THURSDAY, AUGUST 1, 1878

THE ECLIPSE OF THE SUN

THE following telegram was received from Mr. Lockyer at the moment of going to press. It contains the fullest account of the results of the Eclipse, and of the conclusions arrived at by some of the most eminent of the observers engaged on it, which has yet been published :—

Corona smaller and less brilliant than in 1869 and 1871. Hydrogen faint in corona. Generally invisible, as was also the case in 1874. Ranyard's polarisation confirmed Young's law, both (?) and lines brilliant. Corona probably photographed in Siam (?). Fluorescent eyepiece worked well. Bright line near B; heat line in ultra red by thermopile. Watson's Vulcan, Right ascension 8° 26′, declination 18° N. Result—lower temperature of corona gas, as confined to chromosphere; almost entirely continuous spectrum, isolated from gaseous spectrum. Corona changes with sun-spots, and prominences increased. Continuation of absorption with deficit in ejected hot matter induces solar radiation. Young, Watson, Draper, Lockyer cable above.

The following telegram appears in the *Daily News* of yesterday from its special correspondent at Rawlings, Wyoming, U.S., under date July 29 :—

The eclipse has been most satisfactorily observed at all the northern stations, and at all the southern ones from which news has been received up to the present time.

The corona was markedly different from those observed in 1869, 1870, and 1871, and this year the observations have demonstrated the great variation in the structure and condition of the sun's outer atmosphere when there are most and fewest spots on his disc. The corona was small, of a pearly lustre, and the indications of definite structure were limited to two portions. Several long rays were seen, and Prof. Newcomb, who had erected a screen on a high pole, thinks he detected the zodiacal light extending six degrees from the sun. Prof. Draper, who used a Rutherfurd grating two inches square and a camera of large aperture, and Mr. Lockyer, who placed a small grating in front of an ordinary portrait camera, both obtained photographs of the spectrum of the corona. A continuous spectrum only was recorded, and in ordinary spectroscopes the bright lines usually seen were altogether absent. Mr. Lockyer, who observed with a simple grating, saw no rings.

All these are so many indications of a wonderful change since 1871, and there is great probability that the substance which gives rise to the continuous spectrum is not that which produces any of the lines.

Prof. Newcomb's party and Prof. Barker made a careful search for the dark lines in the corona, but none were observed. Prof. Young has telegraphed that there were no lines observed in the ultra violet at Denver. It would appear, therefore, that he also has obtained photographic evidence of a continuous spectrum. The radial polarisation observed in 1871 has been confirmed by Prof. Holden.

A new use of the eclipse has been introduced on this occasion. Professors Newcomb, Watson, Holden, and others have included a search for intramercurial planets in their programme, and Prof. Watson has been fortunate enough to detect a body of four and a half magnitude near the sun, which certainly is neither a known star nor a planet.

Every facility has been afforded to the astronomers, and a fourth station along the northern line crossing the belt of totality was at the last moment organised by the Union Pacific travelling photographic car being run to a point between the Eclipse camps at Separation and Preston.

The tasimeter, the new instrument on which Mr. Edison has been working unceasingly here, has proved its delicacy. During the eclipse he attached Thomson's galvanometer, the index being set to zero, when the telescope carrying the tasimeter was pointed several degrees from the sun. The point of light rapidly left the scale, when the corona was brought upon the fine slit by which the tasimeter itself was protected. There was no chromosphere to speak of, and only one prominence, like the horn observed in 1868, but very dim.

OUR NATURAL HISTORY COLLECTIONS

ON referring to the "Bill to enable the Trustees of the British Museum to remove Portions of their Collection," our readers will see that our correspondent, "Naturalist," in our last issue (p. 328), is correct in supposing that this measure contemplates no change whatever in the administration of the natural history collections when placed on their new site in South Kensington. The fourth clause of the Bill expressly reserves all the "rights, powers, duties, and obligations" of the fifty trustees, except as regards the mere removal of the portions of the collections specified in the schedule. And we must agree with our correspondent that this measure will be directly contrary to the opinion of many of our leading naturalists, and to the recommendations of the Royal Science Commission.

As regards the first point, it is only necessary to refer to the memorial presented to the Chancellor of the Exchequer in 1866, when the subject of the removal of the natural history collection was under discussion. The memorial, which was drawn up primarily in *support* of the removal of the natural history collections from the rest of the British Museum, and is signed by Mr. Bentham, Mr. Darwin, Sir J. Hooker, Prof. Huxley, and other well-known names, states that in the opinion of the memorialists "it is of *fundamental importance* to the progress of the natural sciences in this country that the administration of the natural history collections should be placed under one officer, who should be immediately responsible to one of the Queen's ministers." The Bill as drawn proposes to leave the natural history collections exactly as they are, under the rule of fifty trustees responsible to no one but to themselves.

Let us now turn to the Fourth Report of the "Royal Commission on Scientific Instruction and the Advancement of Science," issued in 1874, in which the affairs of the British Museum, and more especially of the natural history collections belonging to it, are discussed. After an exhaustive account of the circumstances of the case and an analysis of the evidence given before them by the leading naturalists of the day on the subject, the Royal Commissioners came to the following conclusions :—

1. That the occasion of the removal of these collections to the new buildings now being erected at South Kensington for their reception be taken advantage of to effect a change in the *governing authority and official administration* of that division of the museum.

2. That the director of the natural history collections should be appointed by the Crown, and should have the entire administration of the establishment under the control of a Minister of State, to whom he should be immediately responsible.

Now it is hardly necessary to point out that if the Bill before the House of Commons be passed in its present state (whereby all "the rights, powers, duties, and obligations" of the Trustees of the British Museum are expressly reserved), the recommendations of the Royal Commissioners will be treated as so much waste paper. If the Government appoints a Commission of the best men of the country to advise them on a subject of which they know nothing, it seems to us to be hardly civil to allow an Act of Parliament to be passed in the teeth of their deliberate recommendations without even taking the trouble to explain why these recommendations are not to be carried into effect. Yet this is what is now proposed to be done.

HULL'S GEOLOGY OF IRELAND

The Physical Geology and Geography of Ireland. By Edward Hull, M.A., F.R.S. (London : Stanford, 1878.)

THE great map of the veteran Sir Richard Griffith, followed by the detailed labours of other geologists, especially of the Geological Survey, and of its lamented director, the late J. B. Jukes, has explained the general geological structure of Ireland, and sketched, partly in outline, partly in considerable detail, the curious problems which that structure suggests. As yet, however, the abundant published information to be gleaned from papers and memoirs regarding Irish geology lies chiefly scattered through the *Transactions* of various scientific societies, and the Explanations of the Survey. Some of these publications are not nearly so widely known as they deserve to be, or as they assuredly would be if it were more easy for geological students in general to procure a reading of them. Mr. Hull has, therefore, done good service in preparing this little handbook to the geology and geography of Ireland. It is a most useful compendium of information, and its utility is greatly enhanced by the references to those works and papers where the subjects he discusses are more fully treated.

The volume is divided into three parts. In the first of these the author gives a digest of what is known regarding the geological formations of Ireland. In treating of the palæozoic rocks, he follows Harkness and others in regarding the metamorphic rocks of the north-western counties as the general equivalents of the unaltered Lower Silurian masses of the rest of the island, thus identifying both groups of rocks with those which occupy a similar position in Scotland. In this he is undoubtedly correct, and is quite justified by the sections published by Murchison and others. In these days, however, when almost every dictum of our fathers is called in question, and when able observers on both sides of the Atlantic are loudly proclaiming that they can find no true palæozoic gneiss and schist anywhere; when Alpine rocks—once devoutly regarded as metamorphosed Cretaceous strata—have been pushed back and back till their enemies will not let them have a footing among any even of the palæozoic formations, it certainly would be a good and serviceable piece of work to fix, if possible, by means of fossils, the horizon of the quartzites and limestones of Donegal, and to demonstrate, by numerous transverse sections, that these rocks pass truly, and with no deceptive overturn, beneath the younger gneissose and schistose masses. In Prof. Hull's necessarily brief summary he does scant justice to the Old Red Sandstone. To some extent he makes up for this by the greater fulness of his account of the Carboniferous system, to which he gives considerable interest by the parallelism, suggested by his long experience in Lancashire and elsewhere, between the established divisions of the system in England and the grouping which he has been able to recognise in Ireland. The fragments of Permian and Mesozoic deposits in the north of Ireland are duly mentioned; a more detailed description is given of the huge volcanic plateau of Antrim, and the successive stages of its history; while the Glacial and Post glacial formations receive tolerably ample illustration.

Having laid his foundation of facts, Mr. Hull proceeds, in Part II., to build upon it his explanation of the present physical geography of Ireland. Beginning with the mountains he arranges them in groups, and points out in each case the evidence of their age. The remark just made regarding the metamorphic rocks of Donegal may be repeated here in reference to the alleged age of these north-western mountains. Of course as Upper Silurian rocks lie against them and contain conglomerates derived from them, these heights must be far older than Upper Silurian times. The author assigns them to a long unrepresented interval between the Upper and Lower Silurian periods—a date to which the corresponding Scottish Highlands have also been referred. In dealing with the Wicklow Highlands so admirably worked out by Jukes and his colleagues, Mr. Hull suggests that as the granite there was certainly protruded before the Old Red Sandstone had been laid down, it may even have been earlier than Upper Silurian time, and "therefore synchronous with the mountains of Donegal, Mayo, and Galway." But the Old Red Sandstone of the South of Ireland, thick though it be, seems to represent only the upper member of that system. The vast period of the Lower Old Red Sandstone, so rife elsewhere in subterranean movements and volcanic outbursts, is not known in the south of the island, unless we may conjecture the Wicklow granite to belong to that epoch. The numerous and characteristic ridges and isolated eminences which in the south-western counties and in the central plain rise out of the Carboniferous plain, often with a central core of contorted Silurian rocks, are assigned to an interval of terrestrial disturbance between the Carboniferous and Permian periods. The evidence for this conclusion is fragmentary and has been skilfully marshalled into form by the author; but it cannot be regarded as by any means conclusive. Yet more uncertain is the reference of the Mourne Mountains to the Permian period. That these heights are remnants of an ancient volcanic centre of later date than the Carboniferous Limestone has been made satisfactorily evident by the careful maps and sections of the Geological Survey. The rocks differ a good deal from those of the Tertiary volcanic region of Antrim. Mr. Hull thinks that they have not the same "appearance of recentness" as the latter, and as Permian volcanic rocks have been recognised in the south-west of Scotland, he thinks it a pity that the Emerald Isle should not have a share of them, and so he would fain regard the peaks of Mourne and Carlingford as the stumps of volcanoes which were blazing in the west when those of the Rothliegende were active in central Germany. All that, in the present state of our knowledge, can be affirmed about these rocks, is that they are later than the Carboniferous Limestone. They may be called Tertiary with about as much probability as Permian.

The wrongs of Ireland go back at least as far as the close of the Carboniferous period. Mr. Hull, with praiseworthy calmness, sketches the process by which his country has been despoiled of its once extensive coal-fields, and, while pointing regretfully to the few little scraps left here and there to tell of former mineral wealth, doomed to irretrievable destruction before either Celt or Saxon set foot upon the land, he consoles us with the just reflection that "the character of the inhabitants and their destiny as an agricultural or pastoral people were fixed altogether independently of social or political considerations." The author, following Jukes in his explanation of the history of Irish rivers, gives some interesting details regarding a few of the principal water-courses of the country. His account of the numerous lakes of Ireland is well arranged, but provokingly brief.

In the third part Prof. Hull deals with the glaciation of Ireland, and presents us with a readable summary of what is known up to this time on that subject, his narrative being accompanied by a small coloured map, on which the chief lines of ice-movement are drawn. Though certain tracts are marked on this map as "snow-fields," it is to be presumed that at the time the rocks were being striated in the directions there indicated, the whole island was one vast snow-field, with no boundary of any kind between the tracts here separated and the rest of the country. In a closing chapter the author brings before his readers the days of the mammoth, red-deer, rein-deer, great Irish deer, wolf, bear, and wild boar. To that venerable Irishman, the *Megaceros hibernicus*, a couple of pages are lovingly devoted, where we learn that the reason why he flourished so abundantly in the sister island was "the absence of many of the natural enemies with which he had to contend in Britain and Europe." Happy days these must have been! Who knows but Megaceros may have lived in brotherhood with the earliest human Irishmen until in after ages the "natural enemies" of both crossed over to them from Britain.

The volume is certain to prove useful. To geologists at a distance it presents in brief and readable form a compendium of all that is most striking and interesting in Irish geology. To those who can avail themselves of the numerous opportunities now afforded of visiting and travelling in Ireland it forms an admirable guide-book. Its appearance before the approaching meeting of the British Association is opportune. No member of the Association who means to see a little of Ireland after the Dublin congress is over should neglect to stow a copy of the book into a corner of his portmanteau.

ARCH. GEIKIE

OUR BOOK SHELF

A Treatise on the Cycloid and all Forms of Cycloidal Curves, and on the Use of such Curves in dealing with the Motions of Planets, Comets, &c., and of Matter projected from the Sun. By Richard A. Proctor. With 161 Illustrations and many Examples. (London: Longmans, 1878.)

THIS is a very full book on the curves enumerated; marked by much elegance in the geometrical portion of the work. It is by far the completest treatise we know, and is likely to take its place as a standard work on the subject. It is marvellous how much can be said about these curves, and one is ready to indorse Chasles' opinion—referring to the cycloid—"Cette courbe merveilleuse." Mr. Proctor only slightly glances at the historical side, and merely refers to Pascal's famous questions, a proof of which, we believe, could hardly, if at all, be effected by purely geometrical methods. Use has been made of De Morgan's article on trochoidal curves, the fullest previous exposition of the properties of these curves in relation to epicyclics, and the work, which is admirably printed, has had the advantage of being embellished with drawings from Mr. Perigal's well-known mechanically-traced curves (bicircloids). One section is devoted to the analytical equations to the curves, and the last section is a reprint of two papers which have already appeared in the *Monthly Notices* of the Astronomical Society, entitled "The Graphical Use of Cycloidal Curves to determine (1) the Motion of Planets and Comets, (2) the Motion of Matter projected from the Sun."

LETTERS TO THE EDITOR

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

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

The Microphone

THE pleasure with which those beautiful discoveries and inventions, the telephone, the phonograph, and the microphone, have been appreciated by the world, has been unhappily, and I must say I think unnecessarily, marred by one of the most disagreeable things that can be thrust on the public—a personal claim of priority, accompanied by accusations of bad faith, especially when made against any one of whose name and fame the public has come to feel concerned.

Before troubling the public at all with such a matter, Mr. Edison might surely have reasoned out his claim with Mr. Preece, with whom he had been from the beginning in correspondence, or he might have written immediately to public journals, calmly pointing out the close relation between his own "carbon telephone" and Mr. Hughes' subsequent "microphone." The scientific public could then have calmly judged, and would have felt much interest in judging, how much in common or how much not in common there may be in the physical principles concerned in the two instruments. But by his violent attack in public journals on Mr. Preece and Mr. Hughes, charging them with "piracy" and "plagiarism," and "abuse of confidence," he has rendered it for the time impossible for either them or others to give any consideration whatever to his claims. Nothing can be more unfounded than the accusations! Mr. Preece himself gave, at the Plymouth meeting of the British Association last August, a clear and thoroughly appreciative description of Edison's carbon telephone, and published it in the printed reports of his lecture which appeared in the public journals. The beautiful results shown since the beginning of the present year by Mr. Hughes with his microphone were described by himself in such a manner as to leave no doubt but that he had worked them out quite independently, and that he had not the slightest intention of appropriating any credit due to Mr. Edison. It does seem to me that the physical principle used by Edison in his carbon telephone and by Hughes in the microphone is one and the same, and that it is the same as that used by M. Clérac, of the French "Administration des Lignes Télégraphiques," in the "variable resistance carbon tubes," which he had given to Mr. Hughes and others for important practical applications as early as 1866, and that it depends entirely on the fact long ago pointed out by Du Moncel, that increase of pressure between two conductors in contact produces diminution of electric resistance between them.

I cannot but think that Mr. Edison will see that he has let himself be hurried into an injustice, and that he will therefore not rest until he retracts his accusations of bad faith publicly and amply as he made them. WILLIAM THOMSON

Yacht *Lalla Rookh*, Cowes, July 30

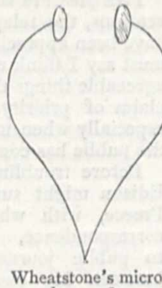
IT may be of interest at the present time to recall the fact that the word "microphone" was first employed by Sir Chas. Wheatstone upwards of fifty years ago. In a paper entitled "Experiments on Audition," published in the *Quarterly Journal of Science* for 1827, Wheatstone remarks:—"The great intensity with which sound is transmitted by solid rods at the same time that its diffusion is prevented affords a ready means of effecting this purpose [augmenting the loudness of external sounds], and of constructing an instrument which from its rendering audible the weakest sounds may with propriety be named a microphone." As the original paper may not be readily accessible, an extract from it is appended to this letter, wherein will be found a description of the simple arrangement proposed by Wheatstone—it is in fact a metallic binaural stethoscope—together with some experiments with the instrument given by the author. The entire paper will appear in the republication of Wheatstone's scientific papers, which the Physical Society will shortly issue, and the instrument itself can be obtained for a trifling sum from Mr. Yeates, of King Street, Covent Garden.

Monkstown, Dublin, July 29 W. F. BARRETT

"Procure two flat pieces of plated metal, each sufficiently large to cover the external ear, to the form also of which they may be adapted; on the outside of each plate, directly opposite the meatus, rivet a rod of iron or brass wire about 16 inches in length, and one-eighth of an inch in diameter, and fasten the two rods together at their unfixed extremities, so as to meet in a single point.

