THURSDAY, JUNE 10, 1886

THE 43-TON GUN EXPLOSION

THE bursting of the 43-ton gun on board the *Collingwood* has naturally attracted considerable attention from men of science as well as from the general public, and it may not be out of place at the present time to compare the ideas of scientific men with the data given in text-books published by authority and put into the hands of artillery officers for purposes of instruction.

The latest gunnery text-book is that compiled by Major Mackinlay, R.A., and published in 1883. In it is a table compiled by another artillery officer, in which is given the calculated and actual results obtained from all classes of ordnance, among them being the 12″ B.L. gun of 43 tons, Mark II., the gun which burst on board the *Collingwood*.

The powder charge is given as 286 lbs. prismatic, projectile 720 lbs.; the total work theoretically producible from the expansion of the charge in the bore 22,884 foot tons; the actual work produced in muzzle energy of projectile 17,180 foot tons. There is therefore, according to the table, a loss of 5704 foot tons to be expended—externally in expelling the powder gases, displacing the atmosphere, and recoil; internally in heating and stretching the gun, in friction of the gas check and gases, and rotating the shot.

In a lecture delivered in January 1885, just after the bursting of the *Active's* 6″ gun, Mr. Wm. Anderson pointed out that the lost work was very much greater than was usually imagined, and he went through a calculation on thermo-dynamical principles of the forces produced in a 10″ B.L. gun. Taking Mr. Anderson's formulæ and adapting them to the 12″ B.L. gun, we shall not have to proceed far before finding out how erroneous is the table given in the text-book. We will only examine the forces external to the gun (*i.e.* those producing recoil), as Mr. Anderson's accuracy on these points has been indorsed by Col. Moncrieff, C.B., F.R.S., and we shall neglect internal forces employed in friction stretching and heating the gun—forces difficult to estimate, and on which there is some difference of opinion.

As to the energy of the projectile there can be no question, but taking the terminal pressure at 3 tons (we believe it has risen as high as 5·5 to 6 tons) the energy of the expelled gases is 12,208 foot tons, that expended in lifting the atmosphere 2501 tons, together 14,714 foot tons; so that, neglecting internal forces altogether—and these are no small quantity—we have 14,714 foot tons of energy against 5704 in the text-book.

We can only conclude that the pressure corresponding to this difference, as well as that due to the forces expended inside the bore, have been entirely neglected by the designers of the guns.

The powder with which the gun was burst was that known as "cocoa"; this powder, while diminishing the maximum pressure carries it further down the bore (a most dangerous thing for guns weak in the chase), and increases the mean and final pressures, and the muzzle velocity; therefore the calculation we have given is probably within the mark for an equal weight of cocoa powder.

The reason for the errors we have pointed out may probably be found in the blind confidence placed in the indications of crusher gauges. It is well known that a certain length of time must be taken up in the compression of all metals, and it is extremely doubtful whether something near the two-hundredth part of a second in which the explosion takes place is sufficient for the compression of copper cylinders, especially when comparisons are made between those near the breech, which are longer under the influence of the powder gases, and those in the muzzle, which are not acted on for any appreciable time.

The only item in the above estimates which has been ascertained by experiment is the muzzle velocity, the others are the result of calculation, and although Col. Moncrieff tells us they are to be trusted when measured in recoil, it would be far more satisfactory were they ascertained by direct experiment.

Means for verification have been pointed out, and although we believe the Government is provided with the instruments nothing has yet been done with them.

The failure of the *Collingwood's* gun raised hopes in the minds of many that at last a proper inquiry into the question would be held; but it has been referred back to the same Committee, associated with the same civilians (except Mr. Leece, who is dead), who recommended that the gun "should remain unaltered," but that "the charge of 295 lbs. of cocoa powder should not be exceeded."

They therefore are to sit in judgment on themselves, and if they relied on the same data when recommending certain additional strength should be given to other guns, as they did when merely limiting the charge of the 12″, what reason is there for supposing that the results with other guns will differ from this one except in loss of life and damage done?

GEOLOGY OF TURKESTAN

Turkestan; a Geological and Orographical Description based upon Data collected during the Journeys of 1874 *to* 1880. By J. V. Moushketoff. Pp. 714. With Map and Engravings. Russian. (St. Petersburg, 1886.)

FOR several years past all who take an interest in Central Asia have followed with great interest the yearly reports published by Profs. Romanovsky and Moushketoff on their geological explorations in the mountains of the Tian-Shan, the high plateaux of the Pamir, and the lowlands of the Amu-daria. The extensive character of these explorations, prosecuted for several consecutive years, and the practical experience of the two Russian geologists promised that new light would soon be thrown on several important but doubtful points in the geology of this most interesting region; but the appearance of their works has been delayed for some years. We have, however, now before us the first volume of M. Moushketoff's work, and when the whole, which will comprise three large volumes, as also M. Romanovsky's work on the same subject, is published, we shall have an almost complete picture of the geology of this region which contains the key to so many important geological questions in Europe.

The first volume of M. Moushketoff's "Turkestan" consists of two parts. The first is an analysis of all explorations made in Turkestan up to 1884; and, the literature of the subject being scattered in periodicals, it will be of great value for the geographer. All the Russian and English explorations are mentioned, and the chief of them briefly analysed. The second part contains a description of the journeys of the author in the "Turan or Aral basin," including Samarkand, the western outskirts of the Tian-Shan, the valley of Ferganah, the western outskirts of the Pamir and Alay region, the valley of the Amu-daria from Termez to Khiva, and the Kyzyl-kum sands. A summary concludes the volume, which is accompanied by a novelty that will agreeably surprise geologists, namely, a geological map of Russian Turkestan, on a scale of 67 miles to an inch. Another map, on a scale of 20 miles to an inch, is in course of preparation, that now published being only intended to show the extension and limits of four great geological subdivisions: the Post-Tertiary deposits; the Tertiary, together with the Chalk, Jurassic, and Trias; the Primary, including the Archæan crystalline slates; and the unstratified crystalline rocks (granites, porphyries, diabases, and so on). Of course, it is regrettable that the Secondary deposits could not be separated from the Tertiary; but we must wait for the appearance of the promised map on a larger scale.

As to the conclusions arrived at in this volume, we may remark at once that the personal inclinations of the author being chiefly directed to petrography on the one hand, and dynamic geology on the other, these two departments have received most attention; while Prof. Romanovsky, being a well-known palæontologist, has devoted his chief attention and wide practical knowledge to the discrimination of the different subdivisions of the sedimentary deposits explored by him. M. Romanovsky having published almost every year very valuable reports on his summer's work, his researches are embodied in M. Moushketoff's work, so that each is complementary to the other.

Nearly the whole of the Aral basin (and we have seen that the author includes under this name the wide tracts east and south-east of Lake Aral) is covered by Chalk, Tertiary, and Post-Tertiary deposits; the remaining portion, that is, no more than one-twentieth of the area, being occupied by crystalline unstratified rocks, metamorphosed slate, and Palæozoic deposits which appear from below the above. A mere glance at a topographical map of the region would be sufficient to indicate their extent—all the hills rising amidst the wide steppes being built up of Palæozoic or Archæan rocks. The Devonian limestones of the mountains Urda-bashi and Karatash; the syenites, diabases, and crystalline slates of the Mogol-tau, Kochkar-ata, and Karnak mountains; and the Devonian and Carboniferous limestones of the Kazy-kurt hills are in this category. Some gold, silver-and-lead ores, copper, as also almandine and beryl, are found in these mountains. It is interesting also to notice that the crystalline rocks in the Palæozoic islands scattered amidst the steppes are much more metamorphosed than the corresponding rocks in the Tian-Shan mountains. They have obviously been long subject to the influence of water, which once covered what is now the steppe region.

Jurassic deposits are the next geological formation found in the East Aral basin. The lowest strata seem, however, to belong to the Rhætic subdivision—the few remains of plants which they contain being some of them Jurassic, while others should be recognised as Rhætic, and the third Triassic. They contain no traces of marine origin, and only one fresh-water shell, the *Anadonta boroldaica*, Romanovsky. It must therefore be concluded that throughout the Triassic and Jurassic periods nearly all Turkestan was a land having on its borders numerous lakes containing sweet or brackish water. These Jurassic deposits appear only on the borders of the East Aral basin: namely, on the Baidam and Saram rivers, and in Ferganah; in the west they are known on the Mangishlak peninsula (Caspian). Everywhere they contain most valuable deposits of coal. We may add that the geologist will thus find, in the Aral basin, the well-known geological feature so characteristic of the structure of East Siberia and Manchuria.

Chalk and Tertiary deposits are widely spread. They constitute the bottom of nearly all the basin, and reach a thickness of 2000 feet in Ferganah, and 5000 feet in the Hissar region. Two systems of dislocation are pretty well observed amidst these deposits which are folded in two chief directions: north-east (60°) and north-west (60°). This observation of M. Moushketoff is well worthy of notice. We thus find, on the outskirts of the hilly tracts of Asia, the two great systems of upheavals which are so characteristic of Asia: the system of ridges and plateaux running from south-west to north-east, which we have found appearing with such persistency in the East Siberian hilly tracts; and the north-western direction, which appears predominantly in South-West Asia.

The Chalk deposits show great variety of structure: sandstones, limestones, and marls predominating. As to their fossils, they appear at some places in immense masses, but the number of species is mostly limited. According to M. Romanovsky, the Upper and Middle Chalk are represented there: the former, very rich in oysters, is closely akin to the Senonian of Europe; it is much developed on the outskirts of the Tian-Shan, especially in Ferganah, but it changes its characters (Senonian Ammonites making their appearance) farther west, in the lower parts of the Amu-daria. The Middle Chalk, which, however, it is difficult to separate from the former, has a still wider extension. The Chalk contains a number of useful minerals; namely, phosphorite, gypsum, naphtha, ozokerite, and sulphur.

The Tertiary deposits are so closely connected with the Chalk deposits that it is often difficult to separate them from one another; they are still poorer in fossils (excepting those on the northern and western shores of Lake Aral, as yet unexplored), especially towards the east, as we approach the Tian-Shan. In this last region we have, as is known, the Eocene deposits, consisting for the most part of deep-sea deposits of Nummulite sandstones. They are covered with Lower and Middle Oligocene, very much like the German and Belgian Tertiary deposits, and these last in their turn disappear under Miocene limestones and Sarmatian clays.

The Tertiary deposits of the Tian-Shan contain, on the contrary, very little or no clays, and chiefly consist of conglomerates and sandstones. Some of them date from

the Eocene period, some others from the Oligocene; while the most recent Miocene and Pliocene deposits contain a fauna in process of decay: the deep-sea fauna of the banks of the Aral is substituted by a shallow-water fauna, and the Nummulite banks disappear. The chief fossils are teeth of sharks, some Lamellibranchiata, and a few oysters (*Sphenia rostrata*, Lamk.; *Modiola subcarinata*, Lamk.; *M. jeremejewi*, Roman.; *Alligator darwini*, Ludw.; *Ostrea raincurti*, Desh.; *O. longirostris*, Lamk., &c.). These features, as also the extension of pudding-stones, especially on the outskirts of the Tian-Shan, are indicative of their littoral origin. The same distinction appears as to the minerals they contain. Several great beds of gypsum, brown-coal, and bituminous slates are found in the Tertiary deposits around Lake Aral, as also naphtha in the Balkhan mountains; but both naphtha and brown-coal are absent in the Tian-Shan deposits, which contain, on the contrary, salt, together with gypsum.

The Post-Pliocene Aral-Caspian deposits can hardly be delimitated from the Tertiary deposits. Their maximum thickness does not exceed 100 feet. Both in the Black-Sands (Kara kum) and the Red-Sands (Kyzyl-kum) they consist of a sandy clay which often passes upwards into a clayey sandstone. As to their petrographical features, they are the same from the Volga to the foot of the Tian-Shan. The fossils they contain (*Cardium edule*, *Dreyssena polymorpha*, *Neritina liturata*, *Adacna vitrea*, and *Hydrobia stagnalis* in the Kara-kum; *Lithoglyphus caspius*, *Hydrobia stagnalis*, *Anadonta ponderosa*, and the Spongia described as *Metschnikowia tuberculata* by M. Grimm in the Kyzyl-kum) are all now living in the Caspian and Lake Aral, and precisely in the littoral shallow-water zone.

What are the limits of this immense Post-Pliocene basin surely forms one of the most interesting problems of geology, and they can already be determined approximately. In the west, the Ergeni hills (which run due south of the great Tsaritoyn bend of the Volga) form its western shore[1]—a great gulf extending along the broad valley of the two Manych rivers towards the Black Sea. Further south it must have been much nearer to the present shore of the Caspian, with a broad gulf to the west in what is now the valley of the Kura. How far this gulf extended towards the north remains still unsettled. The evidence derived from the *Dreyssena polymorpha*, found as far north as the Samara winding of the Volga, is still contested by MM. Möller and Grimm—this species of *Dreyssena* being a too cosmopolitan one; but the discovery of a few Caspian mussels even further north, towards Simbirsk, as well as the orography of this region, make one incline to the opinion that a narrow gulf of the Aral-Caspian Post-Pliocene sea extended almost as far as the mouth of the Kama, with a wide lake filling up the Oka depression of the Volga and communicating with the sea by an outlet. It is known that this basin extended towards Lake Aral and further east, with a peninsula which entered it from the north, and which is now known as the Ust-urt and Mugo-djar hills. How far it extended towards the east remains still unsettled. M. Moushketoff only mentions the supposition of the late M. Severtsoff as to the connection which existed between Lake Aral and Lake Balkhash. However probable this connection, we ought to take into consideration the latest researches of Russian zoologists, according to which the fauna of Lake Balkhash would have much more kinship with the lakes of Central Asia than with the fauna of Lake Aral. If this fact is confirmed, we should probably distinguish two different periods—an earlier and a later one—during which last the connection between Lake Balkhash and Lake Aral was broken, but continued between the former and the eastern lakes of Central Asia.

As to the southern limits of the Aral-Caspian basin, they cannot yet be determined with certainty. Aral-Caspian deposits are wanting in the middle parts of the Kyzyl-kum plateau, so that the southern shores of this basin must have been somewhere in the latitude of the Bukan-tau mountains. Further east they ran in a more southern latitude. In the Sary-kamysh depression and for 160 miles further south we again find Aral-Caspian mussels, as far as the Bala-Ishem wells, and in this region the Uzboy (formerly considered as the old bed of the Amu) disappears. South of Lake Aral they hardly reach the latitude of Merv. From all these data, M. Moushketoff concludes that the basin consisted of two different parts—the Caspian and the Aral part—connected by a narrow outlet passing by the base of the Balkhan mountains. The eastern portion was shallower than the western; it had more islands, and its organic life was poorer. It was also subdivided, in its turn, into two parts connected by the Aibughir outlet.

As to the drying up of this basin and its subsequent modifications, which M. Moushketoff attributes in great part to the agency of the wind, we shall devote to them a second article, inasmuch as the author's observations on the dunes and moving sands deserve special attention.

P. K.

(*To be continued.*)

[1] Prof. Barbot-de-Marny, whose deep insight and keen observation are so highly esteemed, extended these limits further west. Several considerations derived from the orography and physical geography of the region give, in my opinion, great probability to M. Moushketoff's view on the question. He has also had the opportunity of making a more thorough exploration of the region.

THE NATURALIST'S DIARY

The Naturalist's Diary. Arranged and Edited by Charles Roberts, F.R.C.S., L.R.C.P., &c. (Swan Sonnenschein, Le Bas, and Lowry, Paternoster Square).

THIS book may be described as a most excellent *vade mecum* and guide to any person who not only wishes to keep a phenological diary, but who wishes to know what to enter therein. The preface and introduction show forth the principles which have guided the author in making this compilation, and the important services it may be made to render to biologists and to men of science, as well as to practical gardeners, agriculturists, sportsmen, and residents in the country generally. It is also recommended to the notice of tourists, and especially to those who find themselves perchance perforce anchored in some one of our numerous health resorts, cut off from their usual avocations. Mr. Roberts's observations have been made on the breezy downs of Marlborough in connection with the Marlborough College Natural History Society, 1864-84. They include registration of mean, maximum, and minimum temperature in sun and shade, "accumulated temperature" above 42° day-degrees, barometrical observations, rainfall, and direction of wind.

These are, however, only the necessary key to what follows in the most interesting observations upon the first appearance of each familiar flower, the maiden song of each sweet warbler of the grove, the arrival of summer visitants, such as the swallow, swift, corn-crake, or cuckoo, and the emergence of insect, reptile, fish, or hibernating mammal from winter's sleep.

The student is provided with a series of 365 pages, fittingly and instructively introduced, one being devoted to every day in the year. Each page is numbered both prospectively and retrospectively, showing not only the number of days or pages from the beginning, but to the end. These pages are partly blank, and upon the left-hand side the reader is told what to look for in the vegetable or animal kingdom, what flower may be expected to raise its head, or, as the season advances, what fruit may be expected to ripen. We are almost all of us keenly alive to the interest of watching the unfolding season, and a book of this kind embodying information already obtained, and inviting the reader to record his own observations on the same points, must commend itself to a large class of persons. Take as an example p. 133, or the 133rd day of the year, May 13, and we find that we should on this day "look out" for the green hair-streaked butterfly, the light tussock and rivulet moths, and the egg of the lesser whitethroat; we may also look for the spindle-tree in flower and the common mallow, although somewhat before their usual times. The blossom of the whitethorn, which is always known as "May," has been seen at Marlborough on April 30, and again has not been seen till June 4, information which is thus succinctly set forth, "*Cratægus oxyacantha*, 120-155, Hawthorn, Whitethorn, May," the figures indicating the earliest and latest days of the year upon which this favourite flower has been known to bloom.

There appears, indeed, to be no limit to the kind of things which an earnest student of Nature might not pleasantly note as affording material for his *Naturalist's Diary*. And so wide is now the net thrown, and so extraordinary are the correlations of science, that no fact need be passed over as unworthy of notice. For example, we are told in the introduction that "closely connected with the subject of migration, and equally deserving of systematic observation, is the congregation or flocking of birds in the autumn and winter months, as it is probably correlated with hibernation of fishes and reptiles." So that watching the loves of doves, and packing of partridges, listening to the early soft cooings of pigeons, or the crow of the pheasant, chronicling the advent of the cuckoo, or of "sweet Philomel complaining," or listening to the first strains of that "rapture so divine" which the immortal Shelley ascribed to our most sustained songster—in each case we may by accuracy of observation add a drop to the ocean of facts slowly developing into universal knowledge. Such a task could not fail of being attractive. Possibly it may tend to dissipate the sweet and more dreamy influences which steal over us insensibly while experiencing the gradual unfolding of Nature—the feeling so tenderly expressed by Longfellow in his exquisite prelude to the "Voices of the Night"; but this awakening from the poetic dream appears to be the fate of communities as well as of individuals, and we must, we suppose, resign ourselves to it. It is the province of science to ransack, to dissect, to arrange, to chronicle, and not to "babble o' green fields" only, as Dame Quickly said of poor Sir John Falstaff lying a-dying.

