circular hole, directly superimposed, one over the other, but separated vertically by a wide interval. This doubling of the image is due to the collection by the object-glass of divergent light, since, for strictly parallel rays passing in the same general direction, there is no double refraction whatever. Both systems of perpendicular lines are seen in focus at the same time in each of the images, one of which is due to the ordinary, and the other to the extraordinary, ray. By observing these focal points we obtain two indices of refraction, one being the true index of the ordinary ray (μ), and the other not that of the extraordinary ray (μ'), but a very low apparent index, equal to $\frac{\mu'}{\mu}$.

When the section is cut in other directions the images differ very much from one another. That due to the ordinary ray has invariably the same properties. The circular hole is not distorted, and both systems of line are in focus at the same time, so that we may call that image *unifocal*. The other image, due to the extraordinary ray, instead of thus maintaining a constant character, changes very greatly, the maximum of change being when the section is cut parallel to the principal axis of the crystal. There is no focal point whatever at which the circular hole is seen of its true size and shape, and the entire circumference is never all in focus at once. There are two special foci, widely separated, at which the circle is, as it were, drawn out into a long band, at one focus parallel, and at the other perpendicular to the axis. If the section be strictly parallel to the axis the focal point of the ordinary image is nearly half-way between these two foci of the extraordinary ray, and coincides in horizontal position with the point at which the two elongated bands intersect. There is thus no lateral displacement of the images. If, however, the section be not parallel to the axis they are displaced laterally, this character being a very delicate test of the accuracy with which the section has been made. In fact, in all cases, if the two opposite surfaces are parallel, the character and position of the images at once indicate the exact relation between the optic axes and the planes of the plate, whether they be natural or artificial.

On viewing the rectangular grating through a section cut more or less nearly parallel to the principal axis, no lines whatever can be seen by means of the extraordinary ray, unless one system is nearly parallel to the axis. At one focal point one system of lines is seen, and at the other focal point the other system, so that the image due to the extraordinary ray may be said to be *bifocal*. On rotating the grating, the lines are seen to become broader, then obscure, and finally invisible. Unlike the image due to the ordinary ray, the bifocal image has thus a special focal axis, and the lines can never be seen in sharp focus if they are not either parallel or perpendicular to this axis.

On the whole, then, we have three focal points, one for the ordinary, and two for the extraordinary ray; and by observing these we obtain three different indices of refraction, one being that of the ordinary ray μ; and, provided that the section is closely parallel to the axis, the index derived from the lines parallel to the axis in the extraordinary image is the true index (μ) of the extraordinary ray, whilst the third index is of the very abnormally high apparent value $\frac{\mu^2}{\mu'}$.

The characteristic peculiarity of crystals like aragonite, which have two optic axes, is that, when the section is so cut that the images are directly superimposed without lateral displacement, they give two bifocal images, and four apparent indices. When cut in particular directions one of these images may become unifocal, but then there is a more or less considerable lateral displacement of the two images. When the section is cut perpendicular to the line bisecting the acute angle between the optic axes, so as to give two very bifocal images, the images of the circular hole are crosses at two different foci, and not, as in the case of calcite, two circles. Biaxial crystals have three true indices of refraction (μ, μ', μ''), and, if the section be accurately cut in the plane of any two of the axes of elasticity, so that there is no lateral displacement of the images, the four apparent indices observed from the lines of the gratings are as follows:—

	Polarised in one plane.	Polarised in the opposite plane.
From lines perpendicular to the plane of polarisation	μ	μ'
From lines parallel to the plane of polarisation	$\frac{\mu''^2}{\mu}$	$\frac{\mu''^2}{\mu'}$

Calling these observed indices a, b, c, and d respectively, we thus have $\mu'' = \sqrt{a\,c}$ or $\sqrt{b\,d}$. It follows from this that we can determine the value of all three indices by very simple observations, made by employing a single section cut in the plane of any two of the three axes of elasticity. Absence of lateral displacement in the images at once shows us that the specimen in its natural state, or as artificially cut, is sufficiently parallel to one of these planes to be suitable for the determination of the indices; but even if it is not such as to give all three indices absolutely true, one at least may be correct, and the others may be determined approximately. In any case the character and position of the images at once shows in what direction the section is cut, or the relation which any parallel planes of a natural crystal bear to the optic axes, though the phenomena are more complex than in the case of uniaxial minerals.