The rods must be so curved, that when the plates are applied to the ears, each rod may at one end be perpendicularly inserted into its corresponding plate, and at the other end may meet before the head in the plane of the medial line.

The spring of the rods will be sufficient to fix the plates to the ears; but for greater security ribands may be attached to each rod near its insertion in the plate, and be tied behind the head. A more simple instrument may be constructed to be applied to one ear only, by inserting a straight rod perpendicularly into a similar plate to those described above.



Wheatstone's microphone, 1827.

The microphone is calculated only for hearing sounds when it is in immediate contact with sonorous bodies; when they are diffused by their transmission through the air this instrument will not afford the slightest assistance. It is not my intention in this place to detail all the various experiments which may be made with this instrument; a few will suffice to enable the experimenter to vary them at his pleasure:—

1. If a bell be rung in a vessel of water and the point of the microphone be placed in the water at different distances from the bell, the difference of intensity will be very sensible.

2. If the point of the microphone be applied to the sides of a vessel containing a boiling liquid, or if it be placed in the liquid itself, the various sounds which are rendered may be heard very distinctly.

3. The instrument affords a means of ascertaining, with considerable accuracy, the points of a sonorous body at which the intensity of vibration is the greatest or least; thus, placing its point on different parts of the sounding-board of a violin or guitar whilst one of its strings is in vibration, the points of greatest and least vibration are easily distinguished.

4. If the stem of a sounding tuning-fork be brought in contact with any part of the microphone, and at the same time a musical sound be produced by the voice, the most uninitiated ear will be able to perceive the consonance or dissonance of the two sounds; the roughness of discords and the beatings of imperfect consonances are thereby rendered so extremely disagreeable, and form so evident a contrast to the agreeable harmony and smoothness of two perfectly consonant sounds, that it is impossible that they can be confounded."—*Quarterly Journal of Science*, 1827, Part II.

The Meteor Shower of Aquarids (July)

ON July 27 ninety-three shooting stars were seen here, between 10h. 30m. and 14h. 30m., which, after making allowance for time occupied in charting the paths, is equivalent to about twenty-nine per hour for one observer. There was a rich shower of *Aquarids* from a point near μ Aquarii, at R.A. 343°, 14° S. declination, which gave twenty-two meteors. These were rather bright, not very swift, with moderately long paths (averaging 17°), and quite devoid of streaks. I had seen about five meteors of this system on the preceding night, and on the 28th I watched a very hazy condition of sky—in which the stars shone dimly—for four hours, and of forty-four meteors seen five or six others were *Aquarids*. This active shower was well seen by Capt. Tupman on July 27, 1870, with an accurately-defined radiant at 340°—14°, from fourteen meteors (see No. 43 of his catalogue), and on the four following nights he traced about forty-seven others from the same shower, though the centre seemed a little further south, at 340°—19° on the 28th. On the 27th he recorded seven meteors of this stream within the twenty-one minutes, from 14h. 3m. to 14h. 24m. It was also seen by me, at 342°—12° (ten meteors), on August 3-17 last year; and Schmidt gives radiants at 337°—11° for July 20-31, and at 344°—11° for August. Neumayer, in the southern hemisphere, also has a position at 337°—10° (July), and Heis at 339°—10° for July 27-31. The average centre from these eight independent determinations is at 340°—13° for this important shower, which evidently comes to a strong maximum on about July 27-29. The end of July has long been known as a meteor-epoch of considerable intensity, with a maximum, according to Quetelet, between the 27th and 29th, which is thus amply confirmed by recent observations, and proves these *Aquarids* to be but little less in importance to the annually-recurring showers of *Lyrids*, *Orionids*, *Taurids*, and *Geminids*.

It should be pointed out that, in future observations of this special shower, care must be taken not to confuse it with other contemporary showers in Aquarius. There are two radiants on or near the equator in about R.A. 334° and 349°, and one (of very slow meteors) at about 336°—6°, also a fourth at 326°—12° (mean position of five radiants seen by Schmidt and Tupman). They are distinct showers, though separated with difficulty, owing to proximity of position; and it is interesting to note that, if we average them with the strong radiant at 340°—13° referred to above, we have a central radiant at 337°—6°, which coincides exactly with Mr. Greg's position for the *Aquarids* (Nos. 109 and 137 in his catalogue of 1876), which apparently continue from July 5 to October 31. W. F. DENNING

Ashleydown, Bristol, July 29

P.S.—My observations were continued on the night of July 30, when seventy-six shooting stars were seen in four hours; thirteen of these were *Aquarids*, and seven of them visible in the half an hour preceding midnight, after which few were observed. From this I infer that the maximum had probably occurred on the morning of the 30th, when, unfortunately, a thick haze prevented work.—W. F. D.

Physical Science for Artists

WILL you permit me, through your columns, to tell Mr. Abbay that the phenomena—"les rayons de crépuscule"—he refers to in his letter in NATURE, vol. xviii. p. 329, are of not unfrequent occurrence on the west coast of India, in the plains as well as the highlands. Moreover I can recollect being much struck with the appearance whilst travelling in Ireland in the autumn of 1863. The convergence of rays in the east, while the sun was setting, was then new and singular to me, but I have since often observed the phenomenon.

On some occasions the atmosphere has seemed clear, until sunset, when the blue sky has literally reddened, and it is then that the cloud shadows show best as bands of blue stretching from west to east, and visible in the zenith as well as nearer their converging points. E. H. PRINGLE

Clevedon, July 27

Taunton College School

IN your last number, in an article by Mr. Shenstone, of Exeter School, on the formation of a laboratory, he incidentally speaks of the council of this school, of which I am headmaster, as having "quenched the torch of science in the west." As this statement may be prejudicial to me, and can only arise from Mr. Shenstone's being imperfectly acquainted with the facts, I trust to your spirit of fairness to allow me to state publicly (1) that the senior half of the school in the last six months has been through a course of electricity and magnetism illustrated by experiments, and has just passed a creditable examination in those subjects under a Cambridge examiner of high reputation; (2) that there has been a course of lectures on botany this term; (3) that all those boys whose interests require it have been taught chemistry; (4) that we have had a very favourable report of the boys' proficiency in mathematics, which I presume, has some claim to be considered science, though to my great surprise at the present day it is often spoken of as if it had none. The council have left me perfectly free to teach as much or as little science as I choose; I choose, and in all probability always shall choose, to give every opportunity of acquiring scientific knowledge to my pupils, consistent with their instruction in other necessary subjects, and if I find any with strong scientific tastes, to foster them to the utmost. As my academical position was mainly, though not entirely, due to my scientific knowledge, it would be strange if I acted otherwise.

HENRY PEARCE KNAPTON

Taunton College School, July 27

Deep-sea Dredgings off the Gulf of Mexico

I WISH to correct an omission of mine in a notice of the work of the United States schooner *Blake* (NATURE, vol. xviii. p. 198). Capt. Sigsbee's modification of Thomson's wire-sounding machine was used for the deep-sea soundings. The steel wire was No. 20 American gauge, and the time required to reel in with it was always one minute per 100 fathoms. The steel wire rope used for dredging, which was made expressly at the suggestion of Prof. A. Agassiz, was the one mentioned in the notice as being of galvanised steel, with a hemp core (not coil, as printed), and which in the notice appears as if it were the same wire rope that was employed for sounding. The sentence will read correctly if the words "used for dredging" be inserted after the words "the wire rope" in the paragraph. The importance of this suggestion of Prof. Agassiz will be best understood when the immense saving of space gained—one coil of 3,000 fathoms of this wire rope occupying on the reel only a space of 5 feet long, 5 feet high, and 4 wide—and the immense saving in time of lowering and hoisting the dredge, are taken into account.

E. P. W.

ANTHROPOLOGY IN FRANCE[1]

IN the numbers of the *Bulletins* of the French Anthropological Society for 1876 are many papers of importance, some of which we shall briefly bring before our readers.

An admirable series of photographs of natives of New Caledonia, taken by order of the local French authorities, has been made the subject of some interesting notices by M. Paul Topinard. Comparing these pictures and a number of the skulls of indigenous New Caledonians with those of native Australians, he finds that while the former exhibit a greater unity of type than the latter, they also differ from them in presenting a roundness in the contour of the face, due to a predominance of the cellular tissue, which contrasts strongly with the well-marked muscles of the Australian. Their affinity with the negro and New Guinea Papuan types is incontestable. M. P. Topinard discusses in another paper the relative merits of the craniometric and facial modes of measurement, adopted the one by Daubenton and Camper, the other by Blumenbach, and Prichard, and the results obtained by M. de Quatrefages with the instrument invented by him, and named *goniomètre pariétal*. The speaker considers Prichard in error when he attempts to include all Mongolian groups generally under his so-called "ogival" cranial form, this form belonging, in fact only to the Esquimaux.—M. Lagneau wishes to draw the attention of anthropologists to the peculiarities still observable in the people of some parts of La Gironde, known as "Gavaches," or "Marotins," who are descended from certain Angevins, called into the district in about 1525, to repair the ravages caused by a virulent epidemic. In their indolence and slowness they differ strikingly from the vivacious Gascons, among whom they live.—The discovery in the lacustrine houses of Switzerland and Savoy, and in the Lake of Bourget of bronze rods, surmounted with movable rings, has called forth explanations from all quarters. Carl Vogt, among others, has come forward in response to M. Mortillet's invitation to supply him with a clue to their use, and according to him we still have a similar instrument in the "Ringelstock" of the German herdsman, which is formed of a stout nut-stick, terminating in a lateral branch, on which are hung several metal rings. If the noise is not successful in bringing back the animal, the instrument is thrown at its head with an alarming clatter of bells. M. Hamy entertained the members of the society with an account of the eccentricities of Siamese and Chinese fashion in the development of the finger-nails, which, according to some of the fac-similes laid before the meeting, at times attain a length of forty, and even forty-five centimetres, although usually only that of ten or twelve centimetres; in most instances this process of lengthening carries with it a corresponding twisting and interlacing of the nails, which acquire the semblance of antlered horns.—M. Bertillon has for some time been engaged in a careful analysis of the preponderance of one sex over the other in first or second legitimate, and illegitimate births in France, and some other countries, more especially Austria. He finds that in France to every 100 females born alive, there are 105 males; while in regard to still-born births the excess is as 137 to 100. These relations are, however, found to differ essentially when illegitimate births are considered alone, in which case the proportion is as 1,031 males to 1,000 females. In Austria, where the official reports kept of the sex of first and second births admit of more precise calculations in regard to this point, it is found that first births are more frequently masculine, in the proportion of 110·3 to 100; second births being as 105·2 males to 100 females, while the general relation of the sexes for all births is as 106 males to 100 females. This, however, applies only to legitimate births; the proportion falling in the illegitimate to 105 males against 100 females. MM. Lagneau, Broca, and others, took part in the discussion which followed on the reading of M. Bertillon's paper on the Influences of Primogeniture on Sex. In relation to this subject we may refer to M. Sanson's report (laid before the society on May 4, 1876) of the influence of age, vigour, &c., on the offspring, as noted by himself, on sheep and other domesticated animals.—French local archæology and palæontology have received careful attention from the society during the past year. M. Pommerol has described the curious megalithic monuments which are to be found in close vicinity to the mineral springs, ancient mortuaries, and church at Saint-Nectaire, in Auvergne. A dolmen, hitherto known only to the local peasantry

[1] *Bulletins de la Société d'Anthropologie de Paris.* Tome onzième, 1876.

has been cleared from the superincumbent foliage and opened, revealing remains of skeletons which appear to belong to the polished stone-age. M. Lepic has discovered a series of bone-caves near Soyons on the Rhone, and known as La Caverne de Néron. Here human remains are found intermingled with rhinoceros, elephant, horse, and reindeer bones, an immense number of flints, hatchets, arrow-heads, &c. M. Lepic, in extending his explorations to the plain of Soyons, above these caverns, discovered unmistakable remains of human habitations, together with the ordinary kind of bone, silex, and other *débris*. In the latter, however, was found a large hatchet formed of hematite, the first of the kind met with; fragments only of the stone having been hitherto obtained. In the grotto of Savigny stag-horn tools have been found precisely similar to those in use among the Lapps and Esquimaux for smoothing down the rough seams of their skin garments. At the aqueduct at Nîmes a Celtic inscription in Greek characters has been brought to light, this being the third of the kind found in Southern Gaul. The Abbé Maillard has made a careful survey, and drawn up a comprehensive plan of the so-called prehistoric stations at Thorigné-en-Charnie. M. de Prunières has laid before the society the results of his examination of the dolmens of l'Aumède Lozère, in which he had found an enormous mass of human bones belonging, for the most part, to a dolichocephalic race. The great number of the cranial bones, which presented perforations and cicatrised margins, confirms the view that trepanning was resorted to by primitive men for various pathological conditions.—M. Fischer's paper on cave-conchology and his reference to the identification of Isle of Wight fossils at Langerie-Basse, led to an interesting discussion on the question whether navigation could date as far back as the age of bone caverns, or whether different geographical relations alone could explain the presence of shells far from their centres of origin.—M. Boyer has made the skulls found in the Puy-de-Dôme caves the subject of careful study, and shows that a greater variety of type is to be met with than is usually admitted, while M. A. Roujon has turned his attention to the general anthropology of the district, which has led him to the assumption that five distinct types have succeeded one another in France.—M. Mortillet has presented the society with a copy of a map of prehistoric France, drawn up by him for M. Elisée Réclus' "Géographie Universelle," in which he has noted down all stations, caves, and dolmens discovered up to the present time.—M. Piette has drawn up a report of the remains in France of a Gallic civilisation, as exemplified in the collections brought together in the exhibition held at Rheims in 1876. One of the most important of the papers included in the *Bulletins* under consideration is M. Lagneau's exhaustive review of the ethnic distinctions between Celts and Gauls, a question which necessitates a careful reference to classical authorities, and seems still far removed from any satisfactory determination.—Another question similarly open to discussion, although widely different in character, is considered by M. Topinard, who has made the publication of his manual of anthropology the occasion for discussing the differences of meaning, to be practically attached to the terms ethnology, anthropology, and ethnography. A summary of such a paper would be of little use, and from the minutely-detailed series of definitions which the writer has thought it necessary to give, it would appear that Frenchmen have been less ready than ourselves to accept the more special meaning of anthropology as applied to man zoologically, and distinct from man when considered in reference to characteristics of race.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900.—In a recent note upon solar eclipses that will be total upon the North American continent, reference was omitted to one in the last year of the present century. On May 28, 1900, the moon's shadow will traverse the southern part of the United States territory, entering it near New Orleans and passing off in Chesapeake Bay. The elements of this eclipse are as follow:—

G.M.T. of Conjunction in R.A., May 28, 1900, at 2h. 56m. 22s.

	°	′	″	
R.A.	64	56	48·5	
Moon's hourly motion in R.A.		37	16·9	
Sun's „ „		2	32·4	
Moon's declination	21	50	17·1	N.
Sun's „	21	27	15·3	N.
Moon's hourly motion in declination ...		2	38·5	N.
Sun's „ „ „ ...		0	24·2	N.
Moon's horizontal parallax		58	26·6	
Sun's „ „			8·8	
Moon's true semi-diameter		15	55·6	
Sun's „ „		15	47·0	

The central eclipse begins in 116° 34′ west of Greenwich, latitude 18° 0′ N.; it occurs at apparent noon in 44° 50′ W. and 44° 57′ N., and ends in 31° 45′ E. and 25° 21′ N. Other points upon the line of central eclipse in American longitudes are:—

	°	′		°	′			°	′		°	′	
Long.	96	15 W.	Lat.	27	9 N.		Long.	76	4 W.	Lat.	36	45 N.
„	90	9	„	30	7		„	70	29	„	39	1
„	86	28	„	31	57		„	58	23	„	42	47
„	79	17	„	35	20							

At New Orleans the eclipse will be total for about twenty-five seconds, commencing at 7h. 29m. 23s. A.M.; local mean time with the sun at an altitude of 30°, and at the point 76° 4′ W. and 36° 45′ N., totality will begin at 8h. 47m. 27s. A.M., and continue 1m. 39s., which is about the longest duration of the total eclipse in United States territory, and indeed the longest available for observation upon land, on this occasion. After traversing the Atlantic the moon's shadow enters Portugal near Ovar, where totality lasts 1m. 30s., and passes off Spain about ten miles south of Alicante. In Alicante the total phase will commence at 4h. 10m. 11s. P.M., local mean time, ending at 4h. 11m. 29s. At Greenwich a partial eclipse is visible, magnitude 0·68, at 3h. 54m. P.M.

COMETARY NOTES.—Tempel's comet was detected at the observatory of Arcetri, Florence, on July 19, and as stated last week by Prof. Winnecke at Strasburg on the following evening. From the Strasburg observation it appears that the comet will arrive at perihelion September 7·1646 G.M.T. It has also been observed in this country with the aid of the ephemeris, given in this column.

Of the supposed comet reported to have been discovered by Mr. Lewis Swift on July 7, we have no further intelligence.

In a communication to the Royal Astronomical Society, Mr. Tebbutt, of Windsor, New South Wales, puts upon record the circumstance of his having first determined the orbit of the great comet of 1861, in addition to having been its first discoverer (on the night of May 13). Mr. Tebbutt's name was not associated with this grand object in Europe, in the same manner that the great comet of 1858 had been associated with the name of Donati, for the simple reason that there being no telegraph from Australia in that year, the news of his discovery did not reach Europe till the comet had so far diminished in brightness as to be of interest only to the astronomer. Otherwise a message by cable that a large comet discovered by Mr. Tebbutt might be looked for above the European horizon at the end of June, would doubtless have led to "Tebbutt's comet" being as universally known as was "Donati's comet" three years earlier. The period of revolution of Tebbutt's comet is just under 400 years, while that of Donati's is little short of 2,000.