Downton, May 12 JOHN WRIGHTSON

OUR BOOK SHELF

Scientific Results of the Second Yarkand Mission, based upon the Collections and Notes of the late Dr. F. Stoliczka. "Araneida." By the Rev. O. P. Cambridge, M.A. (Published by order of the Government of India, Calcutta, 1885.)

WE have already on several occasions noticed the memoirs published by the Government of India on the collections made during this expedition to Yarkand. The spiders were placed in the very capable hands of the Rev. O. P. Cambridge for description. The collection cannot be considered as fairly representing the fauna of the extensive region traversed during the expedition, an area which Mr. Hume thinks might be subdivided into five well-marked regions, but which the author, judging from the collection of Araneida, conceives might have been well considered as but two: that is, (1) from Murree to Cashmere, including the latter as well as the former; and (2) the whole of the rest of the area travelled over by the Expedition, and comprising the neighbourhood of Leh, the route from Tantze to Chagra and Pankong Valley, and from Yarkand to Bursi, as well as Yarkand and neighbourhood, Kashghar, the hills west of Yarkand, and the Pamir.

In the former of these more than half of the whole number of spiders were collected—69 out of 132. The leading character of these is European, with a few more distinctly tropical and sub-tropical species. The character of the latter region is also European, but with decided sub-Alpine features, and scarcely a trace of any even sub-tropical form; and of the 69 species met with in the former three only were found in the latter, and only one, *Drassus dispulsus*, occurred throughout.

Of the 132 species, 23 seem identical with European species already described, leaving the large proportion of 109 as apparently new to science. Even this number cannot be supposed to represent the new species in the fauna of this region. The season of the year was very much against the success of the collection, and the hands of the collector were very much engaged with other branches of natural history; and there can be no doubt that a large harvest awaits the explorer of the southern slopes of the mountain regions of Cashmere, where the tropical character of the forms will become more marked; and probably a still greater diversity in the species will be found in those from the more central regions of India. For comparison upon these points the author regrets that there exist no materials, for almost nothing has as yet been published about the spiders of tropical India.

Two quarto plates with 21 figures of the more important new species accompany this Report.

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 insure the appearance even of communications containing interesting and novel facts.*]

The Thomson Effect

I AM indebted to Dr. Everett for calling my attention to the confusion which has crept into § 193 of my book on "Heat." I had not noticed it; but, happily, it can easily be removed. Take to the end of the section the statement quoted by Dr.

Everett ; and delete the word "Thus" in the sentence which, at present, (wrongly) follows instead of preceding it. This change is obviously called for by the context :—for the reader has just been told how far *theory* had guided Thomson as to certain "absorptions," &c., of heat ; and, of course, expects next to be told what additional information, as to these "absorptions," &c., Thomson obtained by *experiment*.

Still, confused as it is, the passage could not (except possibly from the point of view of history) embarrass a reader of § 196 ; for the nature of the Thomson effect is there *again* clearly stated, and even illustrated by a diagram. [A much more serious case of confusion is to be found at p. 366, line 15 ; where (by the omission of a few words) my copyist has made absolute nonsense of a quotation from Clerk-Maxwell.]

The statement quoted by Dr. Everett obviously requires to be restricted, as follows :—

An electric current, passing from cold to hot in copper, behaves as a real fluid would do :—i.e. *it tends to reduce the gradient of temperature. In iron, under the same circumstances, it tends to increase the gradient.*

It is clear that this statement has nothing to do with the *general* nature of the Thomson effect :—*i.e.* "absorption" or "disengagement" of heat :—for *this* would depend upon the temperature of the fluid spoken of. It raises the question of the excess of Thomson effect in one locality, over that in another, at a lower mean temperature but with an equal gradient.

Dr. Everett seems to forget that, though the water-equivalent of a metal may be treated as sensibly constant through moderate ranges of temperature, the "specific heat of electricity" cannot so be treated. Using his notation, (with the proviso that θ is *absolute* temperature) we have $\sigma = k\theta$, and the equation he quotes from Thomson is

$$\frac{d\theta}{dt} = -\frac{k\theta}{c}\frac{d\theta}{ax}.$$

Happily, this can be integrated, so that we have

$$\theta = F\left(x - \frac{k}{c}t\theta\right) \quad \ldots\ldots\ldots \quad (1)$$

Now suppose the gradient of temperature to be uniform and positive along x positive (the direction of the unit current) ; when $t = 0$ we have

$$\theta = ex.$$

Generally, therefore,

$$\theta = e\left(x - \frac{k}{c}t\theta\right),$$

$$= \frac{ex}{1 + \frac{k}{c}et}.$$

Thus the gradient becomes less steep :—*i.e.* there is a tendency to reduce temperature differences, when k is positive, as in copper. In iron, where k is negative, the tendency is to make the gradient steeper :—*i.e.* to exaggerate differences of temperature. Of course, as in all these thermo-electric matters, reversal of sign of the gradient reverses the thermal effect.

The general integral (1) denotes a process of continued *simple shearing*, not *translation*, of the "temperature curve." Were it not for heat-conduction, harmonic waves of temperature would tend to become *breakers*. But it is idle to speculate farther.

How much of this is Thomson's I don't certainly know ; and I am for the present too busy to enquire. But it would be difficult to overestimate his services to Thermo-electricity.

This will, I hope, meet with Dr. Everett's approval. As to his letter, I would say (in Scottish legal phrase) "*Quoad ultrà*, denied."

P. G. TAIT

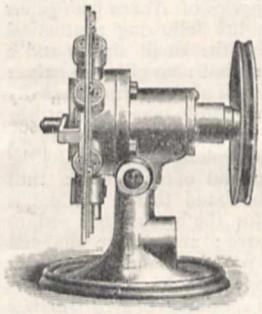
May 28

Power in Laboratories

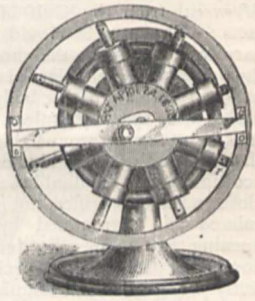
IN connection with the admirable devices for the distribution of driving-power in laboratories, illustrated in NATURE, vol. xxxiii. p. 248, the description of a novel and very effective form of water-engine, with which I have been experimenting for several months, will be of interest.

One of these motors is set up in the cellar of our science hall, where it is supplied with aqueduct-pressure of sixty pounds to the square inch, and the power is transmitted from it by means of rubber belting led over "idle pulleys" to the upper stories of the building, where a small engine-lathe and dynamo are driven. A word will suffice to explain the very simple construction of the motor—a system of radial cylinders, with their bases at the centre of the motor, through which runs the driving-shaft. The pistons in these cylinders are single-acting, and the water is admitted to them in succession by the rotary valve which forms part of the main shaft. The pistons, thus, in pressing outward, exert their force against a strong ring, to which is bolted a cross-bar which engages the crank of the main shaft. Thus the ring, in turning the shaft, has the vibratory motion of an eccentric, and returns the opposite pistons to the bases of the cylinders, at the same time exhausting the water through the interior of the rotary valve. Three pistons are thus constantly exerting a thrust upon the ring, whatever its position, and this thrust being always tangential to the arc of revolution of the crank, there is no "dead centre," and the uniform pressure at right angles to the crank at every part of its arc insures an even rotary motion and obviates the necessity of a balance-wheel. The ends of the piston-rods are slotted, and contain anti-friction rollers which bear against the ring, and this latter is grooved all round, so that, in addition to its simple and rapid motion as an eccentric, the ring is free to perform a slow motion of revolution independently of its work of driving the crank, and the wear of the interior face of the ring is thus equalised and becomes inappreciable.

The supply-pipe for this motor has a diameter of 1½ inches, and it gives an equivalent of nearly 2 horse-power. The flow of water is regulated by means of a balanced valve, under control from every point where the power is used. As the use of the power is, for the most part, discontinuous, like that in lathe-work, I find it better to start and stop the motor as often as desired than to use the ordinary device of shifting a belt off and on a loose pulley. All possible economy of water is assured, as



Side View.



Front View.

none of it runs to waste without giving its equivalent of power at just the time when it is required. It will be seen that this form of motor is specially adapted to such uses, as there is no fly-wheel whose inertia has to be overcome ; and as the motor has no "dead centre," it readily starts from any position, overcoming a maximum resistance.

Where continuous running is required, at an invariable speed, a centrifugal governor is attached to the belt-wheel, and acts upon the amplitude of vibration of the ring, diminishing the stroke of the pistons when the resistance is removed. The governor thus gauges the water-supply exactly proportional to the resistance to be overcome, and makes the motor a very effective driving-power for dynamos and all sorts of machines and apparatus in which a uniform speed is necessary, while the resistance is variable.

The difficulties barring the economic use of water as a motive-power, owing to its weight and incompressibility, seem to have been successfully overcome in this form of motor, with which unexampled speeds have been attained, and more than 80 per cent. of the theoretical power of the water derived. The little cut annexed shows the smallest size of these motors—it stands about 10 inches high, and uses a ¼-inch supply, consuming less than six quarts of water in 100 revolutions. I frequently run it at a speed of 1000 revolutions to the minute, and at the manufactory I have seen the same motor attain double this velocity. The motor runs equally well with compressed air (or with steam, if the piston-packings are changed), and with either of these media even higher speeds are attainable.

I find that the constant readiness of the motor for the immediate development of power, the little care it has required (only occasional oiling), and its economical consumption of water, are

very great advantages in its favour; and, for all laboratories supplied with aqueduct-pressure, I venture to think that it affords the best solution of the problem of inexpensive, convenient, and effective power. DAVID P. TODD

Lawrence Observatory, Amherst, Mass., May 15

Scientific Nomenclature

IN a letter published in NATURE for May 27 (p. 76) Prof. Minchin proposes to replace the expression "potential energy" by "static energy." It seems to have escaped his notice that a similar expression, proposed many years ago by Sir William Thomson, was used until it was replaced by the very words which Prof. Minchin wishes now to abolish. A short account of the question is given by Maxwell in "Matter and Motion," p. 81, and I should like to bring the following passage to the notice of those who take an interest in this question :—

"This is called the 'sum of the tensions' by Helmholtz in his celebrated memoir on the 'Conservation of Energy.' Thomson called it statical energy; it has also been called energy of position; but Rankine introduced the term potential energy—a very felicitous expression, since it not only signifies the energy which the system has not in actual possession but only has the power to acquire, but it also indicates its connection with what has been called (on other grounds) the potential function."

Harrow, June 8 G. GRIFFITH

Neæra

I WISH to request any of your readers who may dredge, or have opportunity this summer, to observe living or fresh specimens of the genus *Neæra*, Gray, and see whether branchiæ exist in that group. A Lamellibranch without branchiæ is anomalous, to say the least. I find in a new species of *Neæra* (sub-genus *Myonera*) from the Gulf of Mexico the following anatomical facts :—The mantle closed except for the small siphon and a narrow short slit for the thorn-shaped foot; no gills, no palps; the oral opening circular, plain; the roof of the peripedal cavity between the base of the body and the mantle margin is flattish, fleshy, with sparse pustules; a peripheral very stout pink muscle runs on each side around this, and is prolonged upward to the shell before the true adductor at each end of each valve, thus accounting for the double scars to be found there; the foot is close to the oral orifice, not grooved for the byssus, but pedunculated and surrounded by a groove; around the siphonal opening are numerous tentacular processes and a moderate number of ocelli. The specimens appear to be adult and perfectly preserved. An examination of specimens of *Neæra arctica* and *Neæra obesa*, Lovèn, indicated a similar state of affairs, though these specimens were not in as good condition as the one from the Gulf of Mexico. I do not find in the literature any categorical statement of the observation of gills in this genus. Clark is non-committal (in his "British Testacea"), Jeffreys speaks of seeing the "pink gills" through the shell, but that which he saw *pink* was without doubt the circular muscle I have mentioned.

The question is worthy of a definite solution. My specimens seem to leave no doubt that there are no gills, but it is always best to be suspicious of material long in alcohol.

WM. H. DALL

Smithsonian Institution, Washington, D.C., May 27

"Plants and their Defences"

WITH regard to the interesting article in your issue for May 6 (p. 5) on "Plants and their Defences," I should like to offer two remarks, and in return would be very glad to receive from you information upon a certain point. (1) The author enumerates different species of plants protected by the severe stings of ants, but does not seem to know the remarkable work of Beccari, "Piante ospitatrici ossia piante formicarie della Malesia e della Papuasia" (Malesia, vol. ii., Firenze, 1885). Beccari describes seventeen partly new species of "Myrmecophilous" Rubiaceæ, among which are eleven of Hydnophytum (not Hydriophytum, as is erroneously given in the article in NATURE). You will find a further contribution to this question in Henry O. Forbes's "Wanderungen durch den Malayischen Archipel," vol. i. pp. 84-88 of the German translation.

For my part, I should be greatly obliged if you would communicate to me the title of the original work from which the author of "Plants and their Defences" has taken his account of *Triplaris Schomburgkiana*, *Schomburgkia tibicinis*, and *Acacia sphærocephala*.

(2) Concerning the same article, Mr. Alfred W. Bennett (NATURE of May 20, p. 52) is inclined to think that the poisonous fluid of the nettle-glands is not formic acid, as generally conjectured, because the fluid frequently has an alkaline reaction. As a matter of fact, Prof. Dr. Haberlandt, at Graz (Austria), has recently, in vol. xciii. of *Sitzungsberichte des kaiserl. Akademie der Wissenschaften in Wien*, 1886, Februar-Heft, shown in his article, "Zur Anatomie und Physiologie der pflanzlichen Brennhaare," that (1) the poison of the stinging glands is not identical with formic acid; (2) nor is it the albumen dissolved in the fluid of the glands; but (3) that most probably this fluid is a transformed ferment or enzymotic poison.

Frankfurt a. Oder, June 2 E. HUTH

A Remarkable Hailstorm

ON April 17, at 4 o'clock p.m. (local time), a very remarkable hailstorm visited the neighbourhood of a small hamlet, called *El Totumo*,[1] not far from the town of Tinaco, section Cojedes, State of Zamora, Venezuela. The place is approximately in 9° 25′ N. lat., and 68° 5′ long. W. of Greenwich, certainly not more than 200 metres above sea-level. My informant is a resident of El Totumo, named Nicolas Moreno Nuñez, who is universally said to be a trustworthy and respectable man. There was first a very heavy thunderstorm with much rain; but after some time hailstones began to fall in such abundance that it might have been easy to collect them by hundreds of bushels, some weighing as much as two ounces. It is well known that between the tropics hailstorms are exceedingly rare in localities situated in the lowlands; but the present case is still more interesting, on account of the colour of the hailstones, some of which were *whitish, whilst others were blue or rose-coloured*. I have read of but one instance in which the two last-mentioned colours were observed, viz. in the hailstorm of Minsk of June 14, 1880, described by Lagunowitch, and quoted by Th. Schwedoff in his memoir "On the Origin of Hailstorms."[2] Schwedoff thinks that the blue and rosy colours are owing to the presence of salts of cobalt and nickel, and thus confirm his hypothesis of the cosmic origin of hail. I do not know whether the existence of those mineral constituents in the hailstones of Minsk was ever made certain by chemical analysis, and it is of course impossible for me to do so in the present case, when almost a month has passed since the phenomenon took place. But it is undoubtedly a very curious coincidence that the *same* colours should have been observed in both instances and in localities so widely separated from each other; whilst there is not the slightest possibility that my informant, an honest and plain countryman of no literary education whatever, should have had any knowledge of such an observation having been made before.

Caracas University, May 12 A. ERNST

VISITATION OF THE ROYAL OBSERVATORY

THE visitation to the Royal Observatory by the Board of Visitors took place last Saturday, when there was a very numerous attendance. The report of the Astronomer-Royal to the Board gives, as usual, an account of the work done during the past year, and references to any points of interest or importance which have been raised. From the report we select the following particulars :—

Mr. Turner has recently investigated the discordance between observations for coincidence of the collimators made respectively through the apertures in the cube of the transit-circle and with the instrument raised. A wooden model of the cube was constructed through which the observation could be made when the transit-circle was raised, and it was thus shown that the discordance was due to the cutting off of portions of the object-glasses by the cube, and not to any effect of temperature. In view of this result it seems desirable that the optical

[1] This is the vernacular name of the calabash-tree (*Crescentia Cujete*); there is, or was, probably a remarkable specimen of this tree in the neighbourhood of the hamlet.

[2] I only know a Spanish translation of Schwedoff's memoir, in *Crónica científica* (Barcelona), 1882, No. 120, pp. 553-60.

definition of the collimator object-glasses should be thoroughly tested.

A discussion of the collimation-observations made throughout the year 1885 with the reversion-prism shows that for the regular observers the personality depending on the apparent direction of measurement is extremely small. Any possible effect of the kind is eliminated by the method of observation adopted with the reversion-prism. The personality depending on the direction of motion, as deduced from the results of reversed and ordinary transits of clock-stars with the reversion-prism, appears to be more decided, though the amount is small except in the case of one observer.

The personal equation instrument was completed last autumn, but was dismounted during the winter to preserve it from injury in the bad weather. Series of observations have been taken with it on five days, and the results appear to be very satisfactory, the accordance being as close as could be expected. The absolute personal equations thus obtained seem to show that all the observers observe too late, the differences between the several observers agreeing well with the relative personal equations found from observations of clock-stars.

The sun, moon, planets, and fundamental stars have been regularly observed during the past year, together with other stars from a working catalogue containing about 2750 stars. Good progress has been made in the observation of these stars, in view of the formation at the end of 1886 of a Ten-Year Catalogue, epoch 1830·0. The annual catalogue of stars observed in 1885 contains about 1250 stars.

The following statement shows the number of observations made with the transit-circle in the twelve months ending 1886 May 20 :—

Transits, the separate limbs being counted as separate observations	5685
Determinations of collimation error	306
Determinations of level error	332
Circle observations	5133
Determinations of nadir point (included in the number of circle-observations)	318
Reflection-observations of stars (similarly included)	530

The value found for the co-latitude from the observations of 1885 is 38° 31′ 22″·04, differing by 0″·14 from the assumed value ; the correction to the tabular obliquity of the ecliptic is + 0″·81 ; and the discordance between the results from the summer and winter solstices is − 0″·98, indicating that the mean of the observed distances from the pole to the ecliptic is too great by + 0″·49.

The mean error of the moon's tabular place (computed from Hansen's Lunar Tables with Prof. Newcomb's corrections) is + 0·02s. in R.A. and + 0″·36 in longitude, as deduced from 105 meridian observations in 1885. The mean error in tabular N.P.D. is − 0″·58, which would appear to agree with the observations of the sun in indicating that the mean of the observed N.P.D.'s is too great.