It would occupy far more time than can be allowed on the present occasion to describe in detail the curious and anomalous appearance due to dichroism or to the laminar structure of particular minerals which gives rise to complex internal reflections. My chief aim has been to call attention to the very valuable facts which may be learned by viewing a circular hole or rectangular grating with a microscope through a parallel plate of any crystalline mineral. The data thus obtained are so remarkably characteristic that they alone would amply suffice to identify a large proportion of natural minerals. In many cases all the necessary observations can easily be made with small crystals in their natural state, which alone is of course a very great gain for practical mineralogy. The chief value of the method is, however, that it enables us to identify portions of minerals of microscopic size in sections of rocks as thin, or even thinner than $\frac{1}{100}$th of an inch with an amount of certainty which leaves little to be desired.

When examining specimens of such a size that their thickness must be measured by means of the scale attached to the body of the microscope, I find that an object-glass of about $\frac{2}{3}$ inch focal length, combined with a somewhat highly magnifying eye-piece, gives the best results. When, however, we come to study the minerals in moderately thin sections of rocks, it is impossible to measure the thickness and the displacement of the focus sufficiently accurately by means of the scale and vernier. The fine adjustment screw of the microscope may then be employed along with a $\frac{2}{3}$ or $\frac{1}{2}$ object-glass, and, if properly constructed and used, the requisite measurements may be made to within $\frac{1}{20000}$th of an inch. We may thus approximately determine the indices in sections only $\frac{1}{1000}$ of an inch in thickness. It is, however, necessary to adopt a system which reduces the number of separate measurements and to a great extent eliminates several sources of error. Instead of attempting to measure the *absolute* thickness of any particular crystal, and the actual displacement of the focal length due to it, the *apparent* thickness of the mineral, *as seen through itself* (t), is measured by means of the rotation of the graduated circular head of the fine adjustment by focussing, first to the top and then to the bottom, of some appropriate specimen. In each particular substance this apparent thickness is equal to the true thickness divided by the index of refraction. The thin glass cover is made somewhat larger than the section, so as to project beyond it, and inclose a layer of the hard and brittle balsam used to fasten down the piece of rock. Selecting for observation a specimen as near as possible to this balsam, so as to avoid any error due to unequal thickness, the difference (d') in the displacement of the focal length due to the mineral and the balsam is ascertained by focussing through each the lines of the grating. This value is positive or negative, according as the index of the mineral is greater or less than that of the balsam. It then follows that $t \pm d'$ is the thickness, as seen through itself, of the amount of balsam of the same real thickness as that of the mineral: the effects of the balsam below and above it, and of the covering-glass, being thus entirely eliminated. If, then, the index of the balsam be m, we can easily calculate that of the mineral (μ) from the following equation:—

$$\mu = m \frac{t \pm d'}{t}.$$

In the case of the hard and brittle balsam used to fasten down the specimen, the value of m is about 1·54; but if there be any doubt about the true index, it can be ascertained by special measurements.

In a similar manner we may determine the index of some unknown mineral by comparing it directly with some other mineral lying near to it, the true index of which is either well known or has been previously ascertained from special measurements. For this purpose quartz is often very suitable, since its index varies very little. One great advantage of this method is that specimens may be observed far away from the edge of the section, provided of course that the minerals compared are so close together as to prevent any error due to unequal thickness in different parts.

It must be borne in mind that, when any mineral has a very powerful double refraction, its apparent thickness, as seen through itself, varies according to the particular ray used for illumination and the direction of the objects chosen to determine the focal distances of the lower surface. There is, however, generally no difficulty in measuring with sufficient accuracy the mean apparent thickness, or that corresponding to some one image, and in calculating out the results accordingly.