Encke's comet will just be coming into view at the observatories of the southern hemisphere, where it is important for the theory of this body that observations should be continued as long as practicable. It was in perihelion on July 26. At the next return in 1881, its track in the heavens will be very favourable for observation in these latitudes.

THE SATELLITE OF NEPTUNE.—In the *Monthly Notices* of the Royal Astronomical Society for June, Mr. Marth has furnished data founded upon Prof. Newcomb's tables, from which the position of the satellite of Neptune may be readily determined for any time during the approaching opposition; but with the approximate times of superior and inferior conjunctions (the angles being 311° and 131° respectively) which are appended, the part of the orbit in which the satellite must be found is easily ascertained without calculation. As has been known since the year 1853, the orbital motion of the satellite is retrograde.

GEOGRAPHICAL NOTES

THE distinguished Italian traveller and naturalist, Sig. L. M. D'Albertis, who has been exploring different parts of New Guinea since 1872, and in 1876-77 made two expeditions into the interior of that country by the Fly River, has arrived in London with his large collections in every branch of natural history.

DR. VAN DER HORCK, who lately made so valuable a tour through Lapland to the Arctic Ocean, is at present organising in Berlin an expedition for the especial purpose of studying the question of the original settlement of America by Asiatics. It is intended that the expedition, which will last from three to four years, shall coast along the entire eastern shore of Asia, up to the Polar Sea, visiting all the chief islands by the way, and then, crossing at Behring's Straits, follow the American coast to San Francisco. The expedition will follow the customary programme of a scientific voyage, making surveys, dredging, collecting objects in natural history, &c. The anthropological features will, however, be the most important, and every effort will be put forth to collect and classify all existing clues to a distant emigration from Asia to America. It is hoped that evidences in this direction may be found on the isolated groups of islands in the more northerly regions. Ample funds have been put at the disposal of the expedition, and it starts under the auspices of the German government and the Berlin Geographical Society.

THE services of the scientific element in the recent Berlin Congress have been recognised by Her Majesty's conferring the honour of knighthood on Mr. Edward Hertslet, C.B., F.R.G.S., Librarian of the Foreign Office and Keeper of the Archives, who perhaps had as much to do with the settling of the boundaries of the new states as the Prime Minister himself.

THE United States Coast Survey steamer *Blake*, which returned some weeks ago from dredging operations in the Gulf of Mexico, is now refitting for another expedition in November. Capt. Patterson, of the Coast Survey, we learn from the *Tribune*, says that the extensive and accurate soundings of the Gulf taken by improved scientific methods in the recent expedition, do not tend to confirm the belief, long held, that the equatorial current, after rushing from the Caribbean Sea through the channel formed by the West India Islands and the northward projection of Yucatan, makes the whole tortuous circuit of the Gulf close by the shores of Central America, Mexico, and the southern coast of the United States, before emerging into the Atlantic between the point of Florida and the Bahamas. The observations tend rather to prove that the force of the incoming equatorial stream expends itself in one direction against the mass of the Gulf long before it reaches the Texas coast, and then turns directly toward and reissues into the ocean. The old theory in regard to the current being unsettled, the expedition now to be made will proceed to repeat certain experiments, and to make others, with the view of either confirming or destroying the latter hypothesis. Exhaustive observations will be made of the region of ocean in and around the eastward islands of the Caribbean Sea, through which the equatorial current makes its entrance, as through a sieve, from the Atlantic into the long channel, 1,500 miles long, formed by the West Indies on the one side and Central and South America on the other, and leading to the Gulf of Mexico. From the experiments and observations of this expedition Capt. Patterson hopes for results which will go far toward laying at rest all merely speculative theories relating to the Gulf Stream. In connection with the investigations hitherto conducted by the Coast Survey expeditions in the Gulf of Mexico, it has been ascertained that the vast current of water pouring from the Gulf into the Atlantic, through the Florida and Bahama gate, has neither the same velocity nor the same temperature. It is believed by Capt. Patterson and his associates that further attention to this curious fact may develop results having an important bearing upon the science of climate and meteorology, making predictions possible as to changes in the seasons of the European countries affected by the Gulf Stream from the observed quantity and temperature of the flow through the Florida Straits.

THE Paris Geographical Society has recently received some interesting intelligence respecting M. Savorgnan de Brazza's explorations on the upper part of the River Ogowé, in Western Equatorial Africa. Having learned from the natives at Dumé that there were some falls on the Ogowé, in the Aduma country, he got together with some difficulty a party to show him their locality. On the way up the river the inhabitants fled from their approach, as they believed that white men brought small-pox with them. On the fourth day the expedition encountered the first rapids on the Ogowé after leaving Dumé; they became more and more numerous, and the breadth of the river diminished considerably. Further on sand-banks extended across the river, which became a succession of rapids in the country of the Atzianas. Among the Akanigues, higher up, the villages are described as very numerous and close together, and the country well cultivated and mountainous; the inhabitants collected on the banks to see the expedition pass. On the tenth day the explorers arrived at the River Passa, which has a strong current, and which is nearly as important as the Ogowé, there become comparatively narrow. On the following day they found themselves face to face with a large sandbank and a strong rapid, which their guides declared to be impassable. Dr. Ballay, one of the party, went by land to Pubava, some twelve miles above the rapids, and found that the Ogowé is not more than twenty metres broad above the falls; he thinks that the River Passa will probably furnish a more convenient route to the eastward than the Ogowé.

As might be expected, Petermann's *Mittheilungen* for August is largely devoted to papers bearing on the recent changes in the East. First we have an article, written before the conclusion of the Berlin Congress, on the territory claimed by Russia from Turkey in Asia. Next comes an important study on the Kara Kum desert, with reference to the proposed Central Asiatic railway. Following this is a series of tables of population statistics on the Sanjak of Seres, in Macedonia. There is also an important paper on Herero Land, in South Africa, to accompany a new map of the region, based on the observations of the Rhenish missionaries, especially those of Herren Böhm and Bernsmann. The number concludes, as usual, with Dr. Behm's admirable monthly summary. Besides the map of Herero Land, there are maps of Armenia, to show the region claimed by Russia, and of the south-east of Europe and Turkey-in-Asia, as re-adjusted by the Berlin Congress.

THE Buenos Ayres *Standard* furnishes some particulars of interest concerning Don Francisco P. Moreno's explorations in Southern Patagonia. The River Gallegos, it appears, has a mean velocity of four to five miles an hour, and is fed by the snows which fall in winter on the volcanic lands. It has two sources, which unite after a short distance, and two small tributaries to the south. The valley could be utilised for agriculture; on both banks mounds of lava are met with towards the south, forming black rocks with broken fragments like columns, wearing an appearance of an ancient city in ruins. All these peaks as far as Cape Virgin are extinguished volcanoes, of an average height of 860 feet. Don F. Moreno believes these eruptions to have been entirely independent of the Andine volcanoes. Between Gallegos and the banks of the San Gregorio, where these peaks are found, they have risen more irregularly than in other parts of Patagonia. The road winds capriciously through low valleys, watered by pools and rivulets, then through sterile tracts, and now and again over grassy elevations. At the confines of the Meseta (table-land) the face of the country changes. To the right the blue and white line of the snow-clad mountains stands out in relief. To the left is seen the summit of San Gregorio, then the narrow Straits, and further off the Fuegian Plains, enveloped in fog and lurid fires. At the Brunswick Peninsula on the Straits the landscape is particularly verdant and undulating, with mineral veins here and there and small woods of the "Calafate" (*Berberis*), which produces a delicious fruit. With regard to the climate of these southern regions, in the western part rain and storms are continual, and it would be difficult to populate it, but on the east the climate is more favourable, and those sudden and terrible atmospheric changes that cause so many shipwrecks are unknown. Don F. Moreno is of opinion that the climate from the River Santa Cruz to Cape Horn may fairly be compared to that of Great Britain, from the English Channel to the north of Scotland. On the high lands it is dry, with night dews, but little rain. In winter snow falls, but in spring, summer, and autumn, the climate is delightful, with some few days of intense heat.

THE new part of *Appalachia*, the journal of the Appalachian Mountain Club, contains Prof. Scudder's presidential address, an exhaustive summary of the various North American surveys, and explorations during the previous years. There are other valuable papers connected with the exploration of the Appalachians; one by Prof. C. H. Hitchcock gives an account of a large number of glacial markings in the White Mountains.

A WORK of great interest is now in course of publication at Vienna (Hartleben): "Die Sahara—von Oase zu Oase," by Dr. Joseph Chavanne. Up to this date twelve parts have appeared; they give excellent descriptions of the great African desert itself and of the tribes frequenting it. The scientific materials are worked out into attractive pictures with considerable skill; the reader travels in thought through the Oasis of Ziban, then makes the acquaintance of Biskra and its people, the so-called Paris of the desert, passing across the El Arnat and through the land of the Beni Mzab as far as In Salah and Tafilet. Numerous well-drawn illustrations add considerably to the attractions of the work.

A NEW book of special interest at the present time has just been published by Cotta, of Stuttgart. Its title is "Cypern, Reiseberichte und Landschaft, Volk und Geschichte." The author is Herr Franz von Loeher.

LETTERS have been received in Holland from Vardö, reporting that every one on board the *Wilhem Barentz*, the schooner of the Dutch Arctic Expedition, was in excellent health, and that hitherto the vessel had behaved admirably.

ON PREHISTORIC REMAINS IN BRUNSWICK[1]

A LARGE quantity of prehistoric remains have been found in the diluvial loam of Thiede and Westeregeln, in the Duchy of Brunswick. This fossil fauna of Thiede numbers about thirty species—the common loess molluscs (*Helix hispida*, *Pupa muscorum*, *Succinea oblonga*), together with remains of horse, reindeer, *Rhinoceros tichorinus*, *Elephas primigenius*, some carnivora, and rodents (as lemming, *Myodes torquatus*, *Arvicola gregalis*, &c.). The lemmings appear especially in the lowermost beds, with some few remains of reindeer and Arctic fox; in the middle beds they are associated with remains of horse, rhinoceros, and elephant, and gradually disappear in the higher horizons.

The fossil fauna at Westeregeln, numbering more than thirty species of mammals alone, is far more abundant and more varied. The mammals are bat, shrew, hyena, lion, wolf, Arctic fox, bear, badger, and especially rodents, all of them (the hare excepted), such as habitually live in holes underground, in steppe-like regions. Among them is *Arctomys bobak*. The remains of *Spermophilus altaicus*, of *Dipus*, and of several species of *Arvicola*, are extremely abundant. Lemming, hare, and lagomys are also met with. The presence of horse, reindeer, bos, and antelope has been ascertained, together with some few bones of *Elephas primigenius* and *Rhinoceros merki*. A well-developed trapezium of a peculiar horse may be possibly interpreted as a connecting form between *Equus* and *Hipparion*. The dental system of *Spermophilus* offers likewise some remarkable particularities. The birds are represented by eleven species—ducks, *Gallinaceæ*, pigeon, lark, bustard, vulture, and largely by species of *Fringilla* and *Hirundo*. Remains of bactrachians (*Bufo*, *Rana*, and *Hyla*) abound in certain localities. Of fishes only one-half of a pike's lower jaw has been met with. The number of molluscous species amounts to seven. The co-existence of insects may be inferred from the presence of many insectivorous mammals and birds.

Man's co-existence is attested at Thiede by axes of the stone period, found immediately beneath the humus; also by flint implements, and traces of fire-places in the lower beds of the loess. At Westeregeln splinters of flint, small fragments of charcoal, and broken bones of animals, indicate the presence of human beings, either permanent or occasional, during hunting excursions. According to Mr. A. Nehring, the discoverer of these deposits, their fauna approximates to the Steppe fauna of south-west Siberia, and is co-eval with the post-glacial period, when Northern Europe had an extreme continental climate. In the neolithic period, this fauna, as indicated by the remains of deer, bear, and beaver, assumed a sylvan character, persisting down to the times of Cæsar and Tacitus.

Mr. Nehring supposes the loam in question to have been transported and deposited by water, admitting, however, the occasional transport of materials by storm winds. Dr. Tietze thinks that the presence of fishes and batrachians offers no objection to the sub-aerial, or wind-origin, of this loess, as fishes, frogs, lizards, and tortoises, live on the steppes of Persia, and are even characteristic of their fauna; and fishes are also found in the artesian wells of the Sahara. Some known facts support the idea of the sub-aërial origin of deposits in localities having nothing in common with steppes. In 1866, the wind blowing from the south, the snow was covered with a stratum of yellow dust; the same phenomenon was observed at Kasan in 1872. Mr. D. Stur ascribes to the action of winds the recent thin layers of quartzose and micaceous particles accumulated on the slopes of the limestone Alps.

[1] By M. A. Nehring and Dr. Tietze. (*Proc.* Imper. Geol. Instit., Vienna March 5, 1878.)

THE TAY BRIDGE

THE new bridge across the Tay, at Dundee, recently completed according to the plans of Mr. Bouch, M.I.C.E., by Hopkins, Gilkes, and Co., of Middlesborough, is the longest structure of its kind in the world. What renders it more remarkable than its enormous size even is the originality in its conception and mode of execution, the result of which has been a structure of great stability and comparatively small cost. Popular accounts of the work have appeared in various publications during its progress and since its completion; but there are various scientific aspects of the undertaking which have not been adequately described. The present article will refer to such technical details as may be of value to those who study the application of scientific principles to industrial ends.

The new methods employed in the construction of the Tay Bridge cannot any longer be regarded as experiments. The severe tests imposed by the Government Inspector and by a heavy traffic uninterrupted during several months removed all uncertainty as to their success and make them of greater value. We may now therefore speak of the details of the structure, so far as these are based on scientific principles, with confidence, seeing that the trial of the bridge may now be regarded as conclusive.

The bridge consists of 85 spans varying in length from 27 to 245 feet. Beginning on the south side there are first 3 spans of 67 feet, then 2 of 88, then 10 of 130, then 13 of 145, 13 of 245, 1 of 162, 11 of 130, 25 of 69, 1 of 170, and 6 of 27 feet. The direction of the approaches on both sides made it necessary to introduce a curve of 1,320 feet radius at each end of the bridge; that on the north side extending over 88°, and that on the south over 16° 30′, the central part of the bridge, 7,960 feet long, being straight. Of the thirteen 245 feet spans, 7 are level, and placed so high that they offer a clear water-way of 88 feet at high water. From these northwards, a slope of 1 in 73 brings the structure to the required height to join the land line, while southward an incline of 1 in 365 serves the same purpose. In order to gain as much clear height as possible in the channel used for navigation, the roadway is laid on the bottom of these large spans, the trains running between the girders, while on the other parts of the bridge, with the exception of the 170-feet span on the north side, the sleepers are fastened on the top of the main girders.

Nature of the River and its Bottom.

The Tay is a tidal river about two miles wide at the site of the bridge. The rise and fall of the tide in ordinary spring tides amounts to about 15 feet, but local circumstances affect this height to a great extent, the difference between the observed and the computed heights sometimes amounting to 3 feet. The strength of current is about five knots per hour. Fig. 1 shows the depth of the water and the nature of the river bottom. The greatest depth is found between piers 15 and 20, but a bank a short distance above the bridge closes up what otherwise would be the best channel for navigation. The rocks on both sides consist of trap. At the south side they rise abruptly to a height of 53 feet, the base being washed by the flood-tide. The river bed to 100 yards out from the south shore is composed of gravel overlaying blue clay with beds of peat and large layers of decayed hazel nuts which at one time grew in abundance near the site of the bridge. Further out the gravel gets coarser, and boulders are found on the river bottom. The trap rock disappears at pier 5, and its place is taken by red sandstone with a rather worn surface. At pier 20 the surface soil consists of sand, and continues to do so to within a few yards of the north side of the river. The sandstone has a northerly dip increasing at pier 15, and from this point northward to pier 78 rock is not any longer found at a depth which makes it available for foundation.

The old river-bed, consisting of gravel and clay, continues, however, almost level along the whole line of the bridge. The sand overlaying it is very sharp and pure and contains a large number of shells. Underneath the gravel is a mixture of sand and clay. From pier 70 northward layers of peat and decayed wood are often found in the sand.

Plan for the Foundations.

The following plan was followed for the foundations:—From pier No. 1 to No. 14 the rock had to be reached, the weight per square foot of surface amounting to eight tons. Piers No. 15 to No. 19 consist of a caisson sunk only a few feet into the bottom, and then piled, each pile having to carry a weight of twenty-five tons. Piers No. 20 to No. 80 are founded on the gravel layer, the pressure per square foot being about two tons. Thence to the north shore the piers rest again on rock.

General Description of Piers.