The observations of the moon with the altazimuth have, as usual, been restricted to the period from last quarter to first quarter in each lunation, the total number of observations of various kinds made in the twelve months ending 1886 May 20 being as follows :—

Azimuths of the moon and stars	213
Azimuths of the azimuth-mark	146
Azimuths of the collimating-mark	176
Zenith-distances of the moon	110
Zenith-distances of the collimating-mark ...	172

The reversion-prism has been used during the past year with the altazimuth for investigation of the personality depending on the apparent direction of motion of stars or the moon. The plan adopted has been to observe a transit over the first three wires with a certain apparent direction of motion and over the last three with the apparent direction of motion changed. A second transit is then observed with the conditions reversed, so that in each double transit there are two sets of observations over the same six wires with the apparent direction of motion different, from which a determination of the personality is obtained by simple subtraction without any calculation of intervals of wires. The results show that the personality is in every case small, and that further observations are required to separate it from accidental errors of observation.

A clock synchronised by hourly currents, on Lund's system, has been presented to the Observatory by the Standard Time and Telephone Company, and is fixed in the Astronomer-Royal's office.

A new plane mirror (silver on glass) has been obtained from Mr. Calver for the Lassell equatorial, and a wooden screen has been fixed at the eye-end to protect the open end of the tube from the heat of the observer's body, it having been found that the definition was much affected by convection-currents at the eye-end, giving rise to an apparent astigmatism which was at first supposed to be caused by tilt of the large mirror. The optical performance appears now to be satisfactory. At Mr. Common's suggestion a frictional connection between the clock and the driving-screw has been applied so as to allow of the latter being turned in either direction (for slow motion in R.A.) without putting the clock out of gear.

For determination of motions of stars in the line of sight, 378 measures have been made of the displacement of the F line in the spectra of 51 stars, and 21 measures of the *b* lines in 8 stars, besides measures of the displacements of the *b* and F lines in the spectra of Mars and Venus, and of the east and west limbs of Jupiter, and comparisons with lines in the spectrum of the moon, or of the sky, made in the course of each night's observations of star-motions, or on the following morning, as a check on the general accuracy of the results. The observations of Sirius during the past twelve months indicate, as in the last three years, a displacement of the F line towards the blue (corresponding to a motion of approach), the amount being slightly larger than in the preceding year. Spectroscopic observations were interrupted on a number of nights through deficient supply of water for the driving-clock of the south-east equatorial. After some correspondence with the Kent Waterworks Company it was arranged that the pressure in the Observatory main should not be reduced to so low a point in the evening, and no further trouble with the water supply has been experienced since. The experiments with the reversion spectroscope of the Oxford University Observatory (lent by Prof. Pritchard) indicate that this form of instrument is well adapted for observation of displacements, provided certain improvements can be effected in the optical and mechanical parts.

For the year 1885 Greenwich photographs are available for measurement on 208 days, and photographs from India and the Mauritius, filling up the gaps in the series, on 152 days, making a total of 360 days out of 365 on which photographs have been measured. The record has thus been made practically complete for 1885 by means of the Indian and Mauritius photographs.

A table of the means of daily areas of spots and faculæ and of the mean heliographic latitude of spots has been formed for each synodic rotation of the sun, and for each year from the commencement of the Greenwich series in 1873 to the end of 1885.

Further experiments for determination of the temperature corrections for the horizontal and vertical force magnets by alternately warming and cooling the basement on successive days were made in the spring of this year, a continuous record of the temperature being obtained by means of the Richard thermograph. The following are the results thus obtained in 1885 and 1886 as compared with the previous determinations, the appa-

rent changes for 1° of temperature being expressed in terms of the horizontal force and vertical force respectively :—

For 1° Fahr. increase of temperature	1868	1885	1886
Apparent decrease of horizontal force	·00018	·00026	·00021
	1882	1885	1886
Apparent increase of vertical force ...	·00020	·00022	·00020

The following are the principal results for magnetic elements for 1885 :—

Approximate mean declination 18° 2′ west.

Mean horizontal force... ... { 3·9376 (in English units). 3·8156 (in metric units).

Mean dip ... ... { 67° 27′ 28″ (by 9-inch needles). 67 27 32 (by 6 inch needles). 67 28 27 (by 3-inch needles).

In the year 1885 there were only three days of great magnetic disturbance, but there were also about twenty days of lesser disturbance for which it may be desirable to publish tracings of the photographic curves. It is proposed to add tracings of the registers on four quiet days to serve as types of the ordinary diurnal movement at four seasons of the year, as was done for 1884.

The automatic drop of the Greenwich time-ball failed on two days during the past twelve months, on one occasion through accumulation of snow on the mast, and on another through failure in the clock-work apparatus for daily reversal of the currents through the electro-magnets. This apparatus has since been removed, and the direction of the currents is now reversed by hand once a week. On one day the ball was not raised on account of the violence of the wind.

As regards the Deal time-ball, there have been seven cases of failure owing to interruption of the telegraphic connections, and on three days the violence of the wind prevented the raising of the ball. There have been three cases of failure of the 1 p.m. signal to the Post Office.

No further action has been taken as regards the establishment of hourly time-signals at the Lizard or Start, as the arrangements for preliminary trial of a collapsible cone at Devonport are not yet completed. One of the Transit of Venus clocks (Dent 2010) has been adapted by Messrs. E. Dent and Co. to give hourly time-signals, and to be synchronised by the help of an auxiliary seconds' pendulum on the plan I proposed in the last report.

The longitude of Gibraltar was determined last year under Capt. Wharton's direction, by exchange of telegraphic signals on August 8, 9, and 12 between Greenwich and Gibraltar, the Eastern Telegraph Co. having courteously given the free use of their telegraph cable for the purpose. The signals were transmitted by relay-action from the ends of the cable to the observing-stations at Greenwich and Gibraltar. Local time was determined at Gibraltar by the officers of H.M.S. *Sylvia* with the sextant, and at Greenwich by Commander Moore and Lieut. Douglas by means of sextant observations, and also by transits with the transit-circle. In connection with this determination a large number of observations of signals were made at Greenwich for the determination of the personal equations of the different observers in observing telegraph signals. At Greenwich the longitude signals were observed by five observers independently. Commander Moore and Lieut. Douglas made a series of observations at Greenwich last summer for comparison of the relative value of determinations of local time made with a sextant and with a small transit instrument respectively.

The record of the past year shows that the work in all branches tends to increase. This increase could not well be resisted without impairing the efficiency of the Observatory, but year by year it causes more pressure on our limited staff, which, in addition to scientific work, is charged with the ever-increasing duties of a Government Office. In this connection I may mention that a good deal of my own time, as well as that of the Chief Assistant, has lately been occupied with various matters connected with the Navy, reference having been made to me on the subject of gun-directors, mirrors for electric search-lights, and binoculars, in all of which there are involved questions requiring careful consideration.

Commencing with the year 1885, Greenwich civil time, reckoning from midnight to midnight and counting from 0 to 24 hours, has been adopted in the spectroscopic and photographic results as well as in the magnetical and meteorological. It is proposed to defer the introduction of this time-reckoning into the astronomical results till the year 1891, for which year the Board of Visitors have recommended its adoption in the *Nautical Almanac*. In an Observatory such as this, where observations of various classes are carried on, there is, however, considerable inconvenience in the retention of the present astronomical day, which now involves the use of two systems of reckoning mean solar time in the same establishment.

The construction of an object-glass of 28 inches aperture and of 28 feet focal length, with suitable tube, to be mounted on the south-east equatorial, has been authorised by the Government, and the necessary funds have been provided in the estimates. The work has been intrusted to Mr. Grubb, with whom I have arranged the details of the tube, which is to be of special construction, adapted to the conditions of the mounting, and available for spectroscopy and photography as well as for eye-observations. Mr. Grubb proposes to provide means for readily separating the lenses of the object-glass to such a distance as will give the proper correction for photographic rays. Messrs. Chance are engaged in the manufacture of the glass for the lenses, and have already made a flint disk which promises to be very satisfactory.

In view of the recent development of astronomical photography, I propose to have constructed, for use with the present 12¾-inch refractor of the south-east equatorial, a combination of a convex flint and concave crown lens, which, when placed about 2 feet within the focus, would correct the chromatic aberration of the object-glass for the photographic rays without alteration of the focal length. If this plan succeeds, the instrument would then be well adapted for photography, thanks to the firmness of its mounting and the excellence of its driving-clock.

THE PAST WINTER

AT the meeting of the Royal Meteorological Society held on May 19 a paper was read on "The Severe Weather of the Past Winter, 1885-86," by Mr. C. Harding, F.R.Met.Soc. The paper dealt with the six months from October to March in a general way, and with the three months from January to March more in detail, as the latter embraced the period during which the weather was most severe, and in which both frost and snow were exceptionally prevalent. The material used in the discussion was for the most part contributed by the kindness of the Meteorological Council.

The greatest deficiency of temperature throughout the winter occurred in the weeks ending January 25, March 1, 8, and 15, the defect on the average amounting to as much as 9° and 10° over the greater part of England. During the fortnight ending March 15 the mean temperature was below the freezing-point in the Midland Counties and in the north-west of England, and, considering the British Islands as a whole, the temperature was lower during this fortnight than in any similar period of the winter. The means for each of the six winter months show that the temperature was below the average over the whole Kingdom in October, January, February, and March. In the east, south, north-west, and south-west of England, and the Channel Islands, as well as over the

greater part of the Midland Counties, and the north of Ireland, temperature was also below the average in December, whilst in the north-west of England and over a great part of the north of Scotland each of the six months was below the average. There was no part of the British Islands, except the Channel Islands, in which the temperature for each week, from the commencement of January until the third week in March, did not fall to the freezing-point or below, whilst in the south-west of England there was not a single exception after the first week in October, and in the east of Scotland, the north-east and north-west of England, the thermometer fell to 32° or below in each week from the commencement of November. The lowest shade-temperatures observed in the British Islands were: in January, −2° at Braemar on the 19th, and 1°·1 at Alston on the 20th; in February, 2°·5 at Braemar and 7°·1 at Alston on the 5th; in March, −2° at Alston and 1°·2 at Buxton on the 7th, and 2° at Braemar on the 12th. There were extremely few instances of the temperature falling below 5°; but temperatures below 10° were observed in January and March over the greater part of Great Britain.

From the commencement of January to the middle of March there was almost continuous frost, and during this period it froze for upwards of 60 nights at many places in the British Islands. At Great Berkhamsted the minimum temperature registered 32° or below in January 22 days, February 23 days, March 18 days, making a total of 63 days between January 3 and March 18; whilst on the grass it froze for 73 consecutive nights, from January 5 to March 18. At Cheadle in Staffordshire, Churchstoke in Montgomery, Llandovery in Carmarthen, and Great Berkhamsted in Hertfordshire, it froze for 33 consecutive nights, from February 14 to March 18, whilst at very many stations the frost continued 30 days or more. In Great Britain the longest period of frost occurred between the middle of February and the middle of March, but in Ireland it occurred generally in January. At Greenwich it froze on 28 consecutive days from February 19 to March 18; the observations from 1845 do not show another instance of frost continuing for so long a period without interruption. The only instances of 20 or more consecutive days are:—

24 days in 1858, from February 17 to March 12.
22 days in 1879, from November 20 to December 11.
21 days in 1855, from January 14 to February 3.
21 days in 1878, from December 6 to December 26.

For the three months from January to March there are but few years since 1845 that have a period of continuous frost of one-half the length of that in 1886. The years with fifteen days or more are respectively:—

1886 (28), 1858 (24), 1855 (21), 1861 (19), 1881 (16).

Taking the actual days with frost at Greenwich, irrespective of continuity, there was frost on 53 days in the present year (1886) from January to March. In 1855 the number of frosts in the corresponding period was 58, but the only other instance of more than 50 days was in 1858, when the number was 53.

Probably the most interesting feature in connection with the past winter was the excessively cold weather experienced over the whole country at the commencement of March. The Greenwich observations from 1814 only show two instances of a similarly low temperature—these were in 1814 and 1845. The unusual frequency with which snow fell was also a matter of interest, and the heavy drifts occasioned serious blocks on many of the northern railways.

The records of the London Skating Club show that there was skating on the Club water in Regent's Park on 38 days during the winter, and 1885–86 was the only winter in which there was skating in each of the four months from December to March since the formation of the Club in 1830, and the only March records of skating in the 56 years are 16 days in 1886, 12 days in 1844, 10 days in 1858, and 1 day in 1853. On a pond at Pinner there was almost continuous skating for 3 months, and and at Rickmansworth for about 70 days, but at both places the ice was most carefully nursed. On January 7 there was safe skating on snow-ice after one night's frost.

The temperature of the water in the Thames at Deptford was, on the mean, slightly in excess of the air. From January 8 to March 20 the entire range was from 40° to 34°; and from March 1 to 19 the maximum temperature was 36°·5 and the minimum 35°, showing a total range of 1°·5.

The recent temperatures observed at several stations over England show that at 1 foot below the surface the greatest cold for the winter was reached during the first 17 days of March. The mean was generally about 2° in excess of the mean air temperature. In January the earth temperature at 1 foot was from 2° to 3° below the average over the whole country, whilst in February it was from 4°·5 to 6°·5 below the average; the first 17 days of March, however, show a much larger defect on the average, the deficiency ranging from 6°·3 at Lowestoft to 8°·5 at Norwood. The temperature of the soil at 2 feet was generally about 2° in excess of that at 1 foot.

The logs of ships traversing the North Atlantic show that the abnormal conditions which prevailed over the British Islands and indeed over nearly the whole of Europe extended also a considerable distance to the westward. They show a decided tendency to a low barometer, during the early months of 1886, in the locality where a high barometer generally prevails, and to the north of this low barometer strong and persistent easterly winds were experienced. These facts tend to show a general reversal of conditions over the Atlantic which would doubtless be very intimately related to our own exceptional weather.

THE ASTRONOMICAL DAY

THE recently published report of the Science and Art Department contains some most important information showing what the recent Government action has been in relation to the resolutions passed at the Washington Conference.

The first letter that we need refer to is one from the Astronomer-Royal, in April last year, suggesting that reference should be made to various scientific Societies, in order to obtain an authoritative expression of opinion from the scientific men in this country interested in the question. This was followed by a meeting of the committee appointed to advise the Science and Art Department on the matter. The following resolution was adopted by the committee, which consisted of Prof. Adams, the Astronomer-Royal, General Strachey, Captain Sir Frederick Evans (since deceased), Captain Wharton (the Hydrographer), and Colonel Donnelly:—"The committee recommend that the report of the British Delegates to the Washington International Prime Meridian Conference, with the resolutions adopted by that body, be communicated to certain Departments of State, learned Societies, telegraph companies, &c., and that they be informed that the resolutions appear to be such as commend themselves for adoption; but before informing the American Government to that effect they would be glad to receive their opinions on the subject."

The Science and Art Department then addressed a letter to various public offices, scientific bodies, and telegraph companies. Their replies may be thus condensed.

The Eastern Telegraph Company, and the Eastern Extension, Australian, and China Company, state that they have always adopted the twenty-four-hour system in timing their messages, thus avoiding the necessity of signalling the letters a.m. and p.m.

The Society of Telegraph-Engineers and Electricians cordially approve of the first six resolutions of the Washington Conference, but they reserve their opinion as to the seventh (the one referring to the application of the decimal system to space and time).

The Royal Astronomical Society forwards the following resolution:—

"The Council of the Royal Astronomical Society desire to express their concurrence in the resolutions of the Washington Conference, and consider it desirable that the reckoning of astronomical time from mean midnight be adopted in the Nautical Almanac for 1890, the earliest practicable date, and that it be thenceforward adopted by astronomers."

The India Office writes that "the Government of India will be perfectly prepared to accept whatever conclusions may be arrived at by Great Britain after the discussions which will doubtless precede any final decision modifying the practice of astronomers, navigators, or others in this country in the reckoning of longitude or time."

The Board of Trade thinks that the resolutions are such as commend themselves for adoption.

The Royal Society forwards a report drawn up by a specially appointed committee, which the Council of the Society adopted:—

"The committee recommend the Council to approve of resolutions 1 to 6.

"With regard to resolution 6, if the change of time-reckoning be generally adopted, and can without inconvenience to mariners be made in the nautical almanacs of all nations for 1890, the committee recommend that year for the change to be made.

"With regard to the seventh resolution the committee would remark that, for astronomical reasons, the division of angular space is bound up with the division of time, and that a decimal division of the day would be opposed to the practice of, we may say, all nations, from very early times to the present day.

"Such a change the committee conceive ought not to be made without the gravest consideration. The committee observe, however, that the resolution does not appear to go beyond the expression of a hope that the subject may be further studied, to which of course there can be no objection."

The Eastern and South African Telegraph Company give the same reply as that given by the two Eastern Companies to which we have already referred.

The Submarine Telegraph Company does not adopt the twenty-four-hour system.

The Office of Works has no observations to make.

The Colonial Office has no objections to offer.

The views of the Admiralty were thus stated in a letter dated July 1885:—

"My Lords desire me to inform you that this question has engaged their attention since the receipt of the communication from the Science and Art Department of the 29th May, but that, seeing how many and varied are the interests involved in a proposal to make any alteration in methods of reckoning time which have for so many hundreds of years prevailed, they have thought it desirable, before offering any opinion, to obtain full information on the results which would follow, and the effect which it might have both on seamen and astronomers, more especially as the main responsibility of action would finally rest on their Lordships, as controlling the production of the Nautical Almanac.

"When their Lordships have received the report of the Board of Visitors to the Royal Observatory, Greenwich, who, as eminent astronomers, have been consulted, they will be in a position to give an opinion; but as they have been advised that that body cannot conveniently meet, without undue haste, until the autumn, their Lordships regret that, for the present, they cannot furnish any definite reply to the question asked by the Lords of the Committee of Council on Education."

The General Post Office letter states that there will be no objection to the adoption of a legally authorised system of counting time from zero to twenty-four hours, and that for some purposes it seems to possess advantages over the present system. The Postmaster-General is inclined to think, however, that, in the case of his Department in particular, the introduction of the system should depend upon popular feeling.

The Elder Brethren of the Trinity House see no objection to the immediate adoption of the sixth resolution, that as soon as may be practicable the astronomical and nautical days will be arranged everywhere to begin at mean midnight.

The above letters are given in the order in which they were received by the Science and Art Department.

In January of the present year, the Admiralty sent a second letter, which we give *in extenso*:—

"SIR, *Admiralty, 5th January*, 1886

"I am commanded by my Lords Commissioners of the Admiralty to inform you that they have had under their careful consideration your letter of the 29th May last, inclosing a copy of the resolutions passed by the International Conference for fixing a Prime Meridian and Universal Day, held at Washington in October 1884, and asking their Lordships' opinion thereon.