In connection with this subject it may be well to call attention to a somewhat interesting fact. If we have, side by side, two substances of different refractive power, but of the same *absolute* thickness, their apparent thicknesses, *as seen through themselves*, vary directly as the velocity with which light moves in them. Indeed, strictly speaking, the determination of minerals in the manner now described depends entirely on an indirect measurement of the velocity with which light is propagated through them in different directions.

In order to illustrate the practical applications of this method, I will describe the results obtained in the case of a section of dolerite from near Glasgow, which, on an average, is about $\frac{1}{400}$th of an inch thick.

I found that the index of a colourless transparent mineral, filling up cavities between the original minerals, was about 1·48 or 1·49. This exactly corresponds with that of analcime, with which its other optical characters agree.

Another colourless mineral, also filling cavities, was found to have the indices and other characters of calcite.

A third colourless mineral, evidently an original constituent, was seen to have a comparatively feeble double refraction, and its index was found to be 1·61. Its general appearance was like that of some felspar, but this index clearly proves that it cannot be any species which contains a considerable amount of alkali, which would greatly reduce the refractive power. The index of labradorite was not previously known, but I find that it is 1·61, and therefore there can be little doubt that the mineral in the section is that species.

The section also contains a number of transparent reddish-brown crystals, their index of refraction being about 1·79. This and their other optical characters closely agree with those of the dark augite in the lava of Vesuvius.

In now concluding this short address I cannot but feel that I have been obliged to omit all allusion to many points of considerable practical importance. I have not attempted to describe the subject in such a manner as would enable any one to at once practically apply the method in all sorts of cases. I gave a somewhat full account of one branch of the subject in my address at the meeting of the Mineralogical Society at Plymouth, and entered into the more purely microscopical aspect of the question in my late address at the anniversary meeting of the Royal Microscopical Society. I propose to communicate a detailed paper to the Royal Society as soon as a correct explanation can be discovered of certain small but remarkable discrepancies between mathematical theory and observation. My chief object now is simply to point out what valuable facts may be learned respecting the nature of any mineral by looking through it with a microscope at a circular hole or rectangular grating. This is a totally different thing to magnifying the mineral itself, or to looking through the mineral at any distant object without a microscope. The success of the method depends entirely upon the optical conditions characteristic of a compound microscope. I have lately greatly improved the apparatus hitherto employed, but the examples already given will, I trust, serve to prove that, even with the less perfect appliances, it was possible to identify in a very satisfactory manner, many of the minerals met with in their microscopical sections of rocks, and thus to determine their constitution with far more certainty than heretofore.

RECENT OBSERVATIONS UPON THE PLACENTATION OF THE SLOTHS

M. JOLY has recently brought before the Academy of Sciences of Paris the results of a careful examination of the structure of the placenta of the Aï, or Three-toed Sloth (*Bradypus tridactylus*, Linn.), and proposes important changes in classification, after comparison of this structure with that of certain allied mammals.[1]

It is now six years since we contributed to NATURE a notice of the observations of M. Alphonse Milne-Edwards upon the fœtal envelopes of another member of the Edentata, the "Tamandua" Ant-eater, published by him in the *Annales des Sciences Naturelles*. This Edentate is there stated to have a "placenta discoïdal envahissant."

The sloths are literally, as Buffon described them, ruminant animals, in that they have four stomachs, but they are, at the same time, wanting in all the other characters which pertain to Ruminants proper. Linnæus, on the contrary, classed them, at first among the Primates, but afterwards among the Bruta—the "Edéntés" of Cuvier—and his example was followed by De Blainville. Cuvier placed the "Tardigrades" (*Bradypus*) at the head of the Edentata, although they possess well-developed canine and molar teeth.