Before describing the *modus operandi* adopted in building the bridge it will be well to give a short description of the piers. The first three commencing from the south side have a rectangular section. At the base they are 14 feet 6 inches by 7 feet 6 inches, and at the top 11 feet 6 inches by 4 feet 6 inches. The clay is excavated at low water, and the rock levelled. A concrete foundation is put in, and on these the piers are erected solid in brick and cement. On the top they have a cope of stone 15 inches in thickness, and on this rest the bed plates and girders. For piers No. 4 to No. 14 two cylinders having at the base a diameter of 9 feet 6 inches are placed at a distance of 12 feet, centre to centre, and connected by a web wall 2 feet 6 inches thick. Under water they consist of brick tubes surrounded by a cast-iron casing 1 inch thick, the centre of each cylinder and the common base being filled up with concrete. Above water the diameter is 8 feet 6 inches below and 6 feet 6 inches on the top, and they are finished off with a course of stone in the same manner as the first three. From piers Nos. 15 to 58 the work above high water consists of iron columns varying in diameter from 12 to 20 inches, and having a thickness of metal of 1 inch. These are braced together by horizontal and diagonal bracings and filled with cement to prevent interior corrosion. In the under water work they differ widely according to the nature of the river bottom and the weight they have to sustain. For those from 15 to 19 a malleable iron caisson 10 feet high, oval in shape with a major axis of 23 feet, and a minor axis of 16 feet is provided with a lining of brick-work 9 inches thick and sunk a few feet into the river bottom. Forty piles are then driven inside as far as a one-ton ram falling from a height of 10 feet will drive them. The depth to which they penetrate varies from 15 to 20 feet. These piles are cut off 3 feet above the ground, and the caisson is filled up level with concrete. On top of this concrete a hollow brick pier, hexagonal in shape, is placed, and the space inside up to low water is also filled with concrete. From low to high water the concrete is replaced by solid brickwork, and a course of stone brings the height of these piers to 5 feet above high water. Piers Nos. 20 to 27 are constructed by joining two 15-feet diameter cylinders above low water, after sinking them through the sand to the gravel bed. They are then carried up in the same manner as described for 15 to 19. The fourteen piers supporting the thirteen large spans have a 31-feet malleable iron cylinder with a lining of brickwork 14 inches thick, and are sunk to the gravel layer, and of such height that after reaching the solid bottom their top is slightly projecting above the river bottom. They are then filled in with concrete, and a brick block corresponding in shape with those used for the other piers, but of greater dimensions, measuring 27 feet in the longest, and 16 feet in the transverse direction, is put on the foundation, filled with concrete, and carried up solid to high water, where it has a cope 5 feet thick. For the 162 and 130 feet spans on the north side the construction is similar to that adopted for piers 20 and 27, while the shorter spans in

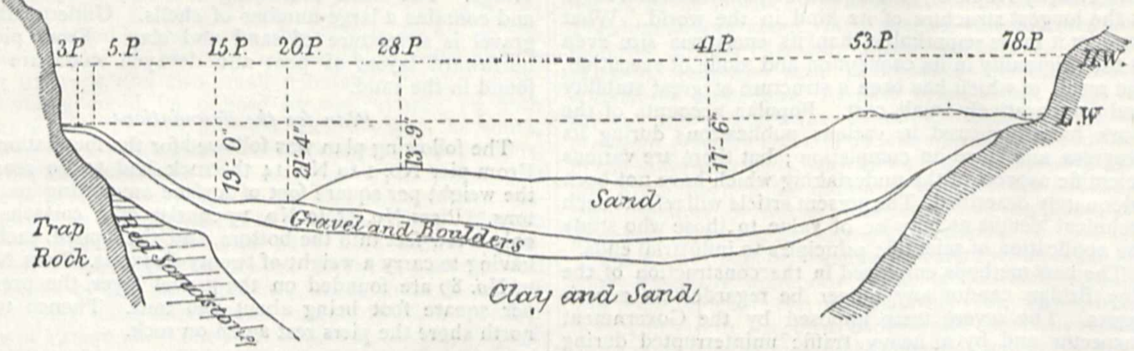


FIG. 1.—Section of river. Horizontal scale 2,000 feet to 1 inch. Vertical scale 50 feet to 1 inch.

the curve are supported by columns set in 6-feet cylinders sunk to the required depth and filled up with concrete.

No Staging to be Used in the Construction.

The change in the nature of the river bottom, the great height at which the bridge had to be constructed and the heavy gales which are prevalent in this part of the country made it necessary from the beginning to depart from the rules generally laid down for the construction of such works. The erection of scaffolding and staging was by these circumstances rendered impossible; and a series of operations were substituted for these old methods which by their success proved to be great improvements, and must have great interest to engineers and others less directly connected with such

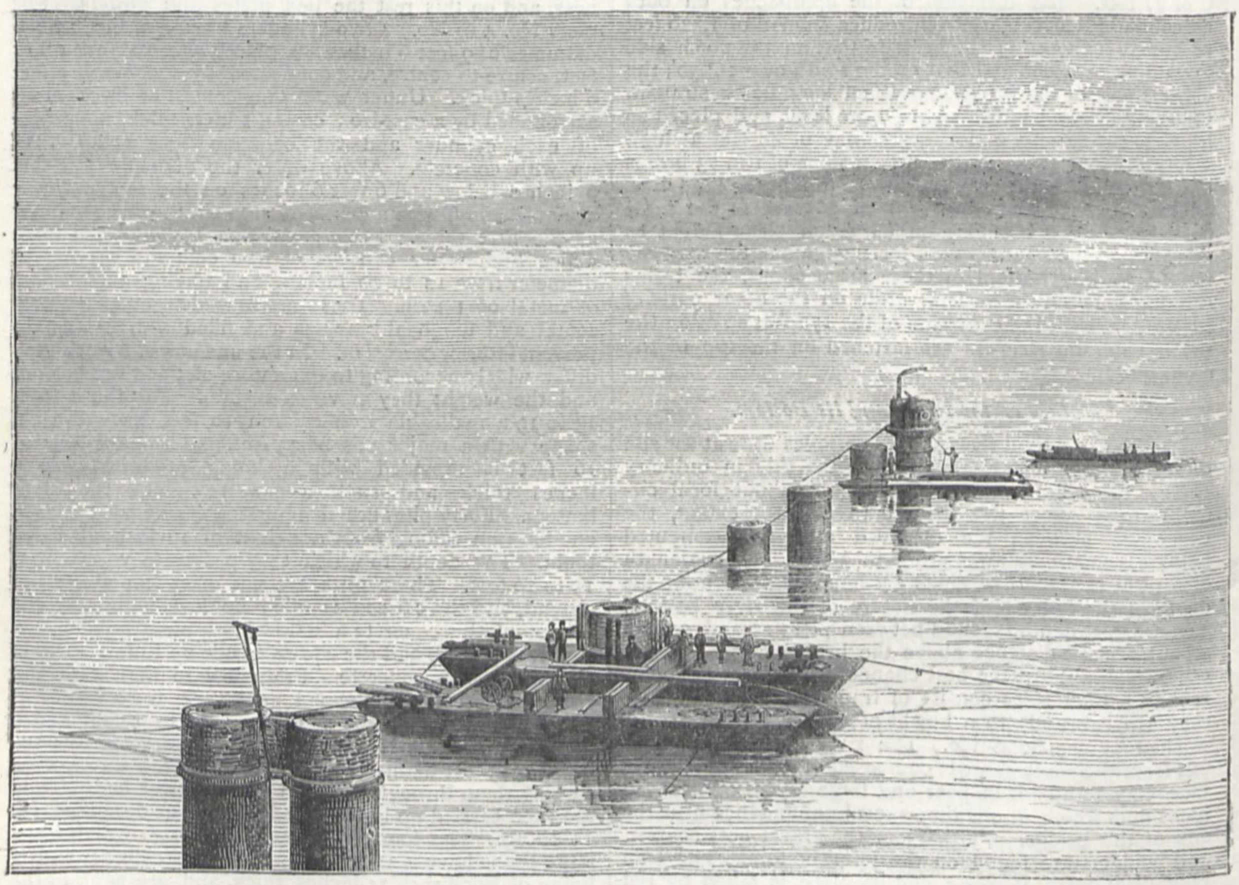


FIG. 2.—Floating and sinking piers.

undertakings. As a rule the building operations were entirely conducted on shore, and for this purpose it was necessary to make preparations which took up the best part of the first year. In addition to the ordinary landing jetties, workshops, and stores, special arrangements had to be made for building the piers and erecting the girders in such a manner that they could be transported to their permanent places without great difficulty. Level foundations of concrete and stone were constructed on the foreshore, some of which were used to put together and rivet the iron caissons forming the outer shell of the piers, others to build the brick work for that part of the piers between the river bottom and low water.

Building and Floating the 9-feet 6-inch Cylinders.

After the caissons had been put together and the brickwork built in, they were floated between barges to the point where they had finally to form part of the structure. The apparatus employed for lifting them consisted of a system of iron girders resting on barges. Flat bars or links having 2″ holes 12″ apart, connected the base of the

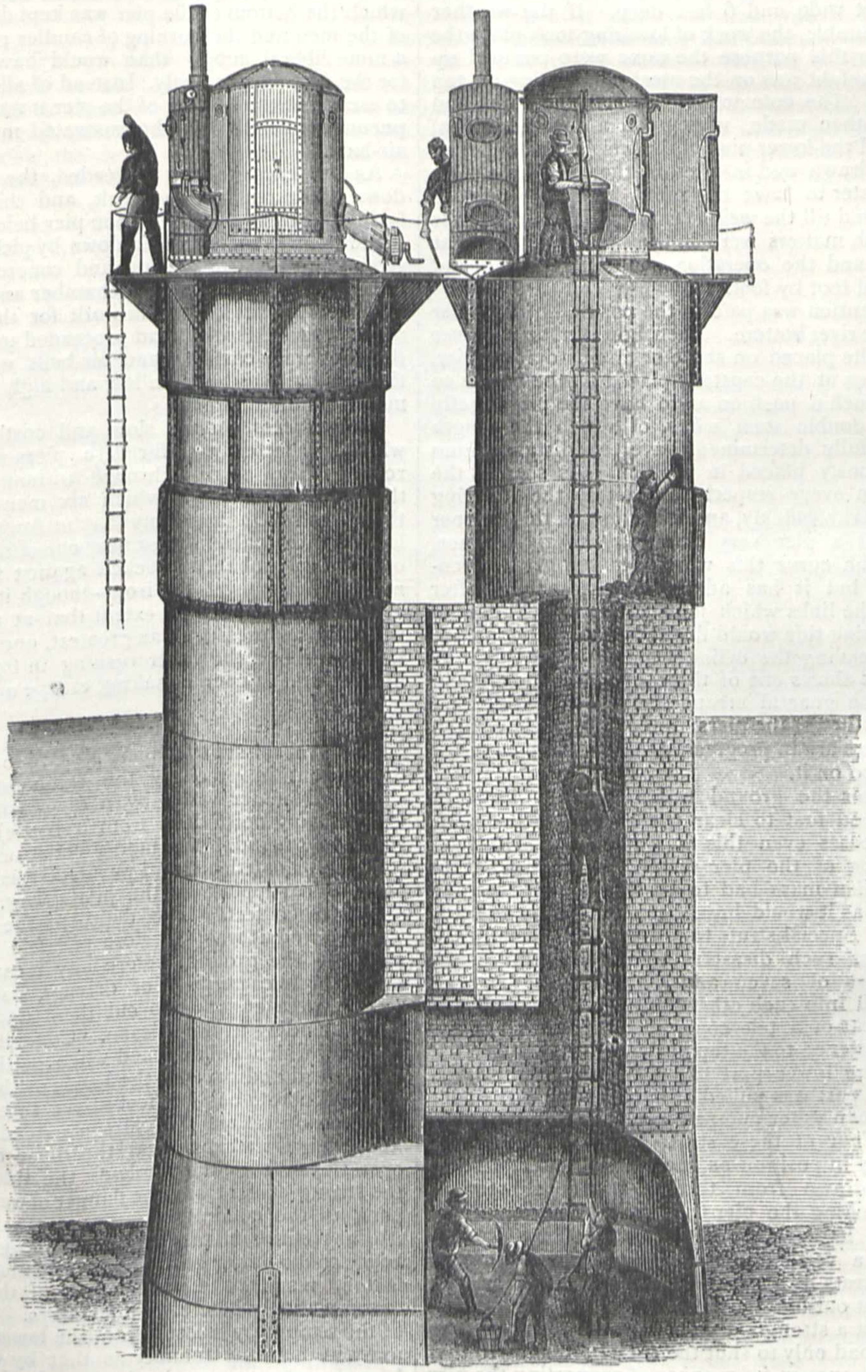


FIG. 3.—Sinking of piers by compressed air.

piers with hydraulic rams placed on these girders. The weight could either be taken on the girders direct or on the rams. At high water the girders were floated over the top of the piers, and after the tide had receded, and the base was accessible, the connection between the lifting links and the base of the cylinder was made. As the tide rose again it lifted the barges, and with them the pier, hanging between them off its resting-place, when it could without difficulty be towed to its destination, where previously moorings had been prepared for it. For this operation it was of course necessary to have a tolerably calm day, and as the weather in the Tay is subject to very rapid changes, the operation was sometimes interrupted and frequently endangered by sudden gales, it becoming necessary to take the piers away from the place where it was intended to lower them, and as they could not be placed back in the same position they had to be taken to Dundee Harbour for shelter. The weight of these piers was about 100 tons, and the carrying barges were 60 feet long by 12 feet wide, and 6 feet deep. If the weather continued favourable, the work of lowering took place the same tide. For this purpose the rams were pumped up 12″ while the weight was on the steel pins resting on top of the girders. The connection between the rams and the links was then made, whereupon a few additional strokes relieved the lower pins of the weight, so that they could be withdrawn and inserted in the next hole. By allowing the water to leave the rams, the pier would of course be lowered till the weight came again on the lower pins, after which matters were in the same position as at the beginning, and the operation could be repeated, and the pier lowered foot by foot.

No great attention was paid to the position of the pier till it neared the river bottom. Then, however, an observer with a theodolite placed on shore or on an adjacent pier, directed the men at the capstans placed on the barges to draw them to such a position as to have the pier exactly in line, while double steel wires, of which the length had been carefully determined, gave the distance from the pier previously placed in position. As soon as the position was in every respect satisfactory the lowering was proceeded with quickly, and it became in this manner possible to put a pier very nearly in its right place. Especially in the curve this work required great attention and care, but it has admirably succeeded. After disconnecting the links which joined the lifting girders to the piers the rising tide would float these with the barges over the top, leaving the cylinder standing on the river bottom. Fig. 2 shows one of these cylinders moored in the river and the general arrangements for floating and lowering. Another of the piers is ready to 5′ above high water, and others are in progress. One has the pneumatic apparatus placed on it.

In most cases the ground was sufficiently level, in others divers had first to clear the bottom of boulders, and in three cases even this was not found effectual, and the settling of the pier on one side caused it to upset. The fallen mass had to be lifted out of the road and broken up as it would have been too costly to set it on end again. Special struts to prevent the possibility of a recurrence of such disasters were then introduced. Two iron tubes of seven and eight inches diameter respectively slid into each other by means of a stuffing-box like the parts of a telescope. The upper end of the top part was fastened to the top of the pier and connected with a pump, the lower part had a mushroom-like base, and when this part was pulled away from the pier under an angle and then water pumped in it took a firm hold in the ground. Four of these struts applied to each pier held it perfectly in position as long as the water pressure was not withdrawn from them. In the subsequent operation of sinking the pier the cocks giving egress to the water were left open, and as long as the motion of the pier was a vertical one the water would escape from all four struts in a gentle flow. As soon, however, as the pier went out of the perpendicular the strut on that side would eject a stronger stream of water, and the man in attendance had only to shut the cock pertaining to that strut to make it answer its purpose of supporting the pier on the side to which it was inclined to fall. This apparatus fully answered the purpose for which it was constructed.

Sinking by the Pneumatic Process.

In order to sink the piers through the layer of clay overlying the rock the pneumatic process was employed. Temporary castings were added to the top of the pier bringing the latter above the highest water, and a malleable iron air-bell, having the usual air-lock for the passage of the workmen, and smaller locks for the passage of excavating material to the outside or concrete to the inside was placed on the top (Fig. 3). A six horse-power steam-engine, connected with an air-pump, supplied the air by the pressure of which the bottom of the pier was kept dry. The breathing of the men and the burning of candles required, of course, a more liberal supply than would have been necessary for the first purpose only. Instead of allowing this surplus to escape at the bottom of the pier it was used to drive a pneumatic hoist lifting the excavated materials up to the air-lock.

As the excavations proceeded, the pier would sink down till it reached the rock, and this movement was facilitated by the bottom of the pier being slightly conical. The rock was then levelled down by pick-axes and chisels so as to give a firm bearing, and concrete material introduced filling up the bottom chamber and the shafts which had been left in the brick-work for the passage of the men. When this work had proceeded to above low-water, the temporary castings and air-bells were removed and the pier built up between low and high water in the usual manner from a barge.

This process, though slow and costly, worked on the whole satisfactorily, so far as the piers were founded upon rock. It was carried through without many accidents, though one occurred in which six men unfortunately lost their lives. On a stormy day in August, 1873, a barge loaded with coals, moored near one of the piers in process of sinking, probably knocked against the structure and must have damaged the iron—though it was not observed at the time—to such an extent that at the next high tide, when the air pressure was greatest, one of the top plates was blown out, the water rushing in from both top and bottom, and of course making escape an impossibility.

Piled Piers.

The oval caissons for piers Nos. 16 to 19, were built, and floated out in precisely the same manner, and then excavated under water by a diver (the excavated substance being hoisted up from a barge) and sunk 2 feet into the ground. A staging constructed of angle iron was then floated out and put over this caisson, and was used as a support for the pile driver. The piles had a length of 60 feet. The depth at the highest tide was 45 feet, and it was therefore possible to drive them 15 feet into the ground, before any means of lengthening them for the purpose of driving, had to be adopted. Divers were engaged to cut them under water, leaving 3 feet standing in the caisson. Concrete lowered in large buckets, which only opened when getting to the bottom, surrounded and covered the heads of the piles, the height of the concrete being 7 feet above these heads. During all these operations the caisson extended temporarily to above high water, so that the diver could continue his operations during the whole of the tide, notwithstanding the strong current, and the danger of washing the essential parts of the concrete away was considerably lessened. An inspection, undertaken for the purpose of ascertaining how far the latter had been successful, gave very satisfactory results, the whole mass of the concrete being found perfectly hard after a few days. The disconnection of the temporary caisson from the lower part, and floating away in the same manner as that by which it had been brought out was a work of little difficulty.