"2. The first five of these resolutions, causing as they do a minimum of change in the customs of this country, cannot but meet with their Lordships' unqualified approval, but do not appear to call for any action on their part.

"3. My Lords do not consider that the seventh resolution demands any remark from them.

"4. With regard, however, to the sixth resolution, which proposes a fundamental change in the mode of reckoning astronomical time, my Lords are deeply interested, not only so far as it may affect Her Majesty's Navy, but in consequence of the responsibility for the publication of the Nautical Almanac being vested by Act of Parliament solely in them.

"5. My Lords are of opinion that the sixth resolution may be regarded in two different lights:—

"1st. It may be considered as the natural corollary of the adoption of a universal time, such time being a civil day at the Prime Meridian; because, should universal time be adopted (for scientific and certain other purposes) the disagreement between civil and astronomical time, if retained, would to a great degree render nugatory the endeavour to introduce uniformity. In this aspect the change would seem to depend upon the adoption of universal time.

"2nd. This proposed change may also, however, be looked upon as intrinsically desirable in itself, besides as in a measure facilitating the adoption of universal time; and in this light action may be taken before any international consensus is arrived at with regard to universal time as recommended by the Washington Conference.

"6. Before, however, coming to any final conclusion on the advisability of sanctioning such changes in the ephemeris as would be necessary to give effect to this resolution, my Lords have felt bound to consult, both as to the principle and in respect of details, those other classes who habitually use the Nautical Almanac, viz., the mercantile marine and astronomers, as represented respectively by the Board of Trade and by the Board of Visitors to Greenwich Observatory, the latter being the most representative body of astronomers to whom my Lords could appeal.

"7. My Lords find that, while there is a general agreement in the desirability of putting an end to the present dual system of reckoning time, the urgency of the change is differently regarded by seamen and astronomers.

"8. Astronomers are now apparently finding many difficulties in the present duplication of time, and are desirous of a speedy change.

"9. At sea it causes but little practical inconvenience, as the two systems do not come into collision, being used for totally different purposes; and my Lords agree with the opinion expressed to them by the Board of Trade, that the change will not be unattended with risk from the possibility of mistakes during the period of transition, and that it must be made with all possible precautions.

"My Lords also fully recognise that the fact of the change rendering the existing epitomes and text-books of navigation to a great extent useless must receive due consideration from several points of view.

"10. It does not, however, appear to my Lords that there is sufficient reason to cause them to place obstacles in the way of making the change desired by British astronomers and many seamen, and recommended by the unanimous votes of the Delegates of the Washington Conference, as they consider that the rearrangement of the Nautical Almanac may be so carried out as to minimise the above-mentioned risks.

"11. My Lords will, therefore, be prepared to sanction such alterations in the Nautical Almanac as will be necessary to establish the change to the new reckoning at a date sufficiently far in advance to give ample warning to seamen.

"12. As, however, the fundamental objects in view of the Washington Conference were, to simplify and unify the modes of reckoning time, to remove present discrepancies, and to endeavour to establish an international system, it would appear that no decided move of any kind should be made until the views of other nations, and more especially those maritime powers which publish astronomical ephemerides, are ascertained. It would be manifestly contrary to the interests of simplification that England should alter the practice of centuries only to find herself alone in the new method of reckoning astronomical time; nor would it be courteous to announce her intention of so doing without consulting other Governments on the steps proposed by their representatives, but not plenipotentiaries, at the Washington Conference.

"13. My Lords will, therefore, be pleased to learn that the opinions and intentions of the other maritime nations have been ascertained at as early a date as practicable, in view of the wishes of British astronomers.

"I am, &c.

"(Signed) EVAN MACGREGOR.

"The Secretary, Science and Art Department,
"South Kensington, S.W."

After the receipt of the second letter from the Admiralty another meeting of the committee was held, and the following report was drawn up for the information of my Lords:—

"Your committee find that the Science and Art Department having consulted the various bodies named in the accompanying list, the first five of the resolutions of the Washington Prime Meridian Conference have received unanimous approval, but demand no action on the part of this country.

"As regards the sixth resolution, which proposes that as soon as may be practicable the astronomical and nautical days shall be arranged everywhere to begin at mean midnight, it appears that the opinion in England is generally in favour of this change in the mode of reckoning astronomical time, and that the Admiralty have expressed their willingness to take the necessary steps to give effect to this resolution of the Conference by introducing civil reckoning into the British Nautical Almanac, the rearrangement of which they are satisfied may be so carried out as to minimise risks from mistakes by navigators during the period of transition, if other maritime nations are prepared to adopt the proposed method of reckoning astronomical time.

"Under these circumstances your committee suggest that the Foreign Office be invited to communicate this result of the inquiries of the Science and Art Department to the Government of the United States, and to inquire whether, as conveners of the Washington Conference, they are now prepared to take steps to invite the adhesion of other maritime States"

Next follows a letter from the Science and Art Department to the Foreign Office, asking them to make the inquiry referred to in the previous report, and another from our ambassador at Washington, stating that the United States Government had taken the matter in hand.

FACILITIES FOR BOTANICAL RESEARCH

IN an article under the above heading, published in NATURE, vol. xxxi. p. 460, I endeavoured to draw the attention of our younger botanists to the importance of extending their studies over a wider field than is at present usual, and mentioned some easily accessible stations at which students might observe tropical vegetation. Since that article was written, I have had the opportunity of acting on my own suggestion, and of visiting Ceylon; I am therefore now in a position to enlarge upon my previous suggestions, and to fill in from personal experience many details which, though often trivial in themselves, may yet bring the possibility of Eastern travel home to the mind of some in such a way as may lead to future action. But while giving some account of the facilities for botanical work in the East, care must be taken not to over-colour the picture; it happens too often that writers of an enthusiastic bent raise expectations in the minds of their readers, which actual experience can only disappoint: in the following paragraphs I shall endeavour to make a purely matter-of-fact statement, and leave the colouring to be filled in at the will or opportunity of the reader. Taking first Peradeniya, we may consider what are its attractions as a station for botanical work, and then pass on to discuss the relative merits of other stations.

In the first place, hardly any port in the east is more accessible than Colombo: it has been aptly called the "Clapham Junction" of the East: the steamers of all nations meet there, and the competition between them produces a moderate scale of fares. Once there, a direct train service lands the traveller in about three hours almost at the gate of the Royal Gardens; the mechanical discomforts of many a journey to remote districts in the United Kingdom are greater than this. The cost of the journey will vary according to the line of steamers selected; by the Peninsular and Oriental line a return ticket can be had from London to Colombo for 90*l.*, 100*l.*, or 110*l.*, according as the return journey is completed in three, six, or twelve months. The charges on the Messageries Maritimes are about the same. The Star, Clan, and British India lines make more moderate charges, but the pace is correspondingly slower. It is little use making a journey of more than 5000 miles for a brief visit; and it may be presumed that, except where the circumstances are extraordinary, students would find it convenient to stay in Ceylon for three or four months, or more. Little is to be gained by scamping an expedition such as this, in which it may often happen that a man may gain his first and last experience of tropical nature; further, the surroundings are so new that it is some little time before one with even a good knowledge of our temperate flora can accommodate himself sufficiently to them to carry on successful work. We may then regard the cost of the journey as 100*l.*, and the time required to make it a success about six months. The choice of season is an important point: in a country of alternating wet and dry

periods it is well to experience both, and for the botanical collector it is important that collections should be finally made up in dry weather; it would be found that leaving England in November, and landing at the beginning of December, the weather would still be wet and vegetation luxuriant, but preservation of dry species would be difficult: a gradual change would be experienced, till in February and March the dry and hot season would have come in, vegetation would be more or less checked, and the preservation of dry specimens would be easy. Returning towards the end of March the English winter would be past, and, if he be a teacher, the traveller would be in time for the summer session in our Universities or medical schools.

Once on the spot the first question is one of accommodation. At Peradeniya there are neither hotels nor lodgings; a house must be taken and temporarily furnished, and it is surprising how cheaply this can be done. I took a small bungalow, the rent of which was Rs. 40 per month; friends lent me some articles of furniture, and an expenditure of Rs. 150 supplied all else that was required for temporary housekeeping. The cost of keeping house, including the wages of two native servants, rent, &c., with a margin for incidental expenses, may be set down at about Rs. 250 per month; allowing further some Rs. 200 for travelling expenses, it will be found that Rs. 1,500 will represent the total necessary expenses of residence in the island for four months. But in its present depreciated state, the rupee is worth only about 1*s.* 6*d.*: it will therefore be sufficient to lodge about 115*l.* at a bank in Ceylon to cover all necessary expenses for four months' residence. I would not advise, however, that that exact sum only should be transferred; it would be more prudent to allow a margin for possible contingencies. The total expenses of a six months' trip to Peradeniya may thus be set down as 250*l.* But there are various ways in which strict economy might reduce the cost, while if two friends were to club together, their individual expenses for housekeeping would be considerably below the sum above stated for one. Thus it will be seen that neither in difficulty of transit nor in point of expense are there sufficient obstacles to prevent a visit to Peradeniya, or some similar station, finding a place in the programme of the career of an average botanist. One of the chief obstacles will be felt by many to be the loss of possible opportunities while absent, or the break in continuity of teaching, or other work in which a man may be already engaged. I venture to think that these are much overrated objections; and against them may be set the very great advantages which a tropical visit carries with it. A further question is, at what period in a man's career will a visit of this sort best repay him? Some will say immediately after taking his degree: but I am inclined to think that even a first-class man is at that time hardly prepared to make the best of the opportunity should it offer. The experience gained by a few years of teaching and of original work at home will indicate what is to be expected and what is to be looked for, and will fit a man in many ways for striking out new lines for himself, even if it have not already defined for him a clear line of research. On the other hand, it is important that travelling should be undertaken before a man settles in life, so that his mind may be as free as possible from distractions and anxieties.

We may now pass on to consider what are the specific advantages presented by Peradeniya as a station for botanical work. It is, as I have said, easily accessible; being more than 1500 feet above the sea, the excessive heat of the low country is avoided, and it may be regarded as a decidedly healthy place. Secondly, it is situated in a central position, both as regards the whole island, and as regards the chief lines of communication by rail and road. Thus it is easy to gain access to the low country by train to Colombo, whence roads, traversed often by horse coaches, will lead along the coast, or inland in various directions; or, taking the up-country line, Newara Eliya may be visited, which lies about 6000 feet above the sea, and would serve as a good centre for working the higher levels; or again, a journey northwards by train and coach to Anuradhapura would give an insight into the low-level vegetation of the drier northern districts. From the above notes it will be readily seen how varied is the character of the country within easy reach from Peradeniya, presenting within a comparatively small area districts varying from the sea-level to 8000 feet, and including both damp and relatively dry areas at low levels. This in itself would lead one to expect a rich and varied flora; and in fact the list of native plants now numbers some 3000 species, a very considerable proportion of which are peculiar to the island. These and other natural advantages are, however, eclipsed by the importance of the Royal Gardens themselves as providing a field for those hitherto unfamiliar with tropical nature. Here there are collected in a small area a great variety of species, both native and imported; truly no botanist who has resided at Peradeniya can any longer complain of want of scope; if he does not find ample material for future work, he can only lay the blame on his own want of imagination. In the excellent herbarium and library, as well as in the fine series of coloured figures of native plants which are lodged in the Garden, he would find the greatest assistance in recognising and naming plants collected; while lastly, in the presence of the Director, who is the best living authority on the flora of Ceylon, are found those social and scientific elements which go far to enhance the pleasure of a visit to Ceylon.

In my former article mention was made of Java, where the Gardens of Buitenzorg, presided over by Dr. Treub, present great attractions for botanists. In my case, shortness of the time at my disposal prevented a visit to this famous Garden, and probably the same difficulty will present itself to others. There is, however, one conspicuous advantage which it possesses over Peradeniya as a station for botanical research, viz. a well appointed laboratory. If, as seems not improbable, a journey to the tropics and a period of steady work among tropical plants become a usual prelude to a career of active teaching in botany, ought not the English to provide themselves with some suitable station for such work? Is every man, whether well-to-do or impecunious, to depend upon his own resources alone for laboratory accommodation, reagents, glass, and all other accessories necessary for his work? or are we to be content to send our botanists to suck what advantage they can from the hospitable Dutch, just as we send our forestry students to study with the French? Surely it would be a most legitimate way of extending the usefulness of the Garden at Peradeniya, and, in a small way it is true, of guarding the credit of England as a tropical Power, to establish a laboratory for the use of travellers. It need not be a large or conspicuous building. Dr. Trimen tells me that suitable accommodation for the present could be found in the buildings already standing in the Gardens, and probably 100*l.* would cover the initial cost of supplying the bare necessaries of life in the laboratory. The knowledge that such accommodation would be found at the other end would certainly encourage those who are doubtful to undertake a journey to Ceylon.

It may be noted that no mention has been made of the Western tropics as a field for research; there can be no doubt as to the richness of the field, but I am not aware that there are any stations in the West which can compare with Peradeniya or Buitenzorg in convenience, accessibility, and general adaptation to the requirements of those who contemplate only a comparatively short visit.

Lastly, the cost of the journey will be found to be the most frequent deterrent from undertaking it; 250*l.* is a large sum to spend upon six months' work which can bring no direct financial return, however great may be the ultimate advantage gained from it; travelling Fellowships are

few; but still there are other sources from which grants may well be made to assist really promising students in attaining so desirable an end; and it is to be hoped that it may be regarded as a legitimate and not unfrequent outlet for public or private grants, to enable young men, who will ultimately engage in teaching, towards the attainment of experience which must always be of value to them in the exercise of their profession.

F. O. BOWER

NOTES

THE following is the list of Fellows elected into the Royal Society on Friday last, June 4:—Shelford Bidwell, M.A., William Colenso, F.L.S., Harold B. Dixon, F.C.S., Major-Gen. Edward Robert Festing, R.E., Andrew Russell Forsyth, M.A., Prof. A. H. Green, M.A., Prof. Victor Horsley, F.R.C.S., Raphael Meldola, F.R.A.S., Philip H. Pye-Smith, M.D., Henry Chamberlaine Russell, B.A., Adam Sedgwick, M.A., Prof. W. Cawthorne Unwin, B.Sc., Robert Warington, F.C.S., Capt. William James Lloyd Wharton, R.N., Henry Wilde.

ARRANGEMENTS are being made by the officers of several French Societies for holding an International Congress at Biarritz for discussing papers upon climatology, mineral and thermal springs, and allied subjects. A letter has been received from the Foreign Office transmitting copies of documents, and stating that the French Government is anxious that members of scientific Societies in this country should assist. The co-operation of the Royal Meteorological Society has also been specially asked by the President of the Congress, Dr. Durand Fardel. The sittings at Biarritz will occupy the first week in October, and be followed by a three weeks' tour to the principal watering-places of Southern France. Fellows of the Royal Meteorological Society will be allowed to travel over all French railways at half price. For further particulars apply to the Assistant Secretary of the Society.

THE Council of the Society of Arts have awarded the Society's silver medals to the following readers of papers during the Session, 1885-86:—To Prof. Francis Elgar, LL.D., for his paper on the load-lines of ships; to Henry Davey, for his paper on machinery in mines; to Prof. W. C. Unwin, for his paper on the employment of autographic records in testing materials; to C. V. Boys, for his paper on calculating machines; to Prof. Leonard Waldo, D.Sc., for his paper on watch-making by machinery; to John Mackenzie, for his paper on Bechuanaland and Austral Africa; to Edward Combes, C.M.G., for his paper on the industries and commerce of New South Wales; to G. Gordon Hake, for his paper on Cyprus since the British occupation; to Prof. W. N. Hartley, F.R.S., for his paper on photography and the spectroscope in their application to chemical analysis; to Prof. R. Meldola, for his paper on the scientific development of the coal-tar colour industry; to B. H. Baden Powell, C.I.E., for his paper on Indian manufactures from a practical point of view; to Capt. Richard Carnac Temple, for his paper on the every-day life of Indian women. Thanks were voted to the following members of the Council for the papers read by them:—To Capt. Douglas Galton, D.C.L., C.B., F.R.S., for his paper on results of experiments on mechanical motors for tramways made by the Commission at the Antwerp Exhibition; to W. H. Preece, F.R.S., for his paper on domestic electric lighting.

THE Society of Arts *conversazione* will be held, by permission of the Royal Commission, at the Colonial and Indian Exhibition, South Kensington, on Friday, July 16 next.

MR. TALFOURD ELY has resigned the Secretaryship of University College, London.

THE Russian Geographical Society has awarded this year its great gold medal to M. Yurgens for his remarkable work as chief of the Arctic Meteorological Station at the mouth of the Lena. The Medal of Count Lütke has been awarded to Col. Pyevtsoff for his most valuable account, full of new and interesting information, of his journey in N.W. Mongolia and Northern China, published, with a map, in the fifth volume of the West Siberian Branch of the Society. Great gold medals have been awarded to M. Dmitrevsky for his annotated translation of Otano Kitoro's work on Corea, and M. Tereshkevitch for his statistical description of the Government of Poltava. Small gold medals were awarded, to Prof. Lenz for his work in the capacity of President of the Physical Geography Section of the Society; to M. Fuss, for his calculations of the great levelling through Siberia; to the Director of the Tiflis Observatory, M. Milberg, for his magnetical observations carried on in connection with those of the Polar stations; and to M. Mainoff, for his work on the customary law of the Mordovians. Several silver medals were distributed to MM. Gedeonoff, Fedoroff, Krasnoff, and Ignatieff for astronomical, geological, and botanical works; to several persons who have sent observations on thunderstorms and rains, as also for various ethnographical and statistical researches.

THE Town Council of Banff, along with the Council of the Banffshire Field Club and Office-Bearers of the Banff Literary Society, have formed themselves into a General Committee (with power to add to their number) to promote the subscription of a fund for the erection of a memorial in Banff to the memory of the late Mr. Thomas Edward, A.L.S., "The Scottish Naturalist." The Committee feel sure it will be the desire of many throughout the whole nation to contribute to this fund, and to combine to make the memorial worthy of the universal admiration and respect entertained for Mr. Edward. In order to afford full opportunity for this, it is proposed to add to the Committee ladies and gentlemen throughout the various parts of the country who so appreciate Mr. Edward's life and work as to be willing to interest themselves in providing some substantial and suitable perpetuation of his memory. Communications should be addressed to the Interim Secretary, Mr. John Allan, Town Clerk of Banff.