It will be seen, then, that as regards the position of these animals the embarrassment of the taxonomist has been extreme, as the genus *Bradypus* has been bandied about from the Ruminants to the Primates, and from these latter to the Edentata. Latterly, however, great importance—and with good reason—has been attributed to the structure of the placenta, as affording characters distinctive of the various groups of mammals, and as giving valuable indications of their zoological affinities. The classification of the placenta by Carl Vogt, though scarce a quarter of a century old, into zonary, diffuse, and discoidal, is nowadays acknowledged to be incomplete, nay, even faulty in some of its applications; for we know now, thanks to the work of Alphonse Milne-Edwards, that if the majority of Ruminants have a multicotyledonary placenta, the camel, the chevrotain, and the *Tragulus* have, on the other hand, one of the diffuse variety. It is the same with the digitigrade Pachyderms (wild boar, &c.), while the plantigrade ones (*Proboscidea, Hyracoidea*) differ from the first in having a zonary placenta like that of the Carnivora and Amphibia (seals, &c.). In fine, although stated to be so, this organ is neither diffuse nor subdivided among any of the Edentata studied from the point of view of their placentation. Nay, more; among these animals the placenta offers, according to genera, and even according to species, differences so well marked that it is necessary, following the apposite remark of M. Alphonse Milne-Edwards, to give up seeing between the different types of Edentata affinities as narrow as those which are supposed, even now generally, to exist among them. Carus has represented the placenta of the Aï, or three-toed sloth, as being multi-lobed, but he does not give any precise information as to the number of these lobes, their structure, the extent which they occupy relatively to the membranes of the ovum, and their connection with the uterine mucous membrane [decidua?], &c.

The placenta of the Aï examined by M. Joly presented itself under the form of a veritable membranous pouch constituted by the amnion and the chorion, and garnished, on almost all its external surface, with a large number (more than a hundred) of lobes or cotyledons of more or less irregular shape and of very variable size, from one millimetre to one or two centimetres. Viewed from the external face of the placenta, these cotyledons appear, some rounded and flat, like Nummulites, others of the form and size of seeds of millet. Others, lastly, much larger, grouped in numbers together, recall by their aspect the multi-

[1] *Comptes Rendus*, August 12, 1878.

lobed kidneys of birds and of certain Ophidian reptiles. Cavities, more or less roomy, in which are doubtless inserted the vessels of the hypertrophied mucous membrane, are also visible on the outer surface of the fœtal placenta. But it is specially upon the internal aspect that the lobules form numerous folds exactly limited, of a thickness frequently considerable (more than one centimetre), strongly adherent to the chorion by a pretty long base, free for the most part for the rest of their extent. We can understand, then, up to a certain point, that Carus should have been able to compare this placenta with that of the ruminants, from which it nevertheless differs much, since its cotyledons are made up of full lobes, generally antiguous, and not of isolated capsules, and distant one from the other like those of the fœtal placenta in the cow, or the maternal one in the sheep.

But we are as yet more disposed to assimilate the placenta of Aï to that of the Lemuroids, notably that of the *Propithecus* of Madagascar, which has been described by M. Alphonse Milne-Edwards under the name of *placenta en cloche* or *placenta envahissant*. In Aï, as in *Propithecus*, the chorion is covered almost entirely with thick and crowded villosities, constituting a kind of vascular cushion resulting from the confluence of a multitude of irregular cotyledons. But the Aï approaches *Propithecus* not only in the structure of the placenta but also in its habits, for both are arboreal, and have a diet exclusively vegetable. Besides this the uterus of the Aï is pyriform, like that of the human female and the female of most apes, a peculiarity which, with the possession of pectoral mammœ, approximates *Bradypus* to *Propithecus*. Linnæus and De Blainville seem then to have been guided by a "kind of divinatory intuition," as it were, when they ranked the sloths of Brazil in the order of Primates, only that they ought not to be classed among the apes proper, but by the side of the *Propithecus* of Madagascar and the slow Loris of the East Indies, of which they are the analogues, or American representatives.

M. Joly finally concludes thus: By its bursiform placenta, as well as by many other peculiarities of organisation, the Aï is a Lemuroid, and not an Edentate.

Not the slightest allusion is made by M. Joly to the well-known publications of Prof. Turner upon the comparative anatomy of the placenta, and especially to a paper read before the Royal Society in May, 1873, upon the fœtal structures of that variety of two-toed sloth called by Prof. Peters *Cholœpus Hoffmanni*.