The floating out and fixing of the brick pier which was put on top of this concrete foundation will be described more fully with the operations necessary to complete the large piers. These are certainly the most interesting ones on account of their magnitude, although this very size may have been the means of avoiding particular difficulties which stood in the way of the work connected with the smaller piers. It has been found throughout the operations that in a river subject to such vicissitudes as the Tay, the handling of a very heavy mass is a far less intricate and difficult matter than that of lighter weights, and during the execution of the work connected with the larger spans the operations were not in the least interrupted by weather which would have been absolutely fatal to the smaller piers.

Work on the 245-feet Span Piers.

The under-water work of the large piers can be conveniently divided into three parts: that of building, floating, and sinking the caisson; that of building, floating, and fixing the brick pier; and that of bringing it up to the required height five feet above high water. The first two are, of course, by far the most important. The lower caisson consisted of ⅝ inch malleable iron plates riveted together so as to form 31 feet cylinders 20 feet high. After erecting this structure on the foundation on the foreshore prepared for it, a lining of brickwork 14 inches thick was built inside. This lower part was to form part of the permanent structure. On top of it and connected with it by a bolted horizontal joint, another length of plates was built bringing the whole up to 40 or 44 feet of height, according to the depth of water. This top part merely served a temporary purpose, and in order to resist the effect of the waves and current it was provided with angle iron stiffeners to a far greater extent than the permanent part, which derived sufficient stiffness from its lining of brickwork.

Fig. 4.—Sinking of large caissons.

At four points of the circumference T iron strips ran vertical from top to bottom, and were riveted to the caisson. In these strips or links there occurred three and a quarter inch holes at intervals of 1 foot, and by putting steel pins of slightly smaller diameter through these holes, it became possible to obtain a hold with the hydraulic rams by means of a girder with a claw-like end placed on their tops. The hydraulic rams were placed on the four corners of a square system of girders having projecting ends for the barges. On the under-side of these girders a claw similar to that found on the top of the rams made it possible to take the weight of the pier either on the four lower claws, or the four top claws, which were connected with the hydraulic rams.

Two pontoons, each 70 feet long, 20 feet wide, and 7 feet deep, lifted the weight of girders and the piers standing in between them off the ground by means of the lower claw. It was then floated out; and so powerful was the resistance which the heavy mass, weighing about 200 tons, offered to the current, that two strong tug steamers had to be employed for this purpose. Arrived at its destination, it was securely moored. The first one floated in this manner had to withstand the fury of a three days' gale, during which it had to be left out in the river, the waves washing right over the barges, the hatchways having been nailed and caulked to keep the water out.

To lower the caisson the rams were pumped up 12 inches and the steel pin which connected the upper claw with the caisson inserted. By pumping up again the weight was taken off the lower claw, the pin which had held it there withdrawn and inserted in the hole a foot higher up. The water was then allowed to flow out of the rams and the weight to come down on the lower pin again, during which operation the caisson had necessarily been 12 inches lowered. The work of adjusting it in its right place was accomplished in the same manner as described for the smaller piers. The first of these caissons was lowered down on August 28, 1875, and the same afternoon the floating girders and barges were withdrawn, and the pier left standing on the sandy bottom. The tide was particularly strong, and from the resistance which this mass offered to its flow washed away the sand round about it, thereby causing the pier to heel over to such an extent that next morning it was more than 6 feet out of level. The centre of gravity of these piers, compared to the diameter of the base was, however, so low that no serious apprehensions were felt, and when the sand was excavated on the high side it soon came to the level again. It was always found possible with a little care to keep the pier nearly level in sinking by excavating on one side or another, and no such artificial means of keeping them upright, as had been adopted in the case of the smaller piers, became necessary.

Sinking the Large Caissons.

The best means of excavating the sand out of these piers had been a subject of very careful consideration, and numerous experiments had been tried with varying results, in order to find the best machinery for effecting that purpose. Finally, however, an apparatus constructed upon very simple principles by Mr. Reeves, one of the contractor's assistant engineers, was found the most efficient. The conditions which it had to fulfil were of this kind. It had to elevate the sand from the inside of the cylinder and drop it outside at a small cost, and it had to be constructed in such a manner as to be easily detached from the pier in case of a sudden gale. These conditions were fulfilled by placing the whole apparatus on a barge which could be moored alongside the pier and withdrawn with little trouble and at a moment's notice. On this barge were placed four air-tight tanks each having a circular hole in the bottom, closed by a door on which an india-rubber ring was fastened so as to obtain an air-tight closing. A steam-engine worked two exhaust air-pumps, and each of these pumps was so connected with two of the tanks that by means of a three-way cock either the one or the other could be put in communication with it. From the top of the tanks flexible pipes of 4 inches diameter ran down to the bottom of the pier, and their ends were in charge of the diver, who could direct them. Either of these tanks being put in communication with the pump would be exhausted, and a current of water mixed with sand would rush up the flexible hose, filling up the vacancy. A float indicated the height to which a tank was filled, and before any water or sand could enter the air-pipe and reach the valves, the attendant had to turn the cock which brought the other tank into communication with the exhaust-pump and admitted air into the full one. It then discharged its contents through a hole in the bottom of the barge into the river. The joints of the cylinder not being water-tight, the level of the water inside was always as high as that outside, and the only purpose of the temporary caisson was to protect the divers from the strong current, and give those in charge of the operation an opportunity of observing the position of the pier during its descent. Fig. 4 shows this apparatus at work by one of the large piers.

Building the Brick part of the Pier.

It will be understood that by the sinking of this caisson a hole was formed in the sand, the sides of which were kept up vertically by the caisson while the bottom was formed by the hard gravel layer. This pit was now filled with concrete to a couple of feet above the river bottom, and all the iron above that point removed. The concrete hardening became like a rock with a level surface of 31 feet diameter. The remaining part of the pier up to high water consisted of brickwork only. The lower portion was built on a level part of the foreshore in bricks and Portland cement, which became so hard that the block could be lifted from four points by means of barges and apparatus similar in all but the dimensions to that used for the floating of the 9′ 6″ piers. Previous to the building a layer of paper was spread on the temporary foundation in order to prevent the brickwork from adhering to it. The block was hexagonal in shape, measuring 27 feet in one direction and 16 feet in the other. Its height would depend on the depth of water at the place where it was to be used, and was so regulated that after depositing the block on the artificial rock foundation the top would be a little above low water. The weight of the blocks was about 200 tons. In the centre a hole was left answering a double purpose. First, it allowed the weight of the block to be kept below the point at which it would have become unmanageable and than the concrete which was put in this hole after the block was *in situ* would increase the adhesion between the brickwork and the foundation.

From low to high water line the pier was finished in solid brickwork set in Portland cement, the work of course being interrupted at every rising tide and taken up again when the water was low enough. Four courses of ashlar of an aggregate thickness of 5 feet brought the pier to the height at which the cast iron columns commenced and the bolts to hold down their bases weie fixed in the stone.

Superstructure.

In the erection of the iron superstructure the same principle of not employing staging in the river was adhered to. The iron-work as it arrived, in pieces of from 20 to 35 feet long, from the contractor's works at Middlesborough, was landed on a jetty near the shore about 260 feet long, over which a strong travelling crane could be moved from end to end. Here the parts were put together and riveted up. All the girders with the exception of the 170-feet span and the 27-feet spans, are parallel lattice girders having diagonal struts and ties. The section of the booms is trough-shaped, that of the compression diagonals H-shaped, while the tension bars are flat, varying in thickness from three-eighths to five-eighths of an inch. Those girders which have the roadway on top have half struts running up from the intersections of the diagonals to the top boom, while those where the load is at the bottom have tie-bars for the same purpose. The depth of the 245 feet spans is 27 feet, their width 15 feet, and their weight about 190 tons. In them the rails are carried on longitudinal sleepers resting on iron cross-sleepers 5 feet apart, while in all the other spans wooden sleepers 3 feet apart, and having a section of 12 by 9 inches, carry the roadway.

Floating the Girders.

When a girder was completely erected and riveted up, parts of the jetty on which it rested were removed at each end, and barges were introduced at a low state of the rising tide in the gaps. As the height of the water increased these barges would touch the under-side of the girders, and a further rise would lift them off the bearings on which they had been erected, and keep them floating on the two pontoons. It will be seen that in order to get the ends of the girder free for depositing them on the piers, it was necessary to keep the barges at some distance from these ends and to introduce temporary vertical struts between those parts of top and bottom boom which rested on the barges. In addition to these struts some others were used to steady the comparatively high and narrow girders on their floating supports in case rough weather should occur during the operation. For the different sizes of girders, different jettys and pontoons were used, but apart from this the operation was carried on in the same manner in all cases. But here again it soon became clear that while to carry out the smaller ones in doubtful weather was a dangerous operation, the larger ones were far less liable to disturbance by the weather, and some of them in fact were subjected to a severe trial in this respect, the two tugs on one occasion being unable to tow the structure in the ordinary manner against the strong westerly wind, and breaking all the tow ropes. As soon, however, as additional towing power had been procured, the operation was successfully carried through. Intricate as it seemed to build these heavy girders on shore and tow them to their destination—often more than a mile distant—by the use of plant specially designed for the purpose, the execution became very easy, it seldom taking more than twenty minutes to convey them from the one place to the other.

Lifting the Girders to their Permanent Resting Places.

The general arrangement of the six columns which have to support the larger spans follows that of the brick piers on which they rest. Four centre columns placed in a square and connected by strong vertical and diagonal bracing, are 15 inches in diameter, and from these centre columns the lifting of the span takes place. Each of the columns is about 10 feet long, varying slightly according to the height of the pier, and every second length has brackets cast on to which transverse girders are bolted. The outside columns placed on the point of the pier are 18 inches diameter, and as well as the inside ones 1 inch thick. Between these outside and inside columns rest the ends of the main girders, the end cross girder and end horizontal bracing having been left out so as not to come in the way of the four central columns and their bracings during the process of lifting. To each vertical end post a T strip is bolted from top to bottom in the same manner as was described for the large caissons. In common with these it has $3\frac{1}{4}$ inch holes at 12 inches distance. A transverse trough girder of slightly shorter length than the distance between these end posts is placed on the temporary girders connecting the columns, and in this two hydraulic rams, carrying another girder are fastened. By inserting steel pins in the holes nearest to this top girder, and then pumping up, the main span can be raised to such a height as the stroke of the rams will permit, and if at that point pins are put in the holes then nearest to the fixed or lower ram girder and the weight allowed to come down upon these, the rams can be lowered again without letting the main girders down, and by a shifting of the pins to a lower hole, the operation can be repeated, each stroke of the rams causing a rise of the girders of 1 foot. The motive power is derived from a pump worked by manual labour, the space at disposal not permitting the introduction of steam-power for this purpose. The diameter of the pump-plungers must therefore be small, and the movement of the rams consequently a slow one. It was, however, possible to lift 20 feet a day, and during the long days of summer a 40-feet lift has often been reached in 24 hours. Another set of apparatus was kept in readiness on the next lifting girder, and with it operations were continued, when the girder had become too high for the lower ones, which then in their turn were shifted to a higher point. As the girder rose, the bracings connecting the outer columns with the four central ones were put in, and after it had reached its final height a system of girders capable of carrying the bed plates and superstructure were fastened on the top of the columns, and the girder which had been elevated to a few inches above its proper height was lowered down on them. Before this could, however, be done, they had to be connected to the next set of girders, as they were calculated as continuous girders and joined together in sets of four. To make these junctions, one of the ends had to be lifted up from 5 to $6\frac{1}{2}$ inches, while the junction plates making the top and bottom booms continuous were riveted on. The lowering of the girder at the other end would then produce an initial strain in these junctions and fulfil the requirements of continuity. A good deal of time was required for making these junctions, the junction plates having all to be carefully marked and drilled while the girders were still hanging in the apparatus, and this circumstance in one case led to a disaster which caused great loss and delay. On February 3, 1877, while the work of joining the two southmost of the 245 feet spans was in preparation, a gale of unprecedented severity came down the valley of the Tay with such a fierceness and suddenness that it was even impossible to get near enough to the piers to take off the men who had been at work on them, and they were obliged to seek shelter on one of the adjacent girders which had not been raised. The wind continuing to blow in strong gusts produced violent vibrations in the unbraced ends of the girders and gradually shifted them to the edge of the lifting girders, causing one side to fall when the limit of stability was reached, breaking down the pier and precipitating the other girder in consequence. The fallen girders had to be lifted, cut up, and replaced by new ones, and the work was thereby materially delayed.

Lifting of the 145 *Spans.*

The lifting of the 145 spans was accomplished in a somewhat different manner. The hydraulic lifting apparatus was placed on the top of a temporary structure of timber fixed on the cast-iron piers, a few feet higher than the top boom of the girder would be after being raised, and long links with holes a foot apart reached to where the girder stood 5 feet above high water. These girders being so much lighter could be raised to the top in one day, but as the arrangement of the columns was somewhat different from that of the 245 feet piers (the girders resting on the four central columns), they were hoisted while fixed together by temporary transverse bracings, which kept them at a greater distance apart than they would finally be, and hoisting them up outside the columns altogether. It was therefore necessary to modify the apparatus to this extent that the girders, after disconnecting the temporary bracing, could be slung in and permanently braced.

The work in connection with this bridge was begun in the summer of 1871, the first stone of the land pier on the south side being laid on July 22 of that year. During the first three years, however, little progress was made, and the operations during that time must be considered as being more of an experimental nature. From August, 1875, however, the progress was very great, and as the managers and men gained experience, the erection of the structure was proceeded with at a vastly accelerated rate. New workshops, jetties, and appliances of various kinds were added, a foundry erected for the casting of columns, and in September, 1876, it was found necessary, in order to keep pace with the building of piers and erecting of girders on shore, to work night and day, and the contractor introduced for the first time in Scotland electric light for out-door work. Two lamps, each of 1,000 candle-power, the current for which was generated by Gramme machines, did excellent service. The lamps were placed at right angles to each other, and in this manner they lit up an area of 100 by 500 yards in such a way that every kind of work could be carried on uninterruptedly. This was of great importance for the floating out of piers and girders which had to be done at high water, the preparations commencing three or four hours beforehand, and therefore having sometimes to be made in the early morning. The last pier was in this manner floated out at seven o'clock on the morning of December 26, 1876.

The bridge was severely tested by Gen. Hutchinson, the Government Inspector of Railways, in February of this year. Five locomotive engines of 72 tons weight each were placed on the large spans and run over them at considerable speed. This weight of 360 tons for each of the 245' spans will never be reached in the working of the railway, 162 tons being the greatest load resulting on each span from the heaviest goods train. Under the test load the deflection of any of the spans did not exceed the calculated limit, and the lateral movement during the passage of trains was but trifling.

On June 1 the bridge was opened for ordinary traffic, and it is now daily crossed by numerous and heavy trains. For the North British Railway Company and the travelling public its completion is of very great importance. But the work must have a still greater importance in the eyes of engineers and those interested in the practical application of scientific principles, as many new methods to overcome formidable difficulties were successfully carried out, some of which might with advantage be used in similar structures. A. GROTHE

THE NORWEGIAN NORTH ATLANTIC EXPEDITION

THE expedition left Bergen on June 15, and proceeded without interruption to the Westfjord, in Nordland, where we had our first station. A temperature-series was here taken with Negretti and Zambra's new deep-sea thermometer, which showed 10°·7 C. on the surface, a minimum of 4°·4 in a depth of 40 fathoms, and 6°·5 at the bottom in 340 fathoms. The *Vöringen* stopped some hours at Tromsö to take on board a pilot, and proceeded to the Altenfjord, where we found 7°·3 at the surface, a minimum of 2°·7 in a depth of 100 fathoms, and 3°·9 in 220 fathoms at bottom. From Alten we went to Hammerfest, where we stayed two days. Our next stations were in the Porsangerfjord and in the Tanafjord. On all these stations we dredged and trawled with good success. On June 26 we were lying at Wardö, where Capt. Wille made magnetical observations of force and inclination. The declination was determined the day before off the coast by going round with the ship, and taking bearings of the sun on different courses. On June 27 we put to sea on an eastward course. The barometer was falling rapidly, and at midnight the wind and sea got so heavy, that the ship was put with the stem against the wind, and we were lying almost still. This situation lasted till the next night, when we again proceeded on our course, but very slowly, the ship pitching heavily, and the wind being constantly ahead. In this manner we found 0° C. at the sea bottom, in about 71° 30' N. and 36° 30' E. from Greenwich. We then sailed northwards and westwards, and passed the said bottom temperature several times, so that I am now able to give its situation pretty accurately in the chart. The northern part of this zero line forms a bay east of Bear (Cherry) Island, where the warmer water reaches a higher latitude, and runs close to the east side of that island, where we for the first time observed the polar ice. The temperature-series showed the accuracy of Weyprecht's observations, that the colder Polar water edges itself along the bottom from the east and north, and the warm Atlantic water runs out in a similar edge in the contrary direction towards Novaya Zemlya and Franz-Joseph Land. On July 4 we were at Bear Island, on the south-east side. We were happy to find the sky almost perfectly clear, a rather rare occurrence on this island. The ship was anchored outside the open coast, and we went on shore at the mouth of a little river, in the vicinity of which there stands a hut, which has been the abode of wintering parties. Here we deposited the mail which we brought for the Dutch polar expedition in the *Wilhem Barentz* schooner. The place was marked with a flag, and the letters, &c., dug down, inclosed in an outer wooden and an inner sheet-iron soldered box. I took a tour upon the nearest hills, collected some rock specimens, and measured the altitude of the highest peak on Bear Island, Mount Misery. The calculation gave me a height of 1,787 English feet, a result which I regard as very accurate. After dinner we weighed and proceeded to the south-west; crossed, the following day, the zero line of bottom temperature on the bank between Bear Island and Norway, sounded in 1,024 fathoms on July 6 in lat. 73° 6' N., long. 11° 56' E.; we went then east-south-eastwards, crossed again the zero temperature line, and shaped our course for Hammerfest, where we arrived on the 8th. The ship is now cleaned; we take in coal, and expect to be ready to sail on a westward cruise in three days. Our first cruise has yielded thirty-eight soundings, seventeen temperature series, ten dredgings, and seven trawlings, all successful. New species of animals have been found by our zoologists. Negretti and Zambra's newest reversible deep-sea thermometer has done us great service; the instrument has, almost without exception, worked very well. I have constantly compared its readings from the bottom with the reading of the Casella, Buchanan's improved form, and found a very close agreement. As I supposed, the wooden box which carries the thermometer gets water-soaked after a few experiments in a few hundred fathoms, so that it no longer floats, but this is no drawback, as the lead rushes down so fast that the thermometer always keeps its upright situation till it reaches the bottom, and it never requires more than three minutes for a perfect accommodation to 0·1 of a degree. I therefore regard this instrument as a very important improvement, and feel much obliged to the inventors and makers.