THE Prince of Wales, considering that the rates of admission to the Colonial and Indian Exhibition at South Kensington should be brought within the means of all classes residing in the Metropolitan area, is making arrangements with the Railway Companies and other bodies in a position to co-operate in the organisation of a scheme whereby every working man, woman, and child will have an opportunity of visiting the Exhibition at greatly reduced prices on every week-day except Wednesday from the middle of August until the close of the Exhibition. Arrangements for enabling the working classes of the provinces to visit the Exhibition have been for some time in operation, under his Royal Highness's direction.

THE first of the conferences convened by the Geologists' Association on "The Mineral Resources of the Colonies and India," was held at the Colonial and Indian Exhibition on Saturday afternoon (June 5), when a lecture was delivered by Prof. V. Ball, F.R.S., on "The Mineral Resources of India and Burmah." The discussion brought out the urgent need for reform of the mining laws of India, and the following resolution, proposed by the chairman (Sir R. Temple), seconded by the Duke of Manchester, and supported by the lecturer and others, was unanimously adopted:—"This Conference having had under its review the mineral resources of India and the obstacles to development and exploitation of the same through the want of suitable or sufficient mining laws, respectfully urges upon the Secretary of State for India the desirability of regulating or revising the regulations for the working of mines in British India, including Burmah, and for the protection of mining interests

therein, and also of negotiating arrangements to the same effect with the Native States." The next conference will be held on Saturday, June 19, when Prof. T. Rupert Jones, F.R.S., will lecture on "The Mineral Resources of South Africa." Sir Charles Mills will preside.

THE latest news from Catania reports that the eruption of Mount Etna has almost entirely ceased. The lava-streams, stopping within 300 metres of Nicolosi, have become hard enough to walk on, but repeated shocks of earthquake of considerable violence continue throughout the region. A huge gulf has yawned at Acireale, but no disasters are reported. A correspondent of the *Standard* writing from Catania on May 27 sends some valuable notes. "The stream of lava issuing from Monte Penitello (an eminence about 4980 feet high, and about 7 kilometres distant from Nicolosi) has travelled a longitudinal course of about 6 kilometres, and has formed four basins, the last of which is behind Monte Nocella. The width of the stream is about 2½ kilometres. The stream flows directly southward from the north-east. The western branch, which flows towards Dogola Arcino, has done but little damage, traversing in its course mostly gravelly soil. Prof. d'Amico, who is studying the phases of the eruption from the Observatory of Pennesi, in Acireale, has contributed to the archives of Catania a complete record of all the volcanic disturbances which he has noted up to date. The maximum number of 92 telluric convulsions was registered on the 19th inst. On the following day there were only 20, but subsequently the number rose from 25 to 30, 27, 35, and finally to 52, on Tuesday the 25th."

SEVERAL shocks of earthquake were felt at Smyrna, in the Island of Chios, and in the Erythrian Peninsula on the night of June 5.

PROF. MILNE recently made an attempt to sound the depth of the crater of Asamayama, the active volcano about seventy miles to the north-west of Tokio, and in the historic period one of the most destructive of all Japanese volcanoes. The attempt however failed owing to unfavourable weather. No details of the experiment or of the precise manner in which it was to be carried out have been received as yet.

WE have already referred to the threatened abolition, of alteration, of the Imperial College of Engineering in Tokio, in consequence of administrative changes which have resulted in the abolition of the Department of Public Works, under which the College was placed. As the names of several men well known in the English scientific world have been associated with this institution, we are glad to be able to say that the change has not been so great as was at first apprehended. Mr. Mori, the new Minister of Education, long the representative of Japan in this country, has established a new University, to which the Engineering College has become affiliated, as well as the former Medical College. Except in two important details, the organisation remains the same. The College now comes under the exclusive control of Japanese, in other words, the post of Principal, hitherto held by Dr. Divers and his predecessor, is no longer to be occupied by a foreigner, and the whole University is to be governed by its professors, and not by ordinary officials. The idea, says the *Japan Mail*, is "to emancipate learning and its professors from the too often ignorant and always hampering control of the ordinary official." Everything now is subject to the professorial body. Japan is not to lose the services of any of the foreign professors of the College. Dr. Divers continues as Professor of Chemistry, but in the Science instead of the Engineering College. Prof. Milne continues in the Chair of Mining Engineering, and there is a probability that he will also be invited to occupy a Chair of Seismology which it is proposed to found. It thus appears that the change is not one which interferes with the work of the College; if anything its status as an educational institution is increased, because it now forms an integral portion of the highest teaching establishment in the country. It is not clear from the account from which we quote whether the College will remain in the fine buildings which were specially erected for it, or whether it will be removed to the University, which is some distance away.

IN connection with this change, the professors and students of the College, meeting for the last time as members of the Engineering College, presented the Principal, Dr. Divers, with a handsome bronze vase, inlaid with gold. Prof. Milne, as the senior, in handing the present to Dr. Divers on behalf of the subscribers, made a short speech referring to the services of the Principal to Japan, his pupils, and colleagues; and with this ceremony an institution in which English science has, or should have, a peculiar interest, came to an end, but only to rise again in another shape, let us hope for increased usefulness to Japan.

THE Chair of Seismology which has been founded in the Science College of the new University of Japan has been filled by the appointment of Mr. K. Sekiya as professor.

AT Cambridge to-day (Thursday) a vote of the Senate is to be taken in favour of appointing a syndicate to obtain plans and estimates for the erection of a Geological Museum, to confer with the Sedgwick Memorial Committee, and to report before the middle of the Michaelmas term. Thus it appears likely that at last the Sedgwick Museum will become an actual fact, after twelve years of incubation.

THE current number of the *Proceedings* of the Bath Natural History and Antiquarian Field Club contains several papers of scientific interest. Mr. Broome continues his list of fungi found in the neighbourhood of Bath. Mr. Blomefield, writing on the firs of Bournemouth, argues that these trees are true natives of that part of the country, in opposition to the theory that the Scotch fir, though indigenous in Scotland, is not indigenous in England. Dr. Norman describes the fresh-water algæ of the Bath thermal waters; and Mr. McMurtrie the salt-springs found at great depths in the Coal-measures at Radstock.

FUNGI also occupy a considerable space in the *Proceedings* of the Belfast Naturalists' Field Club, as in those of the Bath Society, for Mr. Lett gives a list of the fungi of the North of Ireland which fills more than 50 pages. Dr. Malcolmson describes some recent *Ostracoda* of Belfast Lough, and appends an elaborate table of their distribution. Mr. Joseph Wright adds two lists—one of the Foraminifera of Down and Antrim, the other of the Cretaceous Foraminifera of Keady Hill in the county of Derry. The record of the meetings is very full, and contains much information on various scientific subjects connected with the North of Ireland.

ARRANGEMENTS have been made by the Colonial and Indian Aquarium authorities to bring over a consignment of some of the principal species of fish in the waters of Java for purposes of exhibition. The British India Steamship Company have undertaken to transmit them in specially made glass carriers, which have been forwarded to Java for that purpose. Fourteen specimens of the *Chelone midas*, or green turtle, have lately arrived at the Aquarium from West India; also a collection of land crabs from the same quarter.

THROUGH the instrumentality of the National Fish-Culture Association the River Lea was last week enriched with a quantity of salmon fry, which were turned into those *locales* most suitable to their requirements. Although the Lea is in a very polluted condition, there are portions free from contamination where fish thrive well. The Severn Fishery Board have turned into their river a large number of salmon fry. The ova from

which they were hatched out were collected in the first instance by the Board and forwarded to the National Fish-Culture Assotion to incubate, which was done most successfully. The Severn Fishery Board are to be commended upon the action they have taken to replenish their river with fish, as they set an example to other bodies having the interests of their waters at heart. The hatchery at South Kensington and Delaford belonging to the Association might become an extensive medium in carrying such an object into effect at a minimum cost.

THE additions to the Zoological Society's Gardens during the past week include a Nisnas Monkey (*Cercopithecus pyrrhonotus*) from Nubia, presented by the Rev. W. MacGregor; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. J. Coston; a Common Badger (*Meles taxus*), British, presented by Mr. C. A. Ross; six Black-footed Penguins (*Spheniscus demersus*) from South Africa, presented by Capt. John Hewat; four Siamese Blue Pies (*Urocissa magnirostris*) from Siam, two Small Hill-Mynahs (*Gracula religiosa*) from Southern India, a Rufous necked Weaver Bird (*Hyphantornis textor*) from South Africa, presented by Mr. J. M. Cook, F.Z.S.; a Golden Eagle (*Aquila chrysaetos*) from Russia, presented by Mr. Walter Holdsworth; six Long-eared Owls (*Asio otus*), British, presented by Mr. G. B. Burnand; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, three Ruffs (*Machates pugnax*), British, deposited; a Glaucous Macaw (*Ara glauca*) from Paraguay, four Crested Pigeons (*Ocyphaps lophotes*) from Australia, four Amherst's Pheasants (*Thaumalea amherstiæ*) from China, two Great American Egrets (*Ardea egretta*) from South America, two Lapwings (*Vanellus vulgaris*), British, four Indian Tree Ducks (*Dendrocygna arcuata*) from India, purchased; a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET BROOKS II.—The following ephemeris for this comet is by Prof. C. Frisby (Science Observer Special Circular, No. 67):—

For Greenwich Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
June 11	6 23 20	69 15·0 N.	0·0380	0·1783	0·26
15	6 58 55	66 54·1	0·0557	0·2015	0·21
19	7 27 41	64 28·3	0·0734	0·2275	0·17
23	7 39 51	62 58·9	0·0909	0·2486	0·14
27	7 59 57	60 49·5 N.	0·1081	0·2704	0·12

The brightness on May 2 is taken as unity.

COMET BROOKS III.—Dr. S. Oppenheim has calculated the following elements and ephemeris for this comet from observations made on May 25, 28, and 30, at Arcetri, Rome, and Vienna:—

T = 1886 June 2·90285 Berlin M.T.

ω = 173° 57′ 49″·6
Ω = 47 14 43·5 } Mean Eq. 1886·0.
i = 16 8 52·3

$\log q$ = 0·170230

Ephemeris for Berlin Midnight

1886	R.A. h. m. s.	Decl. ° ′	Log r	Log Δ	Brightness
June 8	12 18 3	1 1·8 S.	0·1709	9·9183	0·87
12	12 26 1	3 32·8	0·1721	9·9274	0·83
16	12 34 25	6 1·6	0·1739	9·9375	0·79
20	12 43 15	8 27·4	0·1763	9·9486	0·75
24	12 52 27	10 49·2	0·1793	9·9605	0·70
28	13 1 59	13 6·1 S.	0·1828	9·9732	0·65

The brightness on May 25 is taken as unity.

The comet is faint, and not bright as stated in the telegram announcing the discovery.

SPECTROSCOPIC DETERMINATION OF THE MOTION OF THE SOLAR SYSTEM IN SPACE.—Dr. R. von Kövesligethy mentions (*Astronomische Nachrichten*, No. 2731) that some three years ago he tried to deduce the speed with which the sun is travelling in space and the point to which its progress is directed, from the observations of the displacements of lines in stellar spectra published in the *Monthly Notices*. The latter inquiry he gave up, as the data supplied did not seem sufficiently trustworthy for a satisfactory result to be obtained from them. He therefore assumed the apex as found from the discussion of the proper motions of stars, viz. R.A. = 216°·0, Decl. = 35°·1 N. Taking the simple arithmetical mean of the observations of the individual stars observed—about 70 in number—he found the speed of translation of the solar system to be about 8·6 geographical miles per second. This rate of motion would agree far better with Struve's value, derived from the consideration of the proper motions of stars, than Herr Homann's (NATURE, vol. xxxiii. p. 450) result does. Dr. Kövesligethy does not, however, place much reliance on the result he has thus obtained.

PUBLICATION OF THE ZONE-OBSERVATIONS OF THE "ASTRONOMISCHE GESELLSCHAFT."—M. Doubiago, who has succeeded the late Marian Kowalski as Director of the Kasan Observatory, has recently issued a volume containing the observations made at Kasan during the years 1869–77, of the stars situated in the zone between 75° and 80° of north declination. The principal object of this work, undertaken by M. Kowalski by arrangement with the *Astronomische Gesellschaft*, was the determination of the positions of the stars contained in this zone down to the ninth magnitude. M. Kowalski, however, determined to include in his work all the stars of the *Bonner Durchmusterung* situated in the above-mentioned zone, about 5000 in number, as well as a considerable number of fainter stars. The observations, commenced in 1869, were finished in 1879, and the present volume contains 14,329 observations, that is, about half the total number necessary to complete the projected scheme of having four observations of each star. The results are given in the usual form in which zone-observations are published, viz. the apparent positions for each day of observation are given, together with the reduction to the mean place for the beginning of the year. As far as we remember, Kasan has the honour of being the second of the observatories engaged on the zone work of the *Astronomische Gesellschaft* which has published their observations, Prof. Krüger having already published his Helsingfors zones (55° to 65° of north declination) in two volumes, the first volume having appeared in 1883, and the second in 1885.

THE MADRAS OBSERVATORY.—Mr. Pogson's report for the year 1884 has recently been issued. He points out that during the year a work on "Telegraphic Longitude Determinations in India" was printed and published. The number of observations made with the meridian circle during the year was 844, which brings up the total number of observations made with this instrument since 1862, now awaiting publication, to 51,722. The separate results and annual catalogues will fill eight volumes, to be followed by a final catalogue of about 5000 stars, reduced to the epoch 1875. All the reductions are completed up to date, and Mr. Pogson hopes that these volumes will appear in fairly rapid succession. We hope so too. The speedy publication of a catalogue of 5000 stars would do much towards restoring the Madras Observatory to the position, as a scientific institution, which it formerly held.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JUNE 13-19

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 13

Sun rises, 3h. 45m.; souths, 11h. 59m. 45·2s.; sets, 20h. 15m.; decl. on meridian, 23° 14′ N.: Sidereal Time at Sunset, 13h. 43m.

Moon (Full on June 16) rises, 16h. 50m.; souths, 21h. 51m.; sets, 2h. 44m.*; decl. on meridian, 13° 26′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	3 43	12 7	20 31	24 26 N.
Venus	2 0	9 10	16 20	12 52 N.
Mars	11 36	18 1	0 26*	4 7 N.
Jupiter	12 5	18 22	0 39*	2 32 N.
Saturn	5 2	13 13	21 24	22 41 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

June	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
18	B.A.C. 6536	6½	2 59	4 7	85 334
19	B.A.C. 7145	6½	21 40	22 18	113 186

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	June 14,	1 55	*m*
			,, 19,	1 35	*m*
R Persei	3 22·8	35 17 N.	,, 18,		*M*
S Cancri	8 37·4	19 17 N.	,, 19,	21 27	*m*
W Virginis	13 20·2	2 47 S.	,, 17,	21 35	*m*
δ Libræ	14 54·9	8 4 S.	,, 13,	0 24	*m*
			,, 19,	23 58	*m*
U Coronæ	15 13·6	32 4 N.	,, 13,	22 59	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 16,	1 28	*m*
			,, 16,	21 35	*m*
X Sagittarii	17 40·4	27 47 S.	,, 19,	2 20	*M*
W Sagittarii	17 57·8	29 35 S.	,, 18,	0 0	*m*
U Sagittarii	18 25·2	19 12 S.	,, 19,	2 25	*m*
β Lyræ	18 45·9	33 14 N.	,, 14,	0 0	*M*
S Vulpeculæ	19 43·7	27 0 N.	,, 15,		*M*
η Aquilæ	19 46·7	0 43 N.	,, 19,	2 30	*M*
R Lacertæ	22 38·2	41 47 N.	,, 16,		*M*

M signifies maximum ; *m* minimum.

BIOLOGICAL NOTES

Development of Ophiopholis and Echinarachnius.—In the last series of studies from the Newport Marine Zoological Laboratory we find a memoir by Mr. Walter Fewkes, on the development of an Ophiuroid (*Ophiopholis aculeata*, Gray) and of an Elypeastroid (*Echinarachnius parma*, Gray). But few observations have been published on the metamorphosis of Ophiopholis, and these often misleading. The eggs would appear to be extruded separately into the water, and the young pass through a metamorphosis in which a pluteus-larva is formed ; the development of this pluteus is different from that of any described Ophiuran, though allied to that in Ophiothrix. The ova were voluntarily shed by the female on August 17 ; they were fertilised outside the body, and appeared to be very hardy. The yolk has a central and a peripheral region, which are distinguishable in the eight-cell and previous stages of segmentation. The cleavage is like that of other Echinoderms. A gastrula is formed by the invagination of the blastoderm, and consequently the stomach of the pluteus is an infolded wall of the blastoderm, and not formed by delamination from the cells in the cavity. The mesoderm-cells originate in two lateral clusters. The oldest pluteus observed was a little more than three days old ; they, however, appeared to be easily raised, and it is to be hoped that they will be yet traced to an adult form. In Echinarachnius the sexes are distinct, and in some cases there were colour distinctions. In the experiments on the ovum of *E. parma*, artificial fertilisation was resorted to from the middle of July to the end of August ; it was easily effected. In its mode of segmentation it resembles that of other Echinoderms. It has no polar globules, but possibly these may be formed while the egg is in the ovary. As in some other Echinoderms, a gastrula is formed by invagination. The pluteus figured by A. Agassiz in the revision of the Echini as probably that of Echinarachnius proves to belong to this species at about a week old. The development of the young Echinarachnius on the water-tube of the pluteus resembles that of other sea-urchins. The rosette-form of the water-tubes described in other Echinoderms also occurs. The first-formed calcareous deposits of the test are trifid in form, and vary in number in different specimens. The extremity of each trifid division bifurcates later in its growth, and the calcareous body thus formed appears to be inclosed in a transparent wall, which has a spherical outline. Spines are very early formed, and are proportionately very large as compared with those of the adult. The various stages are illustrated in numerous figures on eight, in several cases folding, plates.—*Bull. Mus. Comp. Anat. Harvard College*, vol. xii. No. 4, March 1886.