J. C. GALTON

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Master and Fellows of Gonville and Caius College, Cambridge, have considerably enlarged the chemical laboratory of the College, and have added a small but very serviceable lecture-room, with apparatus-room adjoining. They have likewise provided a private laboratory for the Prælector. The main laboratory now accommodates fifteen students working at one time.

UNIVERSITY COLLEGE, BRISTOL.—The third session of this young institution opened on October 8. The competition for the entrance scholarships was closer than any preceding year, and the general standard of attainments higher. The engineering department of the College is now fairly started, and is almost, if not quite, unique in character, the principal engineering firms in the district having agreed to an arrangement, whereby they receive into their works the engineering students of the College for the six summer months, the six winter months being devoted to the theoretical training of the College. The number of male day students of the College has largely increased; the entries in classical and modern literature, in chemistry, mathematics, and physics, exhibiting a satisfactory increase on those of the preceding year. The attendance at the evening classes is also very large. The scientific side of the College course has been strengthened by the appointment of Mr. W. J. Sollas, M.A., F.G.S., as lecturer on geology. A course of lectures on analytical chemistry is being given by Prof. E. A. Letts, who also resumes his industrial lectures on Dyeing and Scouring at Stroud.—Mr. J. Clapham also continues his course of instruction on Textile Fabrics. A course of lectures on the Technical Applications of Electricity, by Prof. S. P. Thompson, is also announced. The morning lectures on Political Economy are this year delivered by Mrs. Paley Marshall.—Mr. L. A. Goodeve, B.A., has been appointed lecturer on Law.

SCIENTIFIC SERIALS

The American Journal of Science and Arts, September.—In an opening paper on the origin of comets Prof. Newton compares the hypotheses of Kant and Laplace, the former of which represents that these bodies are formed from the matter of the condensing solar nebula; the latter, that they have no relation with this, but were made from matter scattered through stellar space. He shows that the curve of actual distribution of the inclinations of cometic orbits to the ecliptic, agrees well with that required by the hypothesis of Laplace, if we first make reasonable allowance for known perturbations, and for the comets of short periods, but that it is not thus made to agree with Kant's hypothesis.—Prof. Gray explains the distribution of tree species in North America, and traces similar species dispersed over widely-separated continents to a polar centre, where they once flourished in a temperate climate. Among other facts he mentions that while the Atlantic American Forest has almost three times as many genera and four times as many species of non-coniferous trees as the Pacific Forest, it has slightly fewer genera, and almost one-half fewer species of coniferous trees.—Prof. Marsh describes a new pterodactyl from the Jurassic of the Rocky Mountains.—Professors Draper and Watson give their observations on the solar eclipse, and an intra-Mercurial planet respectively.—The animal of *Millepora alcicornis* is figured by Mr. Rice, who confirms the conclusions of Agassiz.—Prof. Verrill notes some additions to the marine fauna of the east coast of North America; and among chemical notes is one on antimony tannate, by the Misses Swallow and Palmer.

Journal de Physique, September.—Some experiments showing the power of a vibratory motion to produce decomposition of explosive liquids and ebullition of superheated liquids are here described by M. Gernez. They consist in rubbing with a damp cloth a clean glass tube containing, *e.g.*, supersaturated seltzer water that has been kept in it for months, or a little nitrous acid below water, or methylchlorhydric ether. In the two former cases there is a projection of liquid; in the latter, a vigorous boiling occurs but soon ceases, owing to the consumption of heat by the vapour formed, reducing the temperature to near the normal boiling-point.—M. Cornu gives an account of his valuable researches on the ultra-violet solar spectrum, which have from time to time been communicated to the Paris Academy.—M. Planté describes effects got with his rheostatic machine; it gives, in general, all the effects of electric machines and induction coils, and these are not apparently much interfered with by the hygrometric state of the air.—We note, among the abstracts, one of recent proceedings of the St. Petersburg Physical Society.