Hammerfest, July 10 H. MOHN

THE TASIMETER

MR. EDISON has applied the principle of his carbon telephone to a new instrument which is said to be a measurer of infinitesimal pressure. The principle is the variation of the electric resistance of a carbon button due to variation of pressure, and the instrument is said to be an extremely delicate thermoscope. We have not yet, however, received any authentic account of its performance or of its accuracy, but its ingenuity certainly deserves a description, for which we are indebted to the *Scientific American*.

It is the outcome of Mr. Edison's carbon telephone. Having experimented with diaphragms of various thicknesses, he ascertained that the best results were secured by using the thicker diaphragms. At this stage, however, he experienced a new difficulty. So sensitive was the carbon button to changes of condition, that the expansion of the rubber telephone handle rendered the instrument inarticulate, and finally inoperative. Iron handles were substituted with a similar result, but with the additional feature of musical and creaky tones distinctly audible in the receiving instrument. These sounds Mr. Edison attributed to the movement of the molecules of iron among themselves during expansion. He calls them "molecular music." To avoid these disturbances in the telephone, the handle was dispensed with; but it had done a great service in revealing the extreme sensitiveness of the carbon button, and this discovery opened the way for the invention of the new and wonderful instrument.

The micro-tasimeter is represented in perspective in Figs. 1 and 2, in section in Fig. 3, and the plan upon which it is arranged in the electric circuit is shown in Fig. 4.

The instrument consists essentially of a rigid iron frame for holding the carbon button, which is placed between two platinum surfaces, one of which is fixed and the other movable, and in a device for holding the object to be tested, so that the pressure resulting from the expansion of the object acts upon the carbon button.

Two stout posts A, B, project from the rigid base piece, C. A vulcanite disc, D, is secured to the post, A, by the platinum-headed screw, E, the head of which rests in the bottom of a shallow circular cavity in the centre of the disc. In this cavity, and in contact with the head of the screw, E, the carbon button, F, is placed. Upon the outer face of the button there is a disc of platinum foil, which is in electrical communication with the battery. A metallic

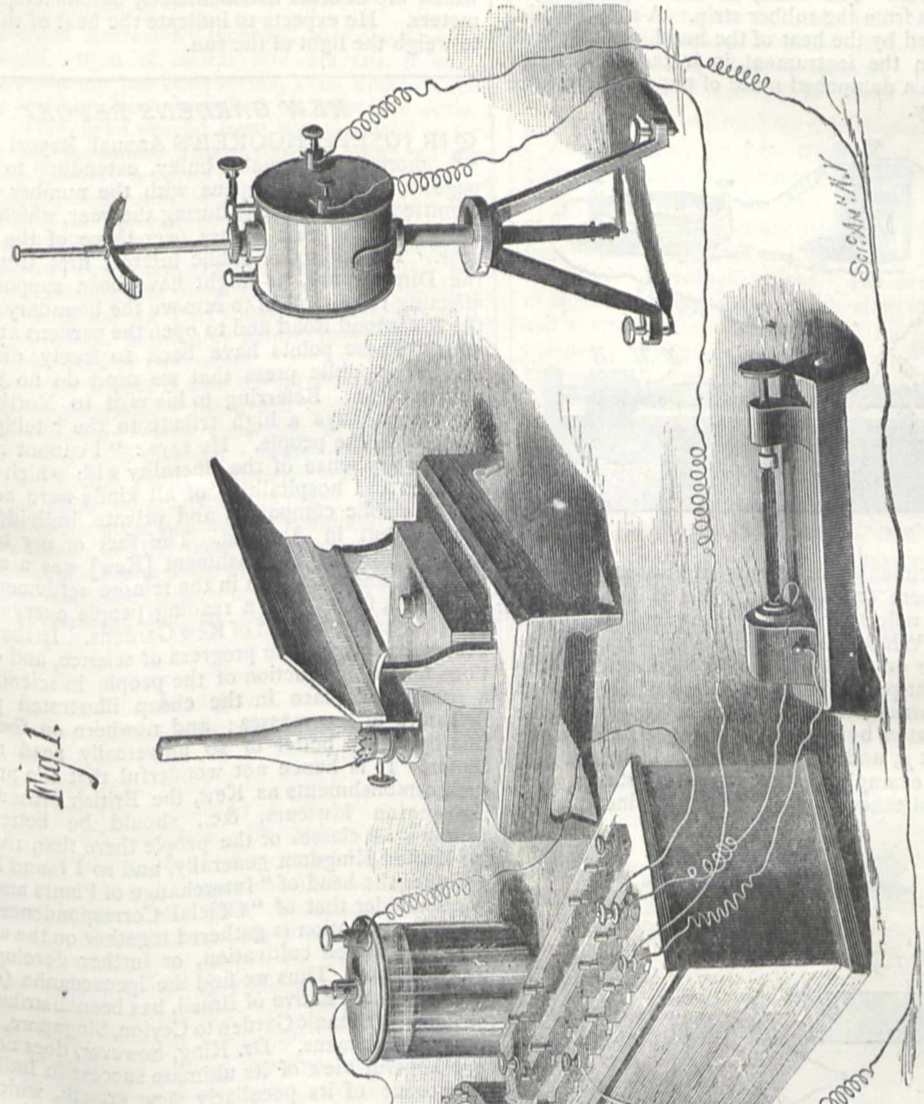


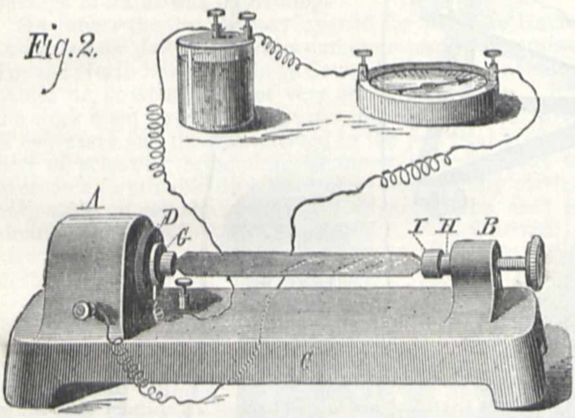
Fig. 1.

EDISON'S MICRO-TASIMETER.

cup, G, is placed in contact with the platinum disc to receive one end of the strip of whatever material is employed to operate the instrument.

The post, B, is about four inches from the post, A, and contains a screw-acted follower, H, that carries a cup, I, between which and the cup, G, is placed a strip of any substance whose expansibility it is desired to exhibit. The post, A, is in electrical communication with a galvanometer, and the galvanometer is connected with the battery. The strip of the substance to be tested is put under a small initial pressure, which deflects the galvanometer needle a few degrees from the neutral point. When the needle comes to rest its position is noted. The slightest subsequent expansion or contraction of the strip will be indicated by the movement of the galvanometer needle. A thin strip of hard rubber, placed in the instrument, exhibits extreme sensitiveness, being expanded by heat from the hand, so as to move through several degrees the needle of a very ordinary galvanometer, which is not affected in the slightest degree by a thermopile facing and near a red-hot iron. The hand, in this experiment, is held a few inches from the rubber strip. A strip of mica is sensibly affected by the heat of the hand, and a strip of gelatin, placed in the instrument, is instantly expanded by moisture from a dampened piece of paper held two or three inches away.

Fig. 2.



For these experiments the instrument is arranged as in Fig. 2, but for more delicate operations it is connected with a Thomson's reflecting galvanometer, and the current is regulated by a Wheatstone's bridge and a rheostat, so that the resistance on both sides of the galvanometer is equal, and the light-pencil from the reflector falls on 0° of the scale. This arrangement is shown in Fig. 1, and the principle is illustrated by the diagram, Fig. 4. Here the galvanometer is at *g*, and the instrument which is at *i* is adjusted, say, for example, to ten ohms resistance. At *a*, *b*, and *c* the resistance is the same. An increase or

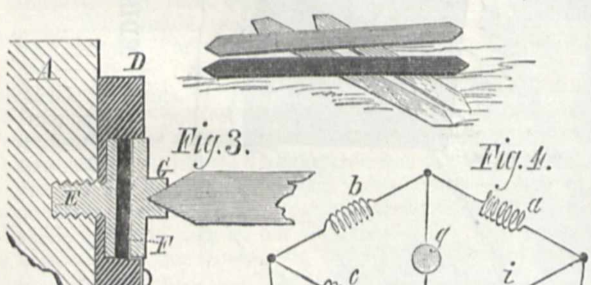


Fig. 3. Fig. 4.

diminution of the pressure on the carbon button by an infinitesimal expansion or contraction of the substance under test is indicated on the scale of the galvanometer.

The carbon button may be compared to a valve, for when it is compressed in the slightest degree its electrical conductivity is increased, and when it is allowed to expand it partly loses its conducting power.

The heat from the hand held six or eight inches from a strip of vulcanite placed in the instrument—when arranged as last described—is sufficient to deflect the galvanometer mirror so as to throw the light-beam completely off the scale. A cold body placed near the vulcanite strip will carry the light-beam in the opposite direction.

Pressure that is inappreciable and undiscoverable by other means is distinctly indicated by this instrument.

Mr. Edison proposes to make application of the principle of this instrument to numberless purposes, among which are delicate thermometers, barometers, and hygrometers. He expects to indicate the heat of the stars and to weigh the light of the sun.

KEW GARDENS REPORT

SIR JOSEPH HOOKER'S Annual Report for 1877 is more than usually bulky, extending to fifty-three pages. The report opens with the number of visitors admitted to the gardens during the year, which amounted to 687,972, a great excess over those of the preceding year. The points of public interest first treated of by the Director are, as might have been supposed, those affecting the agitation to remove the boundary wall along the Richmond Road and to open the gardens at an earlier hour. These points have been so freely discussed of late in the public press that we need do no more than refer to them. Referring to his visit to North America, Sir Joseph pays a high tribute to the intelligence and courtesy of the people. He says: "I cannot adequately express my sense of the liberality with which travelling facilities and hospitalities of all kinds were accorded to me by public companies and private individuals wherever I went in America. The fact of my being connected with this establishment [Kew] was a recognised passport, and this even in the remote settlements of the Far West, for I found a reading people everywhere, few of whom had not heard of Kew Gardens. In the Northern States of America the progress of science, and of institutions for the instruction of the people in science, occupy a prominent place in the cheap illustrated periodical literature of the masses; and nowhere on the globe is this literature better or so universally read as in the States. It is hence not wonderful that the progress of such establishments as Kew, the British Museum, South Kensington Museum, &c., should be better known amongst all classes of the people there than they are in the United Kingdom generally, and so I found it."

Under the head of "Interchange of Plants and Seeds," as also under that of "Official Correspondence," a vast deal of information is gathered together on the acclimatisation, extended cultivation, or further development of useful plants. Thus we find the ipecacuanha (*Cephaëlis ipecacuanha*), a native of Brazil, has been distributed from the Calcutta Botanic Garden to Ceylon, Singapore, Burmah, and the Andamans. Dr. King, however, does not take a very hopeful view of its ultimate success in India, partly on account of its peculiarly slow growth, which tends to prevent its cultivation being taken up with spirit by European planters, and partly on account of its insignificant appearance, which does not even excite interest among the planters. Sir Joseph suggests it as "worthy of consideration whether the Indian government would not do well to establish a nursery in some part of our Indian possessions, with the tropical climatic conditions necessary for its growth." In connection with this subject, considering the great value of the ipecacuanha in cases of dysentery, it is satisfactory to note that there seems some prospect of its cultivation being attempted in the native states of Perak, where the soil and climate are considered to be well adapted to its requirements. Regarding the prophylactic virtues of *Eucalyptus globulus*—a subject which has been to some extent ventilated in our own columns—the experiences of the Kew authorities do not throw any further light on it. As valuable timber-trees, however, there can be no doubt that many of the species of *Eucalyptus* will prove most valuable. Sir Joseph says:—"The merits of the numerous species of this genus are beginning to be understood, and there is no doubt that, where the climate is suitable, few timber-trees can compare with them for rapidity of growth and excellence of wood. Popular misconceptions still, however, prevail on the subject, to some extent. Attempts to grow in tropical climates the species of temperate ones such as *Eucalyptus globulus* can only result in disappointment."

Two points of interest are recorded in connection with the botanical origin of Shiraz and Havana tobaccos. Hitherto the former has been stated, even upon the best authorities, to have been furnished by *Nicotiana persica*. It has, however, been proved from plants raised at Kew from seed of the finest Shiraz tobacco procured from Persia, to be merely a form of *Nicotiana tabacum*, the plant so largely cultivated in North America, and from which the bulk of the commercial tobacco is procured. To the same plant *N. tabacum*, var. *macrophyllum*, is attributed the Cuba and Havana kinds, which have always been described as the produce of *N. repanda*, no such species, so far as Dr. Vidal, the director of the Botanical Gardens, Manila, is aware, being found now in Cuba, either wild or cultivated.

An interesting subject is that connected with vegetable poisons, more particularly the arrow poisons. It is, as is stated, a subject "well deserving of investigation, although it has been doubted whether the ingredients employed have any really poisonous qualities." The evidence on these points is conflicting. Some of the plants from which these poisons are obtained have been promised to Kew, so that before long we shall no doubt know something more definite about them.

Altogether the Kew report is, this year, one worthy not only of perusal, but to be retained for future reference.

NOTES

WITHIN a short period Vienna has lost two of her leading scientific celebrities, von Littrow and von Ettingshausen. We regret to add to the list the name of Baron Karl von Rokitansky, the President of the Vienna Academy of Sciences, who died on July 23 at the age of seventy-four. He was born at Königgrätz, in Bohemia, February 19, 1804. After completing his medical studies at the Universities of Prague and Vienna, he became, in 1828, assistant in the Pathological Anatomical Institute at Vienna. In 1834 he accepted the chair of pathological anatomy in the University, fulfilling, in addition, the duties of prosector in the Vienna hospital, and of legal anatomist for the city. In these varied functions an enormous mass of observations was accumulated, which served as a basis for his "Lehrbuch der pathologischen Anatomie," which appeared in five volumes, 1842-1846, and has survived three editions. At this period von Rokitansky commenced a remarkable series of investigations with the microscope, which Johannes Müller, a few years previously, had introduced into physiological research. From the results of these and other lines of investigation, he rapidly won for pathological anatomy an importance which had been hitherto wanting in German schools of medicine, and caused its recognition as the foundation for all research, not only in pathological physiology, but in the whole province of medicine. The old symptomatic system of classification was replaced by a careful discriminating study of the changes brought about in individual organs by the varied forms of disease. The delicate appliances of modern science enabled him to detect a large number of new diseases, which had hitherto been classed with other diseases on account of the apparent similarity in symptoms. To the classical researches of von Rokitansky, probably more than to any other source, modern diagnosis owes its perfection. The impulse given by him was ably seconded by the contemporary medical authorities of Austria, and on the basis of the principles formulated by von Rokitansky, Hebra in dermatology, Engel in general anatomy, Oppolzer in therapeutics, and Dittrich, Schuh, and Skoda in other special departments of medicine have grounded the famous so-called Vienna-Prague school. Von Rokitansky retired from his professorship three years ago, and published at the same time his last work, "Die Defekte der Scheidewände des Herzens." His merits won for him numerous marks of distinction, and for some time past he has presided over the Imperial Academy of Sciences. He leaves behind him a son, Professor of Music at the Vienna Conservatorium.

WE have received, from the Ethnological Museum of Leipzig, a circular, signed by Drs. Magnus and Pechuël-Loesche, of great importance in reference to the much-debated question as to the development of the sense of colour in men. The object of this circular is to obtain data as to what degree uncivilised peoples perceive colours and distinguish them by names, after the manner of civilised nations. The circular contains a series of inquiries in German and English, along with a scale of colours, and a schedule in which to record the replies to the various questions. The instructions are carefully drawn up, and Drs. Magnus and Loesche intend to distribute the circular by thousands; if the instructions are strictly adhered to the result must be of great value. We believe this circular is only the first of a long series which Dr. Pechuël-Loesche is preparing with the intention of enlarging, in a systematic way, our ethnological knowledge, and especially to solve interesting psychological problems regarding uncivilised tribes. The Ethnological Museum of Leipzig has agreed to receive and take care of all the material collected, which will be at the command of any scientific inquirers who may care to make use of it. We need say nothing in support of this enterprise of Drs. Magnus and Loesche; we would simply urge upon all our readers who are in a position to lend a helping hand, either directly or through friends living abroad, to obtain a supply of the circular referred to, by applying to Dr. Pechuël-Loesche, Museum für Völkerkunde, Leipzig, Germany.

IN the year 1851 the Vienna Academy of Sciences offered a prize for determination of the "Crystalline forms of products obtained in chemical laboratories," which proved fruitful, to a remarkable extent, in crystallographic researches of much importance. More recently new problems have come up with reference to crystallisation, partly in consequence of the labours just referred to, and partly because of the new discoveries of chemistry with regard to the structure of chemical molecules. Wishing to promote research in this direction, the Academy offer a prize of 1,000fl. for "Investigation of the crystalline form of chemical substances, with special reference to homologous series and isomeric groups. A determination of the specific gravity is also desired. The carrying out of optical researches on the crystals measured is deferred for measurement by the winner of the prize." The limit of time is December 31, 1879, and the prize will be awarded in 1880. Papers to be sent in with sealed envelopes and mottoes.