The Leeches of Japan.—In the April number of the *Quarterly Journal of Microscopical Science*, Dr. C. O. Whitman publishes the first hundred pages of a memoir on the leeches of Japan. The material for the study was collected while the author was connected with the University of Tokio (1879–81). The coloured drawings accompanying the memoir were executed by Mr. Nomura, a young Japanese artist, and they well deserve the remarks of the author: "Mr. Nomura's attention to the minutest details, his infinite patience, trained eye, and his remarkably skilful brush, have given results that are marvels for neatness and accuracy." The first part of this study treats of the land leech (*Hæmadipsa japonica*), the medicinal leech (*Hirudo medicinalis*), and of three species of toothless leeches, which form a new genus, Leptostoma. It also contains a comparison of a few species from Europe, Asia, and America, and a considerable portion is devoted to a comparative study of the different genera, in the endeavour to find a satisfactory basis of classification. This has in a great measure been found in a law of abbreviation of the somites, which, in addition, gives a key to the phylogeny of the genera. The land leech is shown to be a highly instructive and specialised form. The genus Hirudo has been re diagnosed (p. 364), and while internal structure has been dealt with to only a very limited extent, still some interesting facts in connection with the nephridial organs of the land leech are detailed, and the existence of from twelve to fourteen sense-organs on the first ring of each complete somite is demonstrated, and they are homologued with the eyes, having possibly also other sense-functions. The author reserves the genus Hæmadipsa for the land leeches of Ceylon, India, and Japan, with three jaws and five inter-genitalia rings. He ascribes the genus to Tennant, but may it not have been formed by Baird? *H. japonica* is confined to the mountain slopes and ravines, never descending into the plains. It is not only a mountain leech, but it keeps habitually to the ground, living in moss, or under damp leaves and rubbish. They are most voracious, and on the approach of man or beast are at once on the alert. They advance by rapid strides. They bite so gently as scarcely to attract attention, but the wound is deep, and the scar is more or less permanent. They gorge on for about 30 to 40 minutes, and then drop ; while sucking they become bedewed with a transparent liquid, which keeps them moist. If placed in water, they do not swim but sink, and then creep out ; and while having a decided preference for a terrestrial life, can support life for days in water. If into a jar of hungry leeches a puff of breath is blown, they become immensely excited, and it will be difficult to keep them in ; while trying to keep back one, a dozen others will rush out. In a most interesting series of paragraphs Dr. Whitman traces the intimate relation that exists between these land and the medicinal leeches, the latter essentially fresh-water forms. The geographical area of land-leeches is mainly within the tropics, though in Japan they are exposed to a wide range of temperature. *H. nipponia* is described as a new Japanese medicinal leech, well known to the Japanese, and with habits and mode of life just like our European leech. Leptostoma, a new genus, is established (p. 376) on three species of almost edentulous leeches, which, though having a common ancestry with Hirudo, were not derived from it. All three species, *L. acranulatum*, *L. edentulum*, and *L. pigrum*, are from Tokio, and are fully diagnosed and beautifully figured. The segmental organs are shown to be sense-organs, and that from them the eyes have developed, so that they may be regarded as incipient eye spots.

New Element of the Blood and its Relation to Coagulation.—In an important paper by Mr. Geo. T. Kemp on this subject, he comes to the conclusion that in addition to the red corpuscles and leucocytes the blood normally contains a third histological element—the "plaques." These have been variously considered as young red corpuscles ; as nuclei floating in the blood ; as being derived from the red or the white corpuscles ; as being fibrin ; and as being globular depositions produced by cooling of the blood ; but the author proves that, although strong resemblances exist between the plaques and other histological elements of the blood, there is not yet sufficient evidence to establish a *genetic* connection. The plaques should therefore, at least for the present, be regarded as independent elements. When the blood is drawn, the plaques break down almost immediately, and this is not true of any other element of the blood. This breaking down of the plaques seems intimately connected, in its time relations at least, with the clotting of the blood. If a good-sized drop of blood from a finger be let fall on a cover-glass, and as quickly as possible washed by a good jet of ·75 per cent. NaCl solution, and then examined under the

microscope, the plaques, which have a property of sticking to the glass slip, will be found to fill the field; some will be isolated, some will be in groups; they will now appear glistening and granular, and their contours are jagged, becoming more and more so as time elapses; finally only a granular mass will be found. If, however, a drop of osmic acid be placed on the finger before the drop of blood be drawn, all the elements will be found presenting their normal appearances, and the plaques will be seen as pale homogeneous structures varying greatly in size, but for the most part about one-third or one-fourth of the diameter of the red corpuscles; they are biconcave, but not as much so as the red corpuscles. Once thus hardened they never change their form, but the plaques first referred to will be found to alter their form very speedily, and *pari passu* with these changes, processes are seen which run out from the granular masses, and when coagulation sets in these processes are nearly always found to be continuous with threads of fibrin. The connection between the breaking down of the blood is not histological but chemical. The plaques appear to give up a soluble substance which is active in coagulation. This active agent is most probably a *fibrin* ferment. Fibrin is deposited histologically independent of any of the cellular elements of the blood, and when the clot is very scant. The fibrin is seen deposited as long, needle-shaped, crystal-like bodies. — *Studies from Biolog. Lab., Johns Hopkins Univ.*, vol. iii. No. 6, May 1886.

ON RECENT PROGRESS IN THE COAL-TAR INDUSTRY[1]

II.

AZO-COLOURS.—Amongst the most important of the artificial colouring matters may be classed the so-called azo-colours. These colours are chiefly bright scarlets, oranges, reds, and yellows, with a few blues and violets. They owe their existence to the discovery by Griess, in 1860, of the fact that the so-called azo-group – N = N – can replace hydrogen in phenols and amido-compounds. But it is to Dr. O. N. Witt that is due the honour of having given the first start in a practical direction to the chrysoidine class of azo-colours by the discovery of chrysoidine, and perhaps still more so by the suggestions contained in a paper read before the Chemical Society. Dr. Caro, of Mannheim, was also acquainted with several compounds which belong to this class at the time Witt published his results, but it does not appear that he made practical use of them until Witt introduced the chrysoidines and tropeolines. To Roussin, of the firm of Poirrier of Paris, is due the credit of having first brought into the market some of the beautiful azo-derivatives of naphthol. Griess, therefore, as the original discoverer of the typical compounds and reactions by which the azo-colours are obtained, may be considered as the grandfather, whilst Roussin and Witt are really the fathers, of the azo-colour industry. Nor must it be forgotten that it is to Perkin we owe the recognition of the value of the sulpho group in relation to azo-colours, a discovery patented in 1863. Moreover it is interesting to note that changes in colour from yellow to red and claret are effected by the increase in the molecular weights of the radicals introduced as well as by the relative positions occupied by these groups.

Indophenol.—Witt is also the discover of a new blue dye-stuff termed indophenol, which has been used as a substitute for indigo. Certain difficulties, however, have arisen in the adoption of this colour on the large scale. The most important use indophenol is at present put to is for producing dark blues on reds dyed with azo-colours, both on wool and cotton. The piece goods are dyed a uniform red first, and then printed with indophenol white; for like indigo itself indophenol yields a colourless body on reduction, and this being a very powerful reducing agent destroys the azo-colour, being itself transformed into indophenol blue. The process works with surprising nicety and is very cheap. The blue is formed and the red discharged with such precision that patterns can be produced in which the blue discharge covers a great deal more space than the original red. This new printing process was devised by Mr. H. Koechlin, of Lorrach. The reds used for the purpose are in the case of wool the usual azo-scarlets, for cotton Congo red.

Artificial Indigo.—About five years ago the speaker had the honour of bringing before this audience[1] the remarkable discovery made by Baeyer of the artificial production from coal-tar products of indigo blue. Since that time but little progress has been made in this manufacture, as the cost of the process, unlike the case of alizarin, has as yet proved too serious to enable the artificial to compete successfully in the market with the natural indigo.

Through the kindness of a number of eminent colour manufacturers in this country and on the Continent, the speaker was enabled to illustrate his subject by a most complete series of specimens both of the colours themselves and of their application to the dyeing and printing of fabrics of all kinds. His thanks are especially due to his friend, Mr. Ivan Levinstein, of Manchester, for the interesting series of samples of cloth dyed with known quantities of fifty different coal-tar colours, each having a different chemical composition; also to the same gentleman, and to Messrs. Burt, Boulton, and Haywood, of London, for the interesting and unique series of specimens indicating the absolute quantities of products obtainable from *one ton of coal*, as well as for much assistance on the part of Mr. Levinstein in the preparation of the experimental illustrations for this discourse. To Dr. Martius of Berlin for a valuable series of colours, especially the well-known Congo red, made by his firm, including samples of wool dyed therewith, he is also much indebted. For the interesting details concerning indophenol and its applications the speaker owes his thanks to Dr. Witt and M. Koechlin.

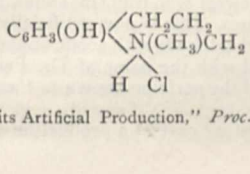
Coal-tar Antipyretic Medicines.—Next in importance to the colour industry comes the still more novel discovery of the synthetical production of antipyretic medicines.

Up to this time quinine has held undisputed sway as a febrifuge and antiperiodic, but the artificial production of this substance has as yet eluded the grasp of the chemist. Three coal-tar products have, however, been recently prepared which have been found to possess strong febrifuge qualities, which if still in some respects inferior to the natural alkaloids, yet possess most valuable qualities, and are now manufactured in Germany at Höchst and at Ludwigshafen in large quantity. And here it is well to call to mind that the first tar colouring-matter discovered by Perkin (mauve) was obtained in 1856 during the prosecution of a research which had for its object the artificial production of quinine.

In considering the historical development of this portion of his subject, the speaker added that it is interesting to remember that the initiative in the production of artificial febrifuges was given by Prof. Dewar's discovery in 1881 that quinoline, the basis of these antipyretic medicines, is an aromatic compound, as from it he obtained aniline. Moreover that Dewar and McKendrick were the first to observe that certain pyridine salts act as febrifuges. So that these gentlemen may be said to be the fathers of the antipyretic medicines, as Witt and Roussin are of the azo-colour industry.

Kairine, the first of these, was discovered by Prof. O. Fischer, of Munich, in the year 1881, whilst engaged on his investigations of the oxyquinolines. The febrifuge properties of this substance were first noticed by Prof. Filehne, of Erlangen. Kairine is manufactured from quinoline, a basic product derived from aniline by heating it with glycerin and nitrobenzene by the following process. When treated with sulphuric acid, SO_4H_2, it forms quinoline sulphonic acid, and this when fused with caustic soda yields *oxyquinoline*, which is then reduced by tin and hydrochloric acid into tetrahydroxyquinoline, and this again on treatment with C_2H_5Br yields ethyl-tetraoxyquinoline or kairine. The lowering of the temperature of the body by this compound is most remarkable, though, unfortunately, the action is of much shorter duration than that effected by quinine itself; but on the other hand, with the exception of its burning taste, it exerts no evil effects such as are often observed after administration of large doses of quinine. The commercial article is the hydrochloride, the price is 85*s.* per lb., and the quantity manufactured has lately diminished owing to the discovery of the second artificial febrifuge, antipyrine.

The following graphical formula shows the constitution of kairine:—



[1] A Discourse by Prof. Sir Henry E. Roscoe, M.P., LL.D., F.R.S., delivered at the Royal Institution, Friday, April 16, 1886. Continued from p. 114.

[1] "On Indigo and its Artificial Production," *Proc. Roy. Inst.*, May 27, 1881.

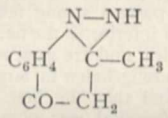
Antipyrine, the second of these febrifuges, was discovered in 1883 by Dr. L. Knorr in Erlangen, and its physiological properties were investigated by Prof. Filehne, of Erlangen. The materials used in the manufacture of antipyrine are aniline and aceto-acetic ether. The aniline is first converted into phenylhydrazine, a body discovered by Emil Fischer in 1876. This body combines directly with aceto-acetic ether, with separation of water and alcohol, to form a body called pyrazol ($C_{10}H_{10}N_2O$). The methyl derivative of pyrazol derived by treating it with iodide of methyl, is *antipyrine*, its composition being $C_{11}H_{12}N_2O$. As a febrifuge, antipyrine is superior in many respects to kairine and even to quinine itself. It equals kairine in the certainty of its action, whilst in its duration it resembles quinine. It is almost tasteless and odourless, is easily soluble in cold water, and takes the form of a white crystalline powder. Its use as a medicine is accompanied by no drawbacks. It occurs in commerce in the free state. The production of antipyrine, in spite of these valuable qualities, is as yet small, its chief employment being in Germany, where it has been successfully used in cases of typhoid epidemic. The price is 6*s*. per pound.

The following equations explain the formation and constitution of this interesting body. The foregoing febrifuges are manufactured at Höchst under the superintendence of Dr. Pauli, to whose kindness the speaker is indebted for an interesting series of specimens illustrative of the manufacture of antipyrine.

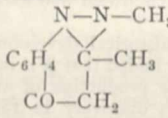
$$\underset{\text{Aceto-acetic ether}}{CH_3.CO.CH_2.CO_2C_2H_5} + \underset{\text{Phenylhydrazine}}{C_6H_5.NH.NH_2}$$
$$= H_2O + C_2H_5.OH + \underset{\text{Pyrazol}}{C_{10}H_{10}N_2O}$$

$$C_{10}H_{10}N_2O + ICH_3 = \underset{\text{Antipyrine-hydriodide}}{IH.C_{10}H_9(CH_3)N_2O}.$$

Dr. Knorr formulates pyrazol thus:



And antipyrine is



The antipyretic effect of this compound is strikingly shown in the following temperature readings in a case of typhoid kindly communicated to the speaker by his friend Dr. Dreschfeld of Manchester. Each of the second set of readings was made two hours after a dose of 30 grains of antipyrine had been administered.

I.	II.	Diff.
105·0	103·0	2·0
103·5	100·2	3·2
103·8	100·8	3·0
105·2	101·4	3·8
104·4	100·6	3·8

Thalline.—The third of the artificial febrifuges is *thalline*, which is offered as the tartrate and sulphate. It is manufactured by the Badische Company. Thalline is said to be used as an antidote for yellow fever. Its scientific name is tetrahydroparaquinanisol, and it was first prepared by Skraup by the action of methyl iodide and potash on paroxyquinoline.

We must, however, bear in mind that none of these synthetical febrifuges are antiperiodics, and therefore cannot be employed instead of the natural alkaloid quinine in cases of ague or intermittent fevers.

Coal-tar Aromatic Perfumes.—A third group of no less interest comprises the artificial aromatic essences, and of these may here be mentioned, in the first place, *cumarin*, $C_9H_6O_2$, the crystalline solid found in the sweet woodruff, in Tonka bean, and in certain sweet-scented grasses. This is now artificially prepared by acting upon sodium salicyl aldehyde with acetic anhydride by the reaction which is associated with the name of Dr. Perkin, and is used in the manufacture of the perfume known as "extract of new-mown hay."

A second interesting case of a production of a naturally occurring flavour is the artificial production of *vanillin*, the crystalline principle of vanilla. Vanilla is the stalk of the *Vanilla planifolia*, which incloses in its tissues prisms of crystalline vanillin, to which substance it owes its fragrance. Tiemann and Harrmann showed that vanillin is the aldehyde of methyl protocatechuic acid—

$$C_6H_3(OH)(OCH_3)CHO, [CHO : OCH_3 : OH = 1 : 3 : 4].$$

The chief seats of the vanilla productions are on the slopes of the Cordilleras north-west of Vera Cruz in Mexico, also the island of Réunion, and in the Mauritius. Since the discovery of the artificial production of vanillin, the growth of the vanilla has been very much restricted.

A variety of vanilla, termed vanillon, obtained in the East Indies, has long been used in perfumery for preparing "essence of heliotrope." This contains vanillin together with an oil, which is probably oil of bitter almonds. The essence of white heliotrope is now entirely prepared by synthetical operations. It is manufactured by adding a small quantity of artificial oil of bitter almonds to a solution of artificial vanillin; when these substances are allowed to remain for some time in contact, the mixture assumes an odour closely resembling that of natural heliotrope. Through the kindness of Mr. Rimmel the speaker was able to render the fragrance of this coal-tar perfume perceptible to his audience. Nor must we forget to mention the so-called essence of mirbane (nitrobenzene), of which about 150 tons per annum are used for perfuming soap; and artificial oil of bitter almonds, employed as a flavour in place of the natural oil.

Coal-tar Saccharine.—Of all the marvellous products of the coal-tar industry, the most remarkable is perhaps the production of a sweet principle surpassing sugar in its sweetness *two hundred and twenty* times. This substance is not a sugar, it contains carbon, hydrogen, sulphur, oxygen, and nitrogen. Its formula is

$$C_6H_4\begin{cases}CO\\SO_2\end{cases}NH,$$

and its chemical name is benzoyl sulphonic imide, or for common use, saccharine. It does not act as a nutriment, but is non-poisonous, and passes out of the body unchanged. The following is a concise statement of its properties, and mode of production from the toluene of coal-tar. It should, however, be first mentioned that the compound benzoyl sulphonic imide (saccharine) was first discovered by Constantin Fahlberg and Remsen, in America. But no patent was taken out for a commercial process till recently, and it is now patented in this country.

Step I.—Toluene is treated with fuming sulphuric acid in the cold, or it is heated with ordinary sulphuric acid of 168½° Twaddell on the water-bath, or not above 100° C. The latter method is the better. The acid is best caused to act upon the toluene in closed vessels rotating on horizontal axles.

$$\underset{\text{Toluene}}{C_6H_5CH_3} + SO_4H_2 = \underset{\text{Toluene sulphonic acids (ortho and para).}}{C_6H_4\begin{cases}CH_3\\SO_2.OH\end{cases}} + H_2O.$$

Step II.—After all toluene (which as toluene is insoluble in the acid) has disappeared, the contents of the agitating vessel are run into wooden tanks in part filled with cold water, and the whole liquid is stirred up with chalk to neutralise the excess of sulphuric acid used and to obtain the two isomeric toluene sulphonic acids as calcium salts.

$$2\left(\underset{\substack{\text{Toluene, ortho- and}\\\text{para-sulphonic acids}}}{C_6H_4\begin{cases}CH_3\\SO_2.OH\end{cases}}\right) + SO_4H_2 + 2(CaCO_3) =$$

$$\left(\underset{\substack{\text{Calcium toluene ortho-}\\\text{and para-sulphonates}}}{C_6H_4\begin{cases}CH_3\\SO_3\end{cases}}\right)_2Ca + CaSO_4 + 2CO_2 + 2H_2O.$$

The neutralised mass is filtered through a filter-press to separate therefrom the precipitate of gypsum, which is washed with hot water, and the washings added to the filtrate.

Step III.—The calcium salts are now treated with carbonate of sodium, to obtain the sodium salts, with precipitation of carbonate of calcium. The precipitate is removed by means of a

filter-press from the solution containing the sodium ortho- and parasulphonates.

$$\left(C_6H_4\begin{cases}CH_3\\SO_3\end{cases}\right)_2Ca + Na_2CO_3 = CaCO_3 + 2C_6H_4\begin{cases}CH_3\\SO_2.ONa.\end{cases}$$

The sodium toluene sulphonates

Step IV.—The solution of the sodium salts from III. is evaporated either in an open or in a vacuum-pan so far that a portion taken out will solidify on cooling. The contents of the pan are then run into moulds of wood or iron, and allowed to cool and solidify. The lumps are at length taken from the moulds, broken up small, and dried in a drying-room, and subsequently in a drying apparatus heated with steam, until quite desiccated.