Atti della R. Accademia dei Lincei (Rome) 1876-77, vol. i.—This part commences with a second instalment of Prof. Respighi's memoir on the latitude of the Roman Observatory.—On fluoride of magnesium, by A. Cossa.—On the theoretical velocity of sound and the molecular velocity of gases, by A. Rieti.—Petrographical studies, by G. Struever (two plates).—On the constitution of chloral ammonia and aldehyd-ammonia, by R. Schiff.—Electrostatic researches, by P. Volpicelli.—On the microscopic aspect of certain nervous fibres, by Franz Boll (two plates).—On some palæozoic fossils of the Maritime Alps and of the Ligurian Apennines, by B. Gastaldi (four plates).—On an objection to Melloni's theory of electrostatic influence, by P. Volpicelli.—Memoir on modular equations, by H. T. Stephen Smith.—On the dilatation, the capillarity, and the viscosity of fused sulphur, by G. Pisati.—On the titanite and the apatite of the Lama dello Spedalaccio, by G. Uzielli.—On the direction of gravity at the Barberini Station on the Monte Mario, by F. Keller.—Experimental researches on the tenacity of metals at different temperatures, by G. Pisati, C. Saporito, and S. Scichilone. The author experimented with copper, steel, brass, and aluminium.—Geological investigation of the mountain group of the Gran Paradiso, by M. Baretti (with seven carefully executed maps).—Experimental researches on electric discharges, by A. Richi (five plates). This and the previous one are amongst the most elaborate papers in the volume.—On the small oscillations of a rigid and perfectly free body, by V. Cerrutti.—On the anatomy and the physiology of the retina, by Franz Boll (one plate).—Ephemerides and statistics of the River Tiber before and after the confluence with the Aniene River, during the year 1876, by A. Bettocchi.—On some cave miriapoda of France and Spain, by F. Fanzago.—On the duration of vitality in the germinative spot, by Dr. G. Colasanti.

—Researches in theoretical crystallography, by G. Uzielli.—On the experimental determination of the electric density on the surface of conducting bodies, by E. Beltrami.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xi. fasc. xiv.-xv.—We note the following papers in this number :—Colouring matters contained in the grape and a new means of judging of the degree of ripeness of this fruit, by S. Pollacci.—Transformation of hydroxylamine into nitrous acid, by Dr. Bertoni.—Action of solar rays on haloid compounds of silver, by Dr. Tommasi.—Reduction of chloral, by the same.—Results of vivisection of the cerebellum, the transverse peduncles, the semi-circular canals, and the nerves of taste, by Dr. Lussana.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, October 2.—H. W. Bates, F.L.S., F.Z.S., vice-president, in the chair.—Mr. J. Lawrence Hamilton, M.R.C.S., was elected a Subscriber, and Mr. Thos. Nottidge a Member of the Society.—In reference to the statement of Mr. F. Smith at the last meeting of the Society, to the effect that the Linnean collection of insects contained in the apartments of the Linnean Society had fallen into a state of complete neglect, Mr. McLachlan read a report on the result of an examination he had since made of that collection. Mr. McLachlan considered that the collection was now in the same condition as it had been for probably a quarter of a century, and that the charge of neglect could not be sustained. Mr. Stainton fully corroborated this view, and stated that from a recent examination of the lepidopterous portion of the collection he had been unable to detect any appreciable deterioration in it since the year 1848, when he had first occasion to consult it.—Mr. Jenner Weir exhibited specimens of *Hipparchia semele* from various localities, showing a tendency to vary in colour on the under side in accordance with the nature of the soil of the district in which the specimens had been taken.—Mr. McLachlan exhibited the eggs and young larvæ of *Ascalaphus longicornis*, found by M. E. L. Ragonot, in the Forest of Lardy, apparently the northern limit of distribution of the species. Mr. McLachlan also exhibited, on behalf of Mr. Edwin Birchall, an example of *Heliothis scutosa*, captured by Mr. Campbell in the north of Co. Donegal, Ireland.—Mr. Rutherford exhibited and communicated a description of a new species of cetoniidæ, from Mount Camaroons. Mr. Rutherford also exhibited a specimen of *Ranaleosoma ruspina*, which was curiously and symmetrically destitute of scales.—Mr. Champion exhibited specimens of *Amara infima*, taken at Cobham, Surrey.—Mr. Forbes exhibited a collection of insects from Switzerland.—Mr. Wood Mason read a note on a saltatorial *Mantis*, and exhibited a specimen of the insect which had been captured on the banks of the Tagus. He also read notes on the hatching period of Mantidæ in Eastern Bengal, and on the presence of stridulating apparatus in certain *Mantidæ*. Mr. Wood Mason also stated that he had discovered a remarkable case of viviparity in an orthopterous insect, *Panesthia javanica*, a cockroach inhabiting the tropical forests of Southern Asia and Australia.