PROF. TAIT is, we hear, engaged in developing for fog-signalling purposes a form of apparatus producing intense sounds with great economy of driving power, which he some time ago exhibited at the Royal Society of Edinburgh. His mechanism is, we believe, devised to produce an effect analogous to that of the drum, which is one of the most economic of noise-producing instruments.

THE commission appointed by the French Government to test the rope used by M. Giffard in the construction of his captive balloon have made their experiments. We have already said that the rope is conical, the heaviest end being uppermost, so that, if any breakage should take place, it will not be in the vicinity of the car, but close to the earth. The resistance of the smaller end has been found equal to 24,000 kilos of traction exerted by hydraulic pressure, and is smaller than anticipated. It had been suggested by Mr. Newall to employ a wire rope of his own make, which would have had a much greater resistance with a smaller weight; but the suggestion was lost, M. Giffard fearing some electric discharge might ignite the gas. The commission has given its authorisation to admit the public, but under the condition that the pressure should be limited to a quarter of the breaking-strain, viz., 8,000 kilos. The ascending-power is generally 5,000 kilos (about 12,000 lbs.). The difference left to bear the pressure of the wind will be about 5,000 lbs. for a balloon whose surface is 4 × 1,170 square yards. The breaking of the rope answers to a resistance of 50,000 lbs., or about ten lbs. per square foot of a plane; it can bear very high wind, and need fear only a tempest. Some observations have already been made by M. Tissandier, but in a somewhat rough manner. An anemometer will be constructed in the car, and its readings will be compared with the readings at the steelyard, to which the rope is attached.

ON July 26, the Council of the Paris Observatory held its quarterly meeting under the presidency of M. Dumas. Admiral Mouchez read a memoir on the most urgent reforms required for the better working of the institution. The new director insists upon the necessity of having a watch kept all night irrespective of the state of weather, for observations to be taken with the meridian circle. Such is the practice at the naval observatory of Montsouris, of which Admiral Mouchez continues to be the director. A large augmentation is required in the *personnel*, a supplementary sum of 54,000 fr. having been asked for that purpose. The Chinese ambassador visited the observatory on July 24, when a large mirror was almost instantly silvered by the Foucault process.

THE French *Journal Officiel* has published the names of those appointed by the Minister to act during three years as members of the Central Bureau of Meteorology. M. Hervé Mangon, and Admiral Mouchez have been appointed to represent the Academy of Sciences, M. Vicomte d'Arlot, sub-director of the Oriental and Chinese Department as delegate of the Foreign Office, Dr. Du Mesnil, Physician of the National Asylum of Vincennes, delegate of the Home Office; Commander Perrier, Member of the Bureau des Longitudes, to represent the War Office; M. Vice-Admiral Cloué, Director of the French Survey, representing the Ministry of Marine; M. Leon Lalanne, Engineer of the Ponts-et-Chaussées, representing the Department of Public Works; M. Cyrien Girard, Member of the Chamber of Deputies, representing the Ministry of Agriculture; M. Berthelot, Member of the Institute, representing the Ministry of Public Instruction; with General Farre, President of the Committee of Fortifications, M. Blavier, Telegraphic Engineer of the Government, to represent the French Postal Telegraphic Administration. The appointments of the officials to fill the several departments of the Central Bureau will soon be made public. It was decided that the Meteorological Bureau will leave the observatory at any cost. An hotel will be obtained for its use in the Rue de Grenelle, Saint Germain, in a part of Paris, which although not central, is at least thickly populated.

A COMMISSION, appointed by the U.S. Congress to select a new site for the Naval Observatory at Washington, held its first meeting on July 15. According to the *New York Tribune*, no money has been voted for expenses, and the Commissioners must therefore be in rather an awkward predicament. The old observatory, in which so much excellent work has been done, is in a very dilapidated condition, and we cannot believe that the U.S. Government will be so parsimonious as to allow the Washington Observatory to lose its place as one of the first institutions of the kind in the world.

AMONGST a large number of designs for the Spinoza monument at the Hague, only two were deemed suitable by the Committee; they were furnished by the sculptors, M. Fr. Hexamer, of Paris, and Herr Joseph Tüshaus, of Düsseldorf. The monument will be erected after the design of the former sculptor.

ON June 1 last, the hundredth anniversary of the foundation of the Society of Arts and Sciences at Batavia was celebrated by a large assembly of members and friends. This Society is the first learned European association which was formed upon Asiatic soil.

AT the Jardin d'Acclimatation at Paris, three enormous tortoises have recently arrived from the Seychelles. The largest of the three weighs no less than 187 kilogrammes (nearly 4 cwt.), and measures 1·17 metres in diameter (about 46 inches).

DR F. MOOK, who for some time past has been busily engaged in making excavations in different parts of Egypt, has just returned to Freiburg (Baden), with a large collection of antiquities. There is no doubt that his collection is the most complete in its special direction which has ever been brought to Europe. It contains no less than 340 skulls from the tombs of Thebes, Dendera, Abydos, and the Pyramid fields, all in the most perfect preservation. Besides these there are some eighty animal mummies, a large quantity of flint implements from Nubia and Egypt, vases, amulets, ornaments, &c. The collection is now exhibited in the University buildings at Freiburg.

WE have received from Messrs. Eberstein, of Dresden, a specimen of an interesting "walking-stick for naturalists or tourists." The stick is a perfect *multum in parvo*, and contains quite a museum of scientific instruments. The handle alone contains a compass, a double magnifying glass, or pocket microscope, and a whistle. Below it there is a thermometer on one side of the stick and a sand-glass on the other. The body of the stick is partly hollow, and in its interior holds a small bottle, which is intended to contain chloroform or ether for killing insects. Along the outside of the body there is a half-metre measure, showing decimetres and centimetres. Near the end of the stick a knife-blade may be opened, which serves for cutting off objects which cannot be reached by hand, such as aquatic plants, &c. At the extreme end a screw may hold in turn a spade (for botanists), a hammer (for geologists or mineralogists), a hatchet, or a strong spike, which would be of great use on glaciers. The whole is neatly finished in black polished wood.

THE following is the title of the essay to which the Howard Medal of the Statistical Society will be awarded in November, 1879:—"On the Improvements that have taken place in the Education of Children and Young Persons during the Eighteenth and Nineteenth Centuries." The essays to be sent in on or before June 30, 1879.

NEXT Sunday evening, August 4, from 6 to 8 P.M., is the last Sunday on which the Grosvenor Gallery will be open to the public this season. Tickets may be obtained by forwarding stamped envelope to the Hon. Sec., Sunday Society, 19, Charing Cross, S.W. More than 3,000 persons visited the Gallery on Sunday evening, July 21.

IN a paper in the last number of the *Journal* of the Statistical Society, on "Failures in England and Wales," it is pointed out, by reference to the tables in Prof. B. Stewart's papers in NATURE, vol. xvi. pp. 9, 26, and 45, that there seems to be some relation between the number of failures and sun-spot periods, just as there is between famines and the periodicity of the same solar phenomenon. Indeed, it is easy to see that this phenomenon must have a widespread influence, and in the interest of the most material commercial interests of our own and other countries, effective measures ought to be taken for its thorough investigation.

THE British Medical Association meets at Bath from August 6 to 9.

NEAR Pombonne (France) the incisor of a mastodon has just been discovered in a sand-pit at a depth of about a metre. It measures 2·95 metres in length, its base is 45 centimetres in diameter, and the whole weighs some 250 kilogrammes. The ivory at the point is particularly well preserved.

THE General Meeting of the German Anthropological Society will take place at Kiel on August 12–14. Prof. Fraas, of Stuttgart, will speak on the drawing-up of a prehistoric map of Germany; Prof. Virchow, of Berlin, on the statistics of the shapes of skulls in Germany; and Prof. Schaaffhausen, of Bonn, on the compilation of a general catalogue of all the anthropological material in Germany.

THE Geologists' Association have arranged for an excursion to the Boulonnais on August 5, and five following days, which, judging from the admirable programme, promises both pleasure and profit to those who join it.

DR. SCHLIEMANN is at Constantinople, and intends resuming his excavations in the Troad if he can obtain from the Porte fifty soldiers as a guard against robbers. From Berlin it is stated that a summary account of the German excavations at Olympia says that the number of marble objects found during the last three winters is 904; of bronzes, 3,734; of terra cottas, 904; of inscriptions, 429; and of coins, 1,270. All the more important ruins have been photographed, and the third volume of the official account is about to appear. An exhibition of all the casts taken will shortly be opened at Berlin.

THE Jardin d'Acclimatation of Paris offers, during the present year, numerous opportunities for ethnological study. The latest arrival is a party of Guachos from the Pampas of South America, consisting of six men, three women, and a child. They are accompanied by a complete collection of the animals of the Argentine Republic, and by seventeen wild horses. The capture of the horses at full gallop with the lasso forms their chief exhibition.

A SECOND edition of Hooker's standard "Student's Flora of the British Islands," has just been published by Macmillan and Co.; several emendations have been introduced.

WE alluded recently to the remarkable record of earthquakes preserved through so many centuries in Japan. Mr. Hattori, of Tokio, has lately described an ingenious seismograph, which was invented by one Choko, 1,750 years ago. It consisted of a cylinder 8 feet in height, ornamented by various characters and designs. The upper part was encircled by a series of eight dragon's heads, in the open mouth of each of which, a copper ball was lightly balanced. The interior of the cylinder was occupied by a system of rods and springs, so delicately joined that the slightest trembling of the earth would serve to push a ball from a dragon's mouth. Immediately below each dragon's head was a frog looking upward, with his mouth likewise wide open, to receive the balls. The sound of the falling ball would call attention to the phenomenon, and the direction of the earthquake would be revealed by the particular ball dropped. This seismograph correctly recorded earthquakes, which were felt strongly at a distance, but were too feeble to be noticed by the senses in the immediate vicinity.

THE African traveller, Hildebrandt, recommends strongly, in the *Korrespondenzblatt der afrik. Gesellschaft*, the use of petroleum for those travelling in the tropics, as a protection against insects. Occasional applications to the face and hands ensured entire freedom from mosquitoes, and the same method sufficed to preserve horses and cattle against the deadly attack of the Dondorobo gadfly, which so often cripples the movements of the explorer. Petroleum, likewise, protected the natural history collections of the traveller from ants, moths, &c.

THE contributors to the *Zeitschrift für wissenschaftliche Zoologie* have just completed the issue of a supplemental volume of 634 pages, following on their thirtieth volume, as a testimonial offering to Carl Theodor von Siebold on the fiftieth anniversary of his doctorate, April 22, 1878. Prof. von Siebold was for long the chief conductor of this most important journal, having now associated with him as active editor Prof. Ehlers. The festival volume is remarkable for the number and eminence of the contributors, and the importance of their contributions. There are more than twenty authors, including Haeckel, R. Leuckart, Ehlers, Oscar Schmidt, von Thering, Forel, Stiela, Weismann, Simroth, F. Leydig, Salensky, Carl Vogt, Möbius, Repiachoff, and L. Graff. Leydig on the Amphipods and Isopods, Möbius on the movements of flying fish through the air, Haeckel on the phylogeny of the Echinoderms, Flögel on the brains of insects, may be mentioned as memoirs of the most valuable kind.

MESSRS. LONGMANS have sent us vol. iv. of "Ure's Dictionary of Arts, Manufactures, and Mines," edited by Mr. Robert Hunt, F.R.S. This volume is supplementary to the preceding three, and it is apparent that an earnest attempt has been made to record all additions, improvements, and new applications of value.

WE have received from Messrs. Maclure and Macdonald the first four parts of a beautifully and faithfully executed series of Portraits of Distinguished Men, among which are the portraits of several men of science—Sir Joseph Hooker, Prof. Owen, Dr. Allen Thomson. The future parts will contain other portraits of men well known in the scientific world. Each portrait is accompanied by a suitable notice, and the work as a whole deserves hearty encouragement.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from India, presented by Dr. Adcock; a Burrowing Owl (*Speohyto cunicularia*) from America, presented by Dr. Geo. E. P. Nixon; a Green-winged Dove (*Chalcophaps indica*) from India, presented by Capt. Otho N. Shaw; six Common Guillemots (*Uria troile*), British Isles, presented by Sir Hew. Dalrymple, Bart.; a Common Nightingale (*Daulias luscinia*), European, presented by Mr. Gee; five Great Bustards (*Obis tarda*), a European Bearded Vulture (*Gypaëtus barbatus*), a Spanish Imperial Eagle (*Aquila adalberti*), a Bonelli's Eagle (*Nisaëtus fasciatus*), a Booted Eagle (*Nisaetus pennatus*), two Lanner Falcons (*Falco lanarius*) from Southern Spain, a Red and Blue Macaw (*Ara macao*), a Blue and Yellow Macaw (*Ara ararauna*) from South America, deposited; an Orang-outang (*Simia satyrus*) from Borneo, a Coati (*Nasua nasica*) from South America, two American Flying Squirrels (*Sciuropterus volucella*) from North America, received in exchange.

THE MOVEMENTS OF FLYING FISH THROUGH THE AIR

THESE movements form the subject of an interesting paper recently contributed by Prof. Möbius to the *Zeitschrift für wissenschaftliche Zoologie* (Band xxx., suppl., p. 343; see *Naturforscher*, June 8, 1878). From his own observations (made during a voyage to Mauritius, *viâ* Suez, and back by the Seychelles) and the observations of others, he describes the principal features of the phenomenon thus:—

The exocœti dart with great velocity out of the water without regard to the direction of the wind and the course of the waves. They do not, during their flight, make any regular fluttering movements with their pectoral and ventral fins, but hold them spread out. In the outspread fins there may occur very rapid vibrations.

The hinder part of the body remains somewhat lower than the fore part during flight.

Directly against the wind they commonly fly further than with the wind, or when their course and the direction of the wind form an angle together.

Most exocœti which fly against the wind or with the wind continue during their whole course of flight in the direction in which they come out of the water. Winds coming laterally upon the original course of the exocœti deflect these into their direction.

All exocœti which withdraw from ships fly during their whole course through the air, near the surface of the water.

When with strong winds they fly against the course of the waves, they commonly rise somewhat over each wave; sometimes their tail dips slightly in the top of the wave.

Only those exocœti whose air-course is crossed by a ship rise to considerable heights (at the most about five metres above the surface of the sea).

By day flying fish seldom light on the ship; they mostly do so at night, and never in calm, but only when the wind is blowing. They mostly fall upon ships which lie not higher than two to three metres above water, and when these are sailing on a wind (the wind coming obliquely from beyond) or with half a wind (the wind coming at right angles against the ship), and are sailing rapidly. Flying fish never come on board from the lee side, but always and only from the weather side.

Not uncommonly when their tail has dipped in the water they describe in the horizontal part of their course, a bow to the right or to the left side.

During wind and a rough sea they appear above the water more frequently than in calm weather.

Before ships, which come upon them in swimming, the exocœti escape into the air, just as they do before fishes of prey and cetacea.

Many authors have affirmed, in explaining the flying of fish, that the pectoral fins operate like the wings of birds, bats, and of insects. Prof. Möbius, however, shows that both the anatomical structures of the pectoral fins and their muscles, and the physiological relations of the position and size of the fins to the volume and weight of the whole body, are against flight-like movements of the pectoral fins.

The movements occasionally observed in these organs during flight are merely a vibration.

The true cause of these movements of fishes through the air are the spring-movements which they impart to their body by means of their very strong side muscles, just as other fish propel themselves powerfully through water. They spring out of the water with great velocity, because the air presents less resistance than the water, and when after some time, they fall back into the water, their outspread fins act like a parachute.

It is easy to understand how the action of the wind combines favourably or otherwise with their flight. By day the direction of their spring is so chosen that the disturbing ship is avoided. By night this orientation by the sense of sight is wanting, and the animals fall into the ship. As any air in strong motion, when it impinges against obstacles (a ship's side or waves), rises, it raises also the fish, so that this flies over the wave, or may come on board the ship. In short, as Prof. Möbius proves in detail, all the phenomena observed may be fully explained by the combined action of the oblique projection forwards and the wind. It may further be mentioned that the flying fish has a peculiar arrangement of the mouth, so that in this a portion of water may be carried during flight for the process of respiration.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Kingdom of Portugal has for its 4,700,000 inhabitants but a single university—that of Coimbra, which was originally founded at Lisbon in 1290. The university has a corps of instructors numbering 70, is attended by 1,100 students, possesses a library of 42,000 volumes, and is equipped with astronomical and meteorological observatories, as well as natural history collections. Advanced education is likewise provided for by polytechnics, medical academies, and industrial institutes in Lisbon and Oporto, and an agricultural school. The elementary schools of the land number 2,450, and parents lose their political rights if their children cannot read and write at the age of 15.

THE University of Strasburg is attended at present by the largest number of students recorded since its establishment, viz., 710, consisting of 45 in theology, 195 in law, 150 in medicine, 177 in philosophy, and 143 in science.

THE new regulations for medical study in France require a term of four years, five examinations, including one in physics, chemistry, and natural history, practical work in the laboratories and anatomical theatre, and two years visiting of the hospitals. The sum requisite for this course of study is 1,360 francs—520 for lectures, and the remainder for examination fees, thesis, and diploma.

AN examination will begin at Merton College, Oxford, on Tuesday, October 15, for the purpose of electing to a Physical Science Postmastership of the annual value of 80*l.*, and tenable for five years from election. After two years of residence the College will raise, by a sum not exceeding 20*l.* per annum, the postmasterships of such postmasters as shall be recommended by the tutors for their character, industry, and ability. Candidates, if members of the University, must not have exceeded six terms of University standing. Information may be obtained from the tutor in physical science.