Step V.—The sodium sulphonate salts are now converted into their corresponding sulphonic chlorides. This is effected as follows:—The dried sulphonates are thoroughly mixed with phosphorus trichloride, itself as dry as possible. The mixture is then placed in lead-lined iron vessels, and a current of chlorine is passed over the mixture till the reaction is ended. The temperature generated by the reaction must be properly regulated by cooling the apparatus with water. The phosphorus oxychloride resulting from the decomposition is driven off, collected, and utilised for developing chlorine from bleaching powder for the chlorinating process, phosphate of lime being precipitated, which can be used in manures. For this purpose the oxychloride is treated with water, and the mixture, now containing hydrochloric and phosphoric acids, is brought into contact with the chloride of lime.

The reaction by which the ortho- and para-toluene sulphonic chlorides are produced is indicated by the following equation:—

$$C_6H_4\begin{cases}CH_3\\SO_3Na\end{cases} + (PCl_3 + 2Cl) =$$

$$C_6H_4\begin{cases}CH_3\\SO_2Cl\end{cases} + POCl_3 + NaCl.$$

Toluene sulphonic chlorides

The two sulphonic chlorides remaining in the apparatus are allowed to cool slowly, when the solid one (the para compound) is deposited in large crystals, so that the liquid one can be easily removed by the aid of a centrifugal machine. The crystalline residue is freed from all the liquid sulphonic chloride by washing with cold water. Only the liquid orthotoluene sulphonic chloride is capable of yielding saccharine, and the liquid product above separated is cooled with ice to crystallise out the last traces of the crystalline compound. The solid parasulphonic chloride obtained as by-product, is decomposed into toluene, hydrochloric, and sulphurous acids by mixing it with carbon, moistening the mixture, and subjecting it under pressure to the action of superheated steam. The total change proceeds in two stages:—

1. $$C_6H_4\begin{cases}CH_3\\SO_2Cl\end{cases} + H_2O = C_6H_4\begin{cases}CH_3\\SO_2OH\end{cases} + HCl.$$

2. $$2\left(C_6H_4\begin{cases}CH_3\\SO_2OH\end{cases}\right) + C = 2(C_6H_5.CH_3) + CO_2 + SO_2.$$

The toluene is then used again in Step I., and the hydrochloric and sulphurous acids in Step VII.

Step VI.—The liquid orthotoluene sulphonic chloride is now converted into the orthotoluene sulphonic amide by treating the former with solid ammonium carbonate in the required proportions, and subjecting the resulting thick pulpy mixture to the action of steam. Carbonic acid is set free, and a mixture of orthotoluene sulphonic amide and ammonium chloride remains.

$$C_6H_4\begin{cases}CH_3\\SO_2Cl\end{cases} + (NH_4)_2CO_3 =$$

Toluene sulphonic chloride

$$C_6H_4\begin{cases}CH_3\\SO_2.NH_2\end{cases} + NH_4Cl + H_2O + CO_2.$$

Toluene sulphonic amide

As the mixture is very liable to solidify on cooling, cold water is at once added to prevent this, and to dissolve out the ammonium chloride, the amide remaining in the solid state. The liquid is separated by centrifugating.

Step VII.—The orthotoluene sulphonic amide is now oxidised, preferably by means of potassium permanganate. The result of this will be, precipitated manganese dioxide, free alkali and alkaline carbonate, and an alkaline orth sulphamido-benzoate. The alkaline liquid requires careful neutralisation during the oxidising process, and especially before evaporating, with a mineral acid, or else the sulphamido-benzoate formed would be again split up into orthosulphonic benzoate and free ammonia, thus:—

$$C_6H_4\begin{cases}CO.ONa\\SO_2.NH_2\end{cases} + NaOH = C_6H_4\begin{cases}CO.ONa\\SO_2.ONa\end{cases} + NH_3.$$

The oxidation process itself is thus represented:—

$$C_6H_4\begin{cases}CH_3\\SO_2.NH_2\end{cases} + 3O + NaOH =$$

$$C_6H_4\begin{cases}CO.ONa\\SO_2.NH_2\end{cases} + 2H_2O.$$

Sodium orthotoluene sulphamido-benzoate

By precipitation with dilute mineral acids, such as hydrochloric or sulphurous acids, the pure benzoyl sulphonic imide is at once precipitated:—

$$C_6H_4\begin{cases}CO.ONa\\SO_2.NH_2\end{cases} + HCl =$$

$$NaCl + H_2O + C_6H_4\begin{cases}CO\\SO_2\end{cases}NH.$$

"Saccharine," or benzoyl sulphonic imide

Saccharine possesses a far sweeter taste than cane sugar, and has a faint and delicate flavour of bitter almonds. It is said to be 220 times sweeter than cane sugar, and to possess considerable antiseptic properties. On this account, and because of its great sweetness, it is possible that it may be useful in producing fruit preserves or jams, consisting of almost the pure fruit alone; the small percentage of saccharine necessary for sweetening these preserves being probably sufficient to prevent mouldiness. Saccharine has been proved by Stutzer, of Bonn, to be quite uninjurious when administered in considerable doses to dogs, the equivalent as regards sweetness in sugar administered, being comparable to over a pound of sugar each day. Stutzer found, moreover, that saccharine does not nourish as sugar does, but that it passes off in the urine unchanged. It is proposed thus to use it for many medical purposes, where cane sugar is excluded from the diet of certain patients, as in cases of "diabetes mellitus," and in this respect it may prove a great boon to suffering humanity, although we must remember that, as certain of the aromatic compounds if administered for a length of time are known to exert a physiological effect, especially on the liver, it will be desirable to use caution in the regular use of saccharine until its harmless action on the human body has been ascertained beyond doubt.

Saccharine is with difficulty soluble in cold water, from hot aqueous solutions it is easily crystallised. Alcohol and ether easily dissolve it. Hence from a mixture of sugar and saccharine, ether would easily separate the saccharine by solution, leaving the sugar. It melts at about 200° C. with partial decomposition.

The taste is a very pure sweet one, and in comparison with cane sugar it may be said that the sensation of sweetness is much more rapidly communicated to the palate on contact with saccharine than on contact with sugar. The speaker expressed his thanks to the discoverer of saccharine, Dr. Fahlberg, of Leipzig, for a complete and interesting series of preparations illustrating the domestic and medicinal uses of this remarkable compound, and also to his friend Mr. Watson Smith for the kind aid afforded him in the experimental illustration of his discourse.

SOCIETIES AND ACADEMIES

London

Royal Society, May 20.—"On the Working of the Harmonic Analyser at the Meteorological Office." By Robert H. Scott, F.R.S., and Richard H. Curtis, F.R.Met.Soc.

On the 9th of May, 1878, Sir W. Thomson exhibited to the Society a model of an integrating machine, which consisted of a series of five of the disk, globe, and cylinder integrators, which had been devised two years earlier by his brother Prof. James Thomson, and a description of which will be found in the *Proceedings* of the Royal Society, vol. xxiv. p. 262. Sir W. Thomson's paper describing this model will be found in vol. xxvii. of the *Proceedings*, p. 371; and reference should be made to both these papers for an explanation of the principle of the machine. In the communication last named it is stated that the machine was about to be "handed over to the Meteorological Office, to be brought immediately into practical work."

The model was received at the Office in the course of the

month, and was at once set in action; the results of the preliminary trials when obtained being referred to a Committee consisting of the late Prof. H. J. S. Smith and Prof. Stokes, who, on July 5 following, submitted to the Meteorological Council a favourable report on the performance of the model.

The Council at once resolved to have a machine constructed, which should be specially adapted to the requirements of the work for which it was intended, viz. the analysis of photographic thermograms and barograms.

In preparing a working design for actual execution, it was found necessary to make several modifications in the details of the mechanical arrangements of Sir W. Thomson's original model, and these were mainly worked out by Prof. Stokes and Mr. de la Rue. The construction of the instrument was intrusted to Mr. Munro. It was considered sufficient to limit the action of the machine so as to extend only to the determination of the mean, and the coefficients as far as those of the third order, in the expression

$$E = a + a_1 \cos\theta + b_1 \sin\theta + a_2 \cos 2\theta + b_2 \sin 2\theta + a_3 \cos 3\theta + b_3 \sin 3\theta + \&c.,$$

and to obtain these it was necessary to have seven sets of spheres, disks, and cylinders.

A description of the machine, as actually constructed, together with engravings giving a general view of the machine, and illustrating some of its details, will be found in *Engineering* for December 17, 1880.

The machine was delivered at the Office in December 1879, and a lengthened series of trials was at once commenced, to determine its constants, and thoroughly test the accuracy of its working, for which purpose systems of straight lines and curves, of which the values were known, were first used. A few small unforeseen difficulties were early met with, necessitating slight modifications in some portions of the instrument.

The chief of these faults was a slight turning of the cylinders upon their axes, when the balls were moved to and fro along the disks, parallel to the axes of the cylinders. The movement was always in the same direction, namely, towards the disks, whether the ball was moved to the right or left. After the trial of many expedients the defect was finally, in great measure, overcome by attaching weights to the spindles of the cylinders. It however still exists in the machine to a slight extent, and its effect is to *decrease* the readings on the cylinders by a very small amount.

It was decided to employ the analyser, in the first instance, in the determination of temperature constants, and careful comparisons have been made of the results obtained by its means with those got by actual measurement of the photographs and numerical calculations, as will presently be mentioned, and the accordance is so very close as to prove that the machine may safely be trusted to effect reductions which could only otherwise be accomplished by the far more laborious process of measurement and calculation.

It will facilitate an apprehension of the method of using the machine to give a somewhat detailed account of the operations involved in the treatment of the curves, with an example of the manner in which the readings of the machine are recorded and dealt with.

The machine is furnished with three pairs of recording cylinders and disks, numbered consecutively 1 to 6, which give the coefficients for the first three pairs of terms of the expansion, and in addition a seventh cylinder and disk from which the mean is obtained. In the thermograms which supply continuous photographic records of the march of temperature, the trace for twenty-four hours covers a length of 8·75 inches, while a vertical height of about 0·7 inch[1] corresponds to a range of ten degrees in temperature; each thermograph sheet contains the record for forty-eight hours.

Conveniently placed in the machine is a cylinder or drum, the circumference of which is equal to the length of twenty-four hours upon the thermograms. Round this cylinder the thermograms are rolled, the fluctuations of temperature indicated by the curves being followed, as the cylinder revolves, by a combination of the movement of the cylinder with that of a pointer moving in a line parallel to its axis.

The handle by which the cylinder is turned gives motion at the same time to the seven disks of the machine, and the operator thus controls by his left hand both the speed with which the curves are paid through the machine and the consequent velocity of the angular motion of the disks, while, by a suitable contrivance, the movements of the pointer, governed by his right hand and following the curve, produce on the face of the disks corresponding movements to the right or left of the balls by which the motion of the disks is conveyed to the recording cylinders.

[1] This value varies slightly for each observatory.

At the commencement of an operation all the cylinders are set to zero; the twelve months curves are then passed consecutively through the instrument; the first pair of cylinders, which gives the coefficients of the first order, and also the mean cylinder, 7, being read for each day, while cylinders 3 and 4, and 5 and 6, which give the coefficients of the second and third orders respectively, are only read for each five days and at the end of each calendar month. The numbers on the cylinders are, however, progressive, so that the increments upon them for any given period could very easily be obtained.

At present only the monthly increments of the readings have been dealt with, so as to obtain the coefficients of the mean daily variation for each month of the year. The process followed is, therefore, simply to divide the monthly increment by the number of days in the month, and then to multiply the quotient by a factor which is determined by the scale-value of the thermograms, and which will therefore be different for each observatory.

As an illustration, the case of Kew for July 1882 may be taken. The increments for the month obtained from the final readings of the cylinders are as follows:—

Cylinder	1.	2.	3.	4.	5.	6.	7.
Observed increment	+2·198	−2·671	−0·101	−0·198	−0·797	−0·564	+56·839
Divided by 31 (the number of days).....	+0·071	−0·086	−0·003	−0·006	−0·026	−0·018	+1·834
Factor	−53·52	+53·52	−26·76	−26·76	−17·84	−17·84	+6·69
Coefficient deduced.....	= −3·80	−4·60	+0·08	+0·16	+0·46	+0·32	+12·27
						Add constant.....	48·17
						Mean temperature.....	60·44

After some trials with the curves for the year 1871, the year 1876 was taken up, inasmuch as for that year the records had been discussed by Mr. H. S. Eaton, F.R.Met.Soc., who had calculated the hourly means of the various meteorological elements for each month separately, and who kindly placed his results at the disposal of the Council.

The working of the machine was thus subjected to an exact test by comparing the results obtained by it with the coefficients in the harmonic series which were calculated from Mr. Eaton's means; and their trustworthy character, and the adequacy of these calculations to serve as a standard with which the coefficients obtained by means of the machine might be compared, was established by calculating them from the *odd* and *even* hours, quite independently, for all the seven observatories.

The outcome of this experiment was thoroughly satisfactory, and the entire series of results obtained both by calculation and from the machine was published as Appendix IV. to the Quarterly Weather Report for 1876, together with a Report prepared by Prof. Stokes, the concluding paragraphs of which may be quoted here, since they sum up in a few words the conclusions arrived at.

"Disregarding now the systematic character of some of the errors, and treating them as purely casual, we get as the average difference between the constants as got by the machine and by calculation from the twenty-four hourly means 0°·065. It may be noticed, however, that the numbers are unusually large (and at the same time very decidedly systematic) in the case of the second cylinder of the first order b_1, for which the average is as much as 0°·150, the seventh of a degree.

"If b_1 be omitted, the average for the remaining cylinders of the machine is reduced to 0°·047.

"We see, therefore, that, with the exception perhaps of b_1, the constants got by the machine for the mean of the days constituting the month are as accurate as those got by calculation, which requires considerably more time, inasmuch as the hourly lines have to be drawn on the photograms, then measured, then meaned, and the constants deduced from the means by a numerical process by no means very short."

The curves for the twelve years 1871 to 1882 inclusive have now been passed through the machine, and the results obtained have been carefully checked so far as the arithmetical work involved is concerned, upon a plan approved by the Council. No *direct* check, short of passing the curves a second time through the machine, can however at present be put on any portion of the results except as regards the means, which have been compared with the means calculated from the hourly readings obtained by measurement from the curves. The results of this work will be published in the Hourly Readings for 1883, but the general results may here be stated.

As a rule, the monthly means yielded by the harmonic analyser agree well within a tenth of a degree with those obtained by calculation from the hourly measurements of the curves; and although in some exceptional cases larger differences have been found, amounting in rare instances to as much as half a degree, it is probable that generally these are less due to defects in the working of the instrument than to other causes. In some cases large breaks in the curves, due to failure of photography, &c., were interpolated when the curves were passed through the machine, but not when the means were worked out from measurements of the curves. Some differences rather larger than usual, and confined chiefly to the earliest years dealt with, have been ascertained to have arisen from the circumstance that when the curves were first measured, to obtain hourly values, the method of making the measurements was not the same as that found by subsequent experience to be the preferable; and also that in some cases the scale-values first used were less accurately determined than has since been found possible.

In both these respects the two methods were on a par in the later years dealt with, and therefore the fairest comparison is to be had with their means.

For 1880, the average difference of the monthly mean for all the seven observatories is 0°·09; for 1881 it is 0°·05; and for 1882 0°·06; and in these three years a difference of 0°·3 between the analyser and calculated means occurred but once, and of 0°·2 but five times.

What has been said is sufficient to show that the instrument is completely applicable to the analysis of thermograms.

It has also been employed on the discussion of barograms, and the curves for the years 1871, 1872, and 1876 have been passed through the machine.

The year 1876 was selected owing to the existing facilities for comparing the resulting figures with those obtained by calculation from Mr. Eaton's means, and the result in this case was equally satisfactory with that for temperature already mentioned.

May 27.—"Family Likeness in Eye-Colour." By Francis Galton, F.R.S.

This inquiry proved that certain laws previously shown by the author to govern the hereditary transmission of stature also governed that of eye-colour: namely, that the average ancestral contributions towards the heritage of any peculiarity in a child are from each parent $\frac{1}{4}$, from each grandparent $\frac{1}{16}$, and so on; also that each parent and each child of any person will on the average possess $\frac{1}{2}$ of that person's peculiarity. The eye-colours were grouped into light, hazel (or dark gray), and dark; then it was shown that $\frac{2}{3}$ of the hazel were fundamentally light, and $\frac{1}{3}$ of them were dark, and they were statistically allotted between light and dark in that proportion. The desired test of the truth of the laws in question was thus reduced to a comparison between the calculated and observed proportion of light- and dark-eyed children born of ancestry whose eye-colours presented various combinations of light, hazel, and dark. The inquiry was confined to children of whom the eye-colours of both parents and of all four grandparents were known. There are six possible combinations of the three eye-colours in the parents, and fifteen in the grandparents, making a total of ninety possible classes, but of these one-half were wholly unrepresented in the returns, and many others were too scantily represented to be of use. The remainder were discussed in six different ways: that is to say, in two groups, *a* and *b*, and each group by three methods. In *a* the families were classified and grouped according to their several ancestral combinations of eye-colour, but only those groups that consisted of twenty or more children were used; there were 16 of these groups and 827 children. In *b* the families were treated separately, but only large families were taken, viz. those that consisted of at least six children: they were 78 in number. In both *a* and *b* separate calculations were made on the suppositions (1) that the parental eye-colours were alone known; (2) that the grandparental were alone known; (3) that the parental and the grandparental were alone known. The conformity between the calculated and the observed numbers throughout every one of the six sets of calculations was remarkably close, and the calculated results obtained by the method (3) were the best.

"Notes on Alteration induced by Heat in Certain Vitreous Rocks, based on the Experiments of Douglas Herman, F.I.C., F.C.S., and G. F. Rodwell, late Science Master in Marlborough College." By Frank Rutley, F.G.S., Lecturer on Mineralogy in the Royal School of Mines. Communicated by Prof. T. G. Bonney, B.Sc., F.R.S.

In this paper an endeavour has been made to ascertain the nature of the changes which are induced in a few typical vitreous rocks by the action of heat only. The specimens experimented upon were—

(1) The pitchstone of Corriegills, Arran.
(2) Black obsidian from Ascension.
(3) Black obsidian from the Yellowstone District, U.S.A.
(4) Glassy basalt lava of Kilauea, Hawaii.
(5) Basalt of the Giant's Causeway, Antrim.

The Arran pitchstone was heated for 216 hours at a temperature ranging from 500° to about 1100° C. The clear, greenish belonites of hornblende, so plentiful in the unaltered rock, were found to have turned to a deep rusty brown through peroxidation of the protoxide of iron which was present in the hornblende. The dusty matter mixed with clear spiculæ of hornblende, which occurred between the belonites and shaded gradually off into the clear glass which immediately surrounded the belonites in the normal state of the rock, has segregated to some extent, a sharp line of demarcation now existing between the dusty matter and the areas of clear glass, while the spiculæ of hornblende have somewhat increased in size if not in number. No actual devitrification of the glass has resulted from the heating.

The obsidian from Ascension showed only a banded structure coupled with streams of colourless microliths and a few felspar crystals when a section of the unaltered rock was examined microscopically. Two specimens of this rock were artificially heated, the first for the same period and at the same temperature as the Arran pitchstone, while the second was kept for 701 hours at a temperature ranging from 850° to 1100° C.

In the first specimen the banded structure disappeared entirely, or almost entirely, but numerous microliths are present in the altered rock, in which the most remarkable change consists in the development of an excessively vesicular structure.

In the second specimen a vesicular structure is also developed, an outer crust consisting of a very thin layer of clear brownish glass, followed by a nearly opaque layer composed of greenish-brown microliths, which shades off into a colourless glass containing similar microliths, which are probably some form of amphibole or pyroxene. The remainder of the specimen has been completely devitrified.

The Yellowstone obsidian in its normal state shows little else but trichites and globulites when examined under a high power.

Two specimens of this rock were heated: the first at from 500° to 1105° C. for a period of 216 hours, the second from 850° to 1100° C. for 701 hours. In the first case a remarkably vesicular structure has been developed; the trichites have entirely disappeared, and small granules and crystals of magnetite have been formed. In the second specimen the changes are very peculiar. The fragment retained its original form, but the surface showed minute blisters or elevations, which, when when cracked open, revealed a cavernous structure produced by

the coalescence of vesicles averaging from ¼ to ½ inch in diameter. These cavities were often lined with a white crystalline crust, and generally contained white crystalline pellets, each about one-third the size of the cavity in which it occurred. Minute crystals of specular iron were detected upon the surfaces of these pellets. The glassy part of the rock, which still remains clear, contains trichites and globulites similar to those in the unaltered obsidian, but they are more numerous in the artificially-altered rock.

The vesicular glassy basalt lava of Kilauea, when examined under the microscope, is seen to contain crystals of olivine and minute crystallites which have not hitherto been referred to any particular mineral species. A specimen of this lava, kept for 960 hours at a temperature ranging from 750° to 1200° C., shows that the olivine crystals have undergone no appreciable alteration, but the glass itself has become perfectly opaque and black, owing to the separation of magnetite.

The specimens of basalt from the Giant's Causeway were fused in Stourbridge crucibles in a gas furnace. One, which was cooled rapidly, appears under the microscope as a clear glass containing vesicles; another, cooled slowly, is black and opaque, except in certain spots where a prismatic structure is visible, the marginal portions of the prisms having a radiating crystalline or fibrous character.

In another case some of the powdered basalt was again fused, and a fragment of cold basalt was placed on the surface and allowed to sink into the molten mass. The result was a glass, which, under the microscope, appears perfectly clear except in the immediate vicinity of the immersed fragment, which is surrounded by an opaque black border containing divergent groups of colourless transparent or translucent crystals. The black border, where it joins the clear glass, is sharply defined, and its opacity and blackness must be regarded as due to a separation of magnetite, as in the case of the altered Kilauea lava.

The first series of experiments were made by Mr. Herman. The specimens from the Giant's Causeway were experimented upon by Mr. Rodwell.

Zoological Society, June 1.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—Dr. A. Günther, F.R.S., exhibited and made remarks on a specimen of a small fish of the genus *Fierasfer* embedded in a pearl oyster.—The Secretary made some remarks on the most interesting objects he had observed during a recent visit to the Zoological Gardens of Rotterdam, Amsterdam, Cologne, Antwerp, and Ghent.—A letter was read from Mr. J. M. Cornely, of Tours, C.M.Z.S., stating that his pair of Michie's Deer had bred in his park, and that a young one had been born on May 15.—Mr. Beddard read notes on the convoluted trachea of a Curassow (*Nothocrax urumutum*), and on the form of the syrinx in certain Storks.—Mr. W. F. Kirby read a paper containing an account of a small collection of Dragon-flies which had been formed by Major J. W. Yerbury at Murree and Campbellpore, N.W. India. The collection contained examples of about twenty species.

Physical Society, May 22.—Prof. Balfour Stewart, President, in the chair.—Messrs. C. A. Bell, W. C. Johnson, and James Swinburne were elected Members of the Society.—The following communications were read:—On the sympathetic vibrations of jets, by Mr. Chichester A. Bell. It has been assumed hitherto that a gaseous or liquid jet vibrates under the influence of a limited range of tones only; effective tones being those which do not differ greatly in pitch from the normal or proper tone of the jet, discovered by Savart and Sondhauss. The author has found, however, that, when the pressure under which a jet escapes is not too great, the latter is affected by all tones lower than the normal, as well as by some above it. Changes may be excited in a jet of either kind by vibratory motions of the jet orifice, or of the fluid behind or external to the orifice. These changes take the form of slight swellings and contractions, which become more pronounced as the fluid travels away from the orifice, and finally cause the jet to break or become discontinuous at a distance which depends upon the intensity of the initial disturbances. At any point within the continuous portion of the jet the successive swellings and expansions represent both the form and the relative intensities of vibrations impressed upon the orifice, and the jet is therefore capable of reproducing very complex sounds, such as those of speech and music. A vibrating jet of air does not, however, emit sound when it plays into free air, or into the wide end of a tube communicating with the ear; but when it plays against a very *small* orifice in the end of a hearing tube, loud sounds may result. This reproduction is most intense when the hearing orifice is placed in the axis of the jet, just within the breaking point, but becomes gradually feebler as the hearing orifice is moved towards the jet orifice or out of the line of its axis. Beyond the breaking point the sounds from the jet at first become confused, and finally are lost. A jet of gas, like a liquid jet, only vibrates so as to produce its normal tone when it strikes upon some obstacle which serves to diffuse the disturbances due to impact, or throw them back upon the orifice. The vibrations of an air jet are also loudly reproduced as sound when it is directed against a small flame below the apex of the blue zone. Liquid jets are but slightly sensitive to aërial sound-impulses, but become highly sensitive when the jet tube is rigidly attached to a sound-board. The vibrations of a jet so mounted are best perceived as sound when the stream strikes upon a rubber membrane tied over the end of a narrow tube which communicates with the ear. For accurate reproduction of speech and sounds in general the jets should be at such a pressure as to respond visibly to a note of about 4000 vibrations per second; and the membrane should be at such a distance from the orifice that the jet never breaks or becomes discontinuous above its surface. The vibrations of very fine jets of any conducting liquid become loudly audible when a portion of the jet, or the "nappe" formed when it strikes upon a flat surface, is included in circuit with a battery and a telephone. This may be accomplished by letting the jet impinge on the end of an ebonite rod, through the centre of which passes a platinum wire; the upper end of the rod is surrounded by a short tube or ring of platinum, the upper margin of which forms a continuous, slightly convex surface with the exposed end of the central wire and the ebonite. The wire and ring form the terminals of the circuit which is completed through the "nappe." Distilled water containing 1/300 of its volume of pure sulphuric acid is recommended as the jet liquid. The author advances a new theory to account for the growth of the vibratory changes in liquid and gaseous jets.—On some thermo-dynamical relations, part 5, by Prof. W. Ramsay and Dr. S. Young. In parts 1 and 2 of this series of papers it was shown that the ratio of the absolute temperatures of any two bodies corresponding to a given vapour-pressure bears a simple relation to the ratio at any other pressure, which may be expressed by the equation $R' = R + c(t' - t)$; where R' and R are the two ratios, c is a constant, and t' and t are the temperatures of one of the two bodies. The determination by Schumann (*Pogg. Ann.*, N.F. 12, 46) of the vapours of methyl-formate and twenty-seven homologous ethers made it possible to compare the vapour-pressures of a large number of bodies belonging to the same class. It was found that when the ethers were compared with ethyl acetate, which was taken as the standard, in every case $c = 0$, and therefore $R' = R$. The temperatures corresponding to the three pressures 260, 760, and 1300 mm. are given by Schumann. Taking the mean value of R for those pressures as correct, and recalculating the temperatures, the greatest difference between the found and recalculated temperatures is 0°·7 C. The vapour-pressures of water or any one of the ethers being accurately known, it is sufficient to determine the boiling-point of any ether belonging to this class, in order to construct its vapour-pressure curve. The absolute temperatures corresponding to the pressures 200 and 1300 mm. for any ether are $·89795t$ and $1·0488t$, where t is the boiling-point at normal pressure in absolute temperature.—A grid-iron slide-rule by Mr. Stanley, designed by Mr. Thacher, was explained by Mr. C. V. Boys. It was equivalent to a slide 60 feet long, and performed multiplication and division with an error not exceeding the 1/40,000 part.—Specimens of safety explosives and their results in shattering blocks of lead were exhibited by H. Sprengel.

Geological Society, May 12.—Prof. J. W. Judd, F.R.S., President, in the chair.—Matthew Blair was elected a Fellow, and Prof. H. Rosenbusch, of Heidelberg, a Foreign Correspondent of the Society.—The following communications were read:—On the maxilla of Iguanodon, by J. W. Hulke, F.R.S.—Notes on the distribution of the Ostracoda of the Carboniferous formations of the British Isles, by Prof. T. Rupert Jones, F.R.S., and J. W. Kirkby. Although all the Ostracoda of the Carboniferous formations are not yet described, there are 170 species and notable varieties known, belonging to thirty-three genera of nine families. About twenty-five of these species, not yet described, but determined by the authors, are introduced into

their lists as giving a fuller idea of the value of this manifold Crustacean group. In the first place they referred to the classification of the Carboniferous strata in Scotland and in England, according to the local differences, taking in succession "Scotland West," "Scotland East," "England North, with the Isle of Man," "England Central and South, with South Wales," as the several districts from which th y have obtained good groups of Ostracoda from different members of the Carboniferous series. In Fife the lowest local Carboniferous strata contain *Beyrichia subarcuata*; higher up come in *Carbonia fabulina*, *C. Kankiniana*, *Bairdia nitida*, and *Leperditia Okeni*; the last, accompanied by other species, occurs throughout this lowest series, in which the record is more complete than in Midlothian and Linlithgowshire, where the same species also occur. In Dumfriesshire and Ayrshire *L. Okeni* and *L. subrecta* have been found in beds even lower than the above-mentioned, and are therefore probably the oldest Carboniferous Ostracoda; other species accompany them higher up, and in Roxburghshire some localities of the Carboniferous Sandstone series are very rich in species. The Carboniferous Limestone series of South-West Scotland has been highly productive of Ostracoda, particularly the shales of the lower beds; thirty-six species are common or characteristic. The middle or coal-bearing portion has yielded but few, chiefly *L. Youngiana*, one Beyrichia, *C. fabulina*, and *C. Rankiniana*. The Upper Limestone group contains many recurrents from below and a few others, including *Youngia rectidorsalis* (MS.). The Millstone Grit equivalents have no Ostracoda, but the overlying Coal-measures are rich in *Carboniæ*, with a few others, such as *Cypridina radiata*. A great variety of genera and species come from beds at or near the base of the Scar Limestone and its equivalents in North Lancashire, Westmoreland, Cumberland, and Northumberland. The calcareous shales of the Yoredale series have several interesting forms, including *Paratura concinna* (MS.); none from the Millstone Grit. The Lower Coal-measures give *Beyrichia arcuata* and *Carbonia*, sp. The middle beds have *B. arcuata* and *Carbonia fabulina*, common; rarer, *C. Rankiniana*, *C. secans*, *C. scalpellus*, *C. Wardiana* (MS.), and *Philomedes elongata*. In the Upper Coal-measures *B. subarcuata* reappears; and in the *Spirorbis*-limestone *Leperditia inflata* is the latest Carboniferous Ostracod in England. In Northamptonshire the deep Gayton boring (at 730 feet) has given *Kirkbya variabilis*, *K. plicata*, *Bythocypris sublunata*, *Macrocypris Jonesiana*, *Cytherella extuberata*, and *C. attenuata*, all but one belonging to the Lower Carboniferous series. In Salop, South Wales, and Somerset the Carboniferous Limestone has yielded several good species of *Leperditia*, *Kirkbya*, *Moorea*, *Bythocypris*, *Bairdia*, &c. *Carbonia Agnes* and *C. Evelinæ* belong to the South Welsh Coal-measures. The distribution of the Carboniferous Ostracoda in Ireland requires further work; but the Lower Carboniferous Shales and the Mountain Limestone near Cork and elsewhere are very rich, as are also some parts of the latter in the Isle of Man. The Ostracoda of the Permian Formation were then treated of in relation to their Carboniferous allies, and the range of the British Carboniferous Ostracods in Europe and North America was noticed in some detail. The results of the examination were shown in two extensive tables.—Note on some Vertebrata of the Red Crag, by R. Lydekker, F.G.S. This communication contained briefly the results of a re-examination of the specimens from the bone-bed of the Red Crag in the British and Ipswich Museums, a series of casts from the latter having been added to the former. The forms noticed were *Hyæna striata*, with which *H. antiqua* and *H. arvernensis* were considered probably identical, *Mastodon*, of which the author thought three species—*M. arvernensis*, *M. longirostris*, and *M. borsoni* were represented; *Sus*, of which two forms, the larger probably *S. erymanthius* or *S. antiquus*, the smaller *S. palæochœrus*, had been detected; a Tapir, which was probably *Tapirus arvernensis* or *T. elegans* rather than *T. priscus*; *Hipparion gracile*; a *Rhinoceros* referable to the hornless *R. incisivus* rather than to *R. schleiermacheri*, though the latter probably also occurred; and a species of Albatross (*Diomedea*) represented by a right tarso-metatarsus, and the associated proximal phalangeal bone of the fourth digit.—The Pleistocene succession in the Trent Basin, by R. M. Deeley, F.G.S. The beds of the lowest division were distinguished from those of the middle and upper by the absence of Cretaceous rock-debris. Older Pleistocene: Early Pennine Boulder-clay, Quartzose Sand, Middle Pennine Boulder-clay; Middle Pleistocene: Melton Sand, Great Chalky Boulder-clay, Chalky Sand and Gravel; Newer Pleistocene: Interglacial River-alluvium, Later Pennine Boulder-clay. Each of the separate stages was then described separately, with details of exposures and sections throughout the area.—On the existence of a submarine Triassic outlier in the English Channel off the Lizard, by R. N. Worth, F.G.S.

Anthropological Institute, May 25.—Francis Galton, F.R.S., President, in the chair.—Mr. Reginald Stuart Poole read a paper on the ancient Egyptian classification of the races of man. This was defined by the famous subject of the four races in the tombs of the kings at Thebes (B.C. 1400–1200). The types were (1) Egyptian, red; (2) Shemite, yellow; (3) Libyan, white; (4) Negro, black. By comparison with monuments of the same period and of a somewhat earlier date, the first race, clearly an intermediate type, was seen to comprehend the Phœnicians, the Egyptians, and the people of Arabia Felix with the opposite coast. The Libyan race included an aquiline type, with marked supra-orbital ridges and receding foreheads, as well as a straight-nosed type. These two types inhabited the south coast of the Mediterranean, and some of the islands. The Negro race included the Negro and Nubian types. The Hittites and Hyksos, or shepherds, were as yet unclassed. Prof. Flower pointed out the resemblance of the aquiline Libyan type to that of the Neanderthal crania, and the oldest European type, and saw in the Hyksos head distinctly Mongolian characters. These two points are of the highest consequence in historical anthropology.—Mr. C. W. Rosset exhibited a large collection of photographs and other objects of ethnological interest from the Maldive Islands and Ceylon.

PARIS

Academy of Sciences, May 31.—M. Jurien de la Gravière, President, in the chair.—Observations of the small planets made with the large meridian instrument at the Paris Observatory during the first quarter of the year 1886, by M. Mouchez.—Note on a new general method of determining directly the absolute value of refraction at all degrees of altitude, by M. Lœwy. This is a further development and more general application of the author's recent communication on the means of determining some absolute values of refraction with a sufficient degree of accuracy.—Researches on the densities of liquefied gases and of their saturated vapours, by MM. L. Cailletet and Mathias. In this memoir the authors' studies are limited to the protoxide of nitrogen, ethylene, and carbonic acid. It is shown that at the critical point the density of the fluid is equal to that of its vapour, whence a practical means of determining graphically the density at the critical point when the critical temperature is known. It is also shown that the expansion of the liquefied gas is greater than that of the gas itself. The methods here described are applicable to all gases whose critical point is higher than the freezing-point of mercury.—On MM. Albert A. Michelson and Edward W. Morley's recent experiments to ascertain the influence of motion of the medium on the velocity of light (*American Journal of Science*, May 1886), by M. A. Cornu. The author briefly describes the American physicists' experiments, which show that the result announced by Fizeau in 1851 is essentially correct, and that the luminiferous ether is entirely unaffected by the motion of the matter which it permeates. At the conclusion of the paper M. Fizeau took occasion to remark that he had never ceased to prosecute his studies on the nature and properties of the ether, and hoped soon to announce the existence of a peculiar variation in the magnetic force of magnets apparently in relation with the direction of the earth's motion through space, and calculated to throw great light on the immobility of the ether and its relations to ponderable matter.—On an arc tangent to the solar halo of 46°, observed on May 30, by M. A. Cornu. Of the numerous halos observed during last month this is described as the most remarkable. It was visible towards 5 p.m. under the form of an extremely vivid iridescent arc concentric with the zenith at a distance of 15° to 20° in a circular sphere of from 60° to 80°. The author considers that from the systematic observation of these phenomena some valuable data might be obtained regarding the condition and movements of the upper atmospheric currents, which would be useful in weather forecasting.—On the heats of combustion and of formation of the solid carburets of hydrogen, by MM. Berthelot and Vieille. The method announced by the authors two years ago for measuring the heat of combustion of the fixed or but slightly volatile organic compounds is here applied to the study of naphthaline, acenaphthene, anthracene, phenanthrene, dibenzyl, and some other

carburets chosen on purpose with a view to determining certain general relations.—On the ammonia present in the ground: a reply to MM. Berthelot and André, by M. Th. Schlœsing. The points in dispute are re-stated, and the author deals fully with the chief objections urged by MM. Berthelot and André against his view that generally speaking the ammonia passes from the atmosphere to the earth.—Note accompanying M. Silvestri's report on the eruption of Mount Etna on May 18 and 19, by M. Daubrée. It is noticed that the present lava-stream, like that of 1883, flows from the crevasse which was opened on the flank of the volcano in the direction from north-east to south-west in the year 1875. But it rises at an elevation of about 1400 metres some 7 kilometres above the town of Nicolosi, which has thus so far escaped destruction.—On the influence of magnesia on Portland cements, by M. G. Lechartier. The author's extensive researches amongst public buildings and structures of all sorts fully confirm the conclusion already arrived at by Rivot regarding the destructive effects of the magnesia present in these cements. The more they are exposed to the direct action