PARIS

Academy of Sciences, October 14.—M. Fizeau in the chair.—The President announced the death of M. Delafosse, member in the Section of Mineralogy.—The following papers were read :—Presentation of vol. ix. of the "Observations of Pulkowa," by M. Otto Struve. This contains micrometric observations made by the author during forty years (with the same instrument and by the same method) on double and multiple stars. They continue the series of twelve years' like observations by his father at Dorpat. By these measurements M. Struve has been able to observe, *e.g.*, the epicycloidal motions of the third star in ζ Cancri, to determine approximately the orbit of 42 Comæ Ber., and clear up the controverted system of 61 Cygni. The measurements in this volume relate chiefly to double stars of the Dorpat catalogue, in the northern hemisphere, and to all systems discovered at Pulkowa. Another volume will contain extended observations.—Formulæ relating to perforation of iron armour plates, by M. Martin de Brettes.—M. Decharme presented a supplement to his memoir on vibratory forms of solid or liquid bodies; it relates to experiments with a large glass plate, with which the former results (with small plates) were confirmed.—M. Champin communicated an observation regarding transformation of apterous into winged phylloxera in the galls.—Third letter of Prof. Watson on the discovery of intra Mercurial planets. M. Mouchez considered the information here given answered his objections in great part, and left no doubt of the reality of the discovery of at least one of the two planets.—Reply to a communication by Herr Weber on thermodynamics, by M. Levy.—On a new micrometer, meant especially for meteorological researches, by M. Govi. In this the threads or fine wires are replaced by the two edges of a slit made in a very thin layer of silver, gold, platinum, or other inalterable metal, placed on the surface of a plate of glass having perfectly plane and parallel faces. The slit is produced by means of a light metallic tracer; and for larger slits the tracer is made to remove the metal in advancing parallel lines. Advantages attach to the extreme thinness of the metallic layer, its opacity, rigidity, and inalterability under considerable thermometric and hygrometric changes, the possibility of easily making slits as narrow or as wide as may be desired, and the facility of substituting different plates for each other in the same frame.—On a new metal, *philippium*, by M. Delafontaine. It is so called in honour of M. Philippe Plantamour, of Geneva, the friend and pupil of Berzelius. The author's former conclusions are confirmed; the new earth (of samarskite), which has a colour and a molecular weight intermediate between those of yttria and terbine, is not a mixture of these two bodies, but an oxide of a new metal. Supposing provisionally that philippine is a protoxide, its approximate equivalent is between 90 and 95. M. Delafontaine gives the properties of some compounds, the philippic formiate, sulphate, nitrate, &c., and describes the spectroscopic appearances gievn by concentrated solutions of philippium. These present a very broad characteristic absoption band which is absent from terbic, yttric, and erbic solutions.—Action of the juice of beet-leaves on perchloride of iron, under the influence of light, by M. Pellet. It has, in absence of chlorophyll, the power of reducing salts of iron easily, in light. This reduction may take place in the dry state, and with solutions having no longer vitality. It is due to oxidation of several organic substances contained in the leaves, such as sugars, tannin, azotised matter, &c.—M. Ronder presented a note on an arrangement for observing the stars in broad daylight, without the aid of a telescope; it consists in the use of a long tube, the lower end of which terminates in a dark chamber.

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