MR. SAMUEL SHARPE has promised to give 5,000*l.* towards the building of the north wing of University College, London, so soon as the Council are prepared to begin the work. It is expected that this liberal donation, together with others which have been received, will enable the building to be very shortly commenced. A sum of 50,000*l.* in all will, however, be required to complete the extensions which are immediately contemplated.

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, June 25.—Mr. John Evans, D.C.L., F.R.S., president, in the chair.—Dr. Paul Topinard, of Paris, was elected an Honorary Member, and the election of the following gentlemen as Ordinary Members was announced:—The Rev. H. W. Watkins, Warden of St. Augustine's College, Canterbury; Hy. Wm. Jackson, M.R.C.S., F.R.A.S., F.G.S., of Lewisham, and Dr. Dunkley, of New Zealand.—A paper was read on the ethnology of the islands of the Pacific, by the Rev. S. J. Whitmee. This paper was chiefly intended to explain an ethnographic chart of the Pacific, coloured according to the author's own observations, and which, in the main, followed the divisions of races in previous charts. In speaking of the people, he said the Melanesians, or black race, might be regarded as the aboriginal people, and that they had affinities, more or less remote, with the blacks found in the various parts of the southern hemisphere. Probably these Melanesians once extended further across the Pacific than they now do. The brown Malayo-Polynesian race had, doubtless, entered Polynesia from the west. The difficulties of such a migration were not insuperable. An example was given of a comparatively recent arrival of a vessel thought to be Chinese or Japanese, at Fotuna, or Home Island, containing forty people. There is a third people in Polynesia differing considerably from both of the others. These are the Micronesians. They probably are primarily from the Philippines, or some other portion of the Indian Archipelago, but are mixed with Melanesian and Malayo-Polynesian blood. There is also reason to believe they have had an admixture of Chinese or Japanese blood derived from the occupants of junks which have been driven by adverse winds to this region.—Mr. Worthington G. Smith read a paper descriptive of palæolithic implements from the gravels of N.E. London, and a paper was communicated by Mr. G. M. Atkinson on a new method of finding the cephalic index.

Entomological Society, July 3.—H. W. Bates, F.L.S., F.Z.S., president, in the chair.—Mr. Basil G. Nevinson was elected an Ordinary Member and Mr. John A. Finzi a Subscriber.—M. Pascoe exhibited a number of insects he had collected during a recent tour through Algeria and the south of Spain; with these there was a remarkable myriopod having the cylindrical body of the Julidæ, but with only one pair of legs to each somite.—Mr. Boyd drew attention to the food plant of *Eluchista cerusella*. This insect had always been considered to feed on the leaves of *Arundo phragmites*, which Mr. Boyd doubted, as he had lately found the larva feeding on *Phalaris arundinacea*, a grass which somewhat resembled the other plant before the flowers appear.—Mr. Distant exhibited some specimens of the homopteron *Ricania australis*, Walk., which had been sent him for identification through Dr. Sharp, from Mr. Lawson, of Auckland, New Zealand, where the species had been observed last year on the dahlia for the first time. These New Zealand forms were, however, much darker in colour than Australian specimens, and hence had probably been introduced for some time. Mr. Jenner Weir exhibited two specimens of *Leucania turca* with several pollinia of *Habenaria bifolia* attached to the trunk of each, and which was only observed in these two instances out of fifty specimens examined. Mr. Weir also exhibited an interesting variety of *Hipparchia hyperanthus*.—Prof. Westwood remarked on a recent note in NATURE, vol. xviii. p. 226, referring to observations made by Dr. A. S. Packard on the manner in which lepidoptera escape from their cocoons, and stated that similar observations had been previously made and recorded by Capt. Hutton (*Trans.* Ent. Soc., 1st. ser. vol. v. p. 85). Prof. Westwood also stated that he had recently heard of injuries done to potato crops by *Cetonia aurata*, which had been found stripping the leaves, and a lepidopterous larva (probably a species of *Botys*), which bored into the stem.—Mr. Dunning read a note on spiders resembling flowers.—The Secretary read a note from Mr. J. Haselden relating to the habits of the honey bee (*Apis fasciata?*) in Egypt.—Mr. Waterhouse communicated a paper on new coleoptera from Australia and Tasmania in the collection of the British Museum.

CAMBRIDGE

Philosophical Society, May 20.—A communication was made by the Rev. E. Hill, on some points connected with the influence of geological changes on the earth's axis of rotation.—The author proved by elementary methods the following results recently obtained by Mr. G. H. Darwin:—(1) That small deformations of the earth cannot alter the position in space of the earth's axis of rotation. For if external forces be neglected this follows immediately from the conservation of angular moments. If we introduce the attractions of the sun and moon, the investigation of precession and nutation will in general still apply to the deformed earth, and the mean obliquity be unchanged. 2. That these deformations cannot sensibly separate the axis of figure from that of rotation. It was shown that as soon as a separation began, the rotation-pole would appear to trace out on the surface a cyclone with its base in the direction along which the figure-pole might be shifting; that the two would coincide about every 300 days, and the greatest divergence thus be infinitesimal. 3. That should the earth yield to strain, these poles would describe a spiral on the surface. This was only shown in a single case. 4. Expansion and contraction will be less effective in shifting the principal axes than transference of surface-matter. For expansion and contraction involve transference of matter from within outwards, or *vice versâ*, and the effect of increase of matter at one point of a radius would be more or less counterbalanced by its subtraction from another point. But transference of matter on the surface may be so arranged that the gain at one point is reinforced by the loss at the other.

MANCHESTER

Literary and Philosophical Society, December 4, 1877.—Transit of the shadow of Titan across the disc of Saturn, November 23, 1877, by Joseph Baxendell, F.R.A.S.

February 11, 1878.—Mr. Binney, F.R.S., sent a marine alga from the Isle of Man for identification. It was not in fruit, but was undoubtedly an unusually narrow fronded form of *Chondrus crispus* (Lamx.).—Mr. C. Bailey, in the absence of Mr. Hurst, read a paper by the latter on the best method of collecting and preserving plants for herbarium purposes, when gathered in tropical or subtropical countries.—Mr. J. Boyd exhibited slides of *Spongilla fluviatilis*, the fresh-water sponge, showing spicules.

February 25.—Results and deductions of rain-gauge observations made at Eccles, near Manchester, during the year 1877, by Thomas Mackereth, F.R.A.S., F.M.S.

March 5.—On the decomposition of ultramarine by carbonic acid, by Mr. S. Sugiura (Student in the Chemical Laboratory of the Owens College). Communicated by Prof. Roscoe, F.R.S.—On siliceous fossilisation, by J. B. Hannay, F.R.S.E., Assistant Lecturer on Chemistry in the Owens College. Communicated by Prof. Roscoe, F.R.S.

March 11.—On bryozoa, by Arthur Wm. Waters, F.G.S.

March 19.—On a remarkable flash of lightning, by B. St. J. B. Joule.—On a barometer, by Dr. J. P. Joule, F.R.S.—A comparison of the standard barometer of the Owens College Physical Laboratory with the working barometer, by Mr. Morisabro Hiraoka, Student of Owens College. Communicated by Prof. B. Stewart, LL.D., F.R.S.—On a new calorimeter, by J. B. Hannay, F.R.S.E., Assistant Lecturer on Chemistry, Owens College.

VIENNA

Imperial Academy of Sciences, March 14.—On processes of degeneration and regeneration in normal peripheric nerves, by Herr Mayer.—Embryology of ferns, by Herr Leitgeb.—New experiments in proof of Döppler's theory of tone and colour variation through motion, by Dr. Mach.—Researches on the origins and the functions of the accelerating nerves, by Dr. Stricker.—On a fluorescein-carbon acid, by Dr. Schreder.—On phenomena in the circulatory apparatus after temporary closure of the aorta (a contribution to physiology of the spinal cord), by Dr. Mayer.—On the salivary glands of *Eledone moschata*, by Dr. Dietl.—On a new geological inclosure in the region of the Carlsbad springs, by Prof. Hochstetter.—On the magnetic declination and inclination at Vienna, by Herr Liznar.—The daily and yearly course of temperature at Port Saïd and Suez, by Herr Kostlivz.

March 21.—On peculiar openings in the upper surface flower leaves of *Francisea macrantha*, Pohl, by Dr. Waldner.—On the electromotive force of metals in aqueous solutions of their sulphates, nitrates, and chlorides, by Dr. Streintz.—On the diffusion of carbonic acid through water and alcohol, by Dr. Stefan.

April 4.—The following, among other papers, were read:—On determination of electric resistance by the electrostatic method, by Herren Gruss and Biermann.—On the heat capacity of mixtures of methylic alcohol and water, by Herr Lecher.—Main features of the actinic theory of heat, by Herr Reschl.—The basaltic lava of the Eifel, by Herr Hussak.—On the organisation of the brain of invertebrates, by Dr. Dietl.—On the arrangement of the more recent tertiary formations of Upper Italy, by Dr. Fuchs.—On Canides from the diluvium, by Dr. Woldrich.

April 11.—New and rare fish of the Vienna museum, by Dr. Steindachner.—Two problems of the dynamical theory of gases, by Lieut. Schlemüller.—The products of the volcano Monte Ferru, by Prof. Doelter.—The geological formation of Attica, Bœotia, Locris, and Parnassus, by Dr. Bittner.—On great subterranean watercourses and reservoirs, and the purity and transparency of certain lakes, by Dr. Boué.—On peculiar properties of some astronomical instruments, by Herr Sterneck.

May 9.—The dolomite ridges of Southern Tyrol and Venetia, by Dr. v. Mojsisovics.—The reptiles and fishes of the Bohemian chalk formation, by Prof. Fric.—On the results of the meteorology of the present, by Herr Hann.—Fish fauna of the Magdalene stream, by Dr. Steindachner.—Nostocolonies in the thallus of the Anthocerotee, by Prof. Leitgeb.—On continuous acoustic rotations and their relation to the principle of surfaces, by Herr Haberditzl.—Comparative anatomy of the seeds of *Vicia* and *Ervum*, by Dr. Beck.—Experimental pathology of œdema of the lungs, by Dr. Mayer.—On the electrolysis of water, by Dr. Exner.—On the relative volumes of atoms, by Herr Wächter.—Development of Chætopoda, by Prof. Stossich.—Chemical composition of diastase and grape jelly, by Prof. Zulkowsky.—Interpolar electrotonus, by Dr. Fleischl.—On the internal friction of glycerine, by Herr Schöttner.

May 16.—On the colours which follow each other in Newton's ring system, by Prof. Rollett.—On azophenols, by Prof. Weselsky and Dr. Benedikt.—On the existence of man at the time of the loess formation, by Count Wurmbrand.—On the apparently secular variations of dry land, by Prof. Suess.

May 23.—On the course of spark-waves in the plane and in space, by Prof. Mach.—On the path of the Comet II. of 1873, by Herr Becka.—Influence of pressure and temperature on the spectra of vapours and gases, by Herr Ciamician.—Theory and application of electro-magnetic rotations, by Dr. Margules.—The laws of the individuality of planets of our solar system; attempt to found a general theory, by Herr Lehmann.—Stones from the peninsula Chalcidice, by Herr Becke. On Berberin, by Dr. Weidel.

June 6.—The following, among other papers, were read:—Contributions to a knowledge of the colour-change of Cephalopoda, by Dr. Klemensiewicz.—On some problems of the mechanical theory of heat (continued), by Prof. Boltzmann.—On the cold-mixture of chloride of calcium and snow, by Dr. Hammerl.—On the gases arising from action of barium-oxide hydrate on albuminous substances, by Dr. Liebermann.—On the mica group (second part), by Herr Tschermak.

June 21.—The protoplasm of the pea (second part), by Prof. Tangl.—On development of hydrogen in the liver, and a method of production of butyric acid of fermentation, by Prof. Pribram.—On the specific viscosity of liquids, by Profs. Pribram and Handl.—Relations between electromotive force and chemical heat-tone, by Prof. Sekulie.—On the best method of showing details of the ethnography of a country with adequate accuracy and completeness in maps, by Prof. Boué.—On motion of electricity in space and Nobili's rings, by Prof. Ditscheiner.

July 4.—Map of the mountains of the moon, from personal observations in the years 1840–1874, by Dr. Schmidt, of Athens Observatory.—Fourth report from the Adria Commission, giving results of meteorological observations for 1871–73, and maritime observations for 1873.—Yearly periods of the insect fauna of Austria-Hungary, by Herr Fritsch.—Determination of the orbit of Comet V., 1874, by Dr. Gruss.—On the molecular size of indigo, by Prof. Lieben.—On heliotropic phenomena in the plant kingdom, by Prof. Wiesner.—On the friction of vapours, by Dr. Puluj.

ROME

R. Accademia dei Lincei, May 5.—The following, among other papers, were read:—On fossil bones in the environs of Rome, by Sig. Ponzi.—On personal errors in observation of the duration of meridian passages of the solar diameter, by Sig. Respighi.—Catalogue of the mean declination of stars of the first to the sixth magnitudes, comprised between the parallels 20° and 64° N. lat. (first part), by the same.—Objections to the induction of Messrs. Humphrey and Abbot, and representation by means of a parabolic curve of the subaqueous velocity, by Sig. Fambri.—On the minute structure of the skin of reptiles, by Sig. Todaro.—Histological researches on the pigmental epithelium of the retina, by Dr. Angelucci.—On the serpentine of Verrayes in the Valle d'Aosta, by Sig. Cossa.—On the serpentine formation of the Pavian Apennines; report on memoir, by Sig. Taramelli.—Theory of the boraciferous soffioni of Tuscany, by Sig. Bechi.—Astronomical and physical observations on the axis of rotation and on the topography of the planet Mars, made at the Royal Observatory of Brera, in Milan, with the equatorial of Merx during the opposition of 1877, by Sig. Schiaparelli.

PARIS

Academy of Sciences, July 22.—M. Fizeau in the chair.—The following among other papers were read:—On the theory of fermentation, by M. Pasteur. He takes objection to the unauthorised posthumous publication by M. Berthelot of some laboratory notes of Claude Bernard, written in October last, and which seem to be opposed to M. Pasteur's views. The notes were those of experiments made in order to test to the utmost those views, not a manifesto against them. M. Berthelot replied.—On the electro-chemical deposit of cobalt and nickel, by M. Becquerel. He points out the priority of his father's and his own experiments on the subject in 1862.—On the variation of the intensity of currents transmitted through mediocre contacts according to the pressure exerted on them, by M. Du Moncel. He has made various observations on this subject since 1856, and in 1875 noted in metallic filings, &c., properties on which Prof. Hughes' thermoscope microphone is based.—Velocity of propagation of excitations in the motor nerves of muscles of animal life in mammalian animals, by M. Chauveau. The average velocity in frogs was first measured and found about twenty-one metres per second. In the pneumogastric nerve of solipedes great differences were observed both in different parts of the nerve and in different animals. In one ass the velocity in the recurrent branch of the pneumogastric was 51 m., in the pneumogastric 68 m., and in the intermediate section 66·5 m. *The activity of conduction decreases from the origin to the termination of nerves.* In *post-mortem* experiments this law is reversed. If the pneumogastric is cut the conduction is retarded somewhat without reaching the figure for the terminal portion of the recurrent nerve. Operating on the middle portion of nerves, the velocity is about the same in animals placed in the same physiological conditions. It is about 65 m. per second, and may rise to 75 m. in strong animals of high breed, or go below 40 m. in common weak animals.—Currents observed in the Suez Canal and consequences resulting from them, by M. de Lesseps. Lake Timsah and the Bitter Lakes act as regulators. The prevalent north and north-west winds from May to October raise the mean level of water at Port Said and depress it at Suez; hence in summer a current, interrupted by the tides, from the Mediterranean to the Red Sea, and finally driving a good deal of water southwards. In winter the reverse occurs. It is estimated that 400,000,000 cubic metres of water are thus annually driven to and fro. This, with the tides, tends to annihilate the effects of evaporation, and aid the dissolution of the salt banks of the Bitter Lakes.—Note on a new earth of the cerium group, and remarks on a method of analysis of columbates, by Mr. Lawrence Smith (sealed packet deposited September 22, 1877).—On mosandrum, a new element, by the same. The new earth was obtained from samarskite; and he established that it differed from that of the yttria group, from oxide of cerium, from lanthanum, and from didymium. M. Soret has, with the spectroscope, confirmed the existence of the metal constituting the base of this new earth.—Discovery of the periodic comet Tempel at Florence, by M. Tempel.—On an apparatus for demonstrating simultaneously the law of recoil of a gun and the law of motion of a projectile, by M. Sebert. The instrument is called a velocimeter.—On the tension of vapour and the freezing point of saline solutions, by M. Raoult. With regard to power of diminishing the tension of vapour, or retarding the freezing point, the different anhydrous salts rank in nearly the same order. The power of producing the one or the other effect is generally greater the smaller the atomic weight.—On the presence of lead in sub-nitrate of bismuth, by MM. Chapuis and Linossier. A method of detection is described.—On a new hexavalent non-saturated hydrocarbon diallylene, C_6H_8, by M. Henry.—On the presence of lithium in the earths and thermal waters of the Solfatara of Pozzuoli, by M. Luca. It is there found in very small proportion in the state of sulphate.—On the peripheric temperature in febrile maladies, by M. Couty. In febrile affections developed normally the temperature increases in the peripheric parts more than in the central, and there is equalisation, or a tendency to this, in all parts of the body.—Relation between manifestations of ozone and turning movements of the atmosphere; observations in 1877, by M. Gully. The coloration of the paper seems to be always greatest to the north of a centre of depression.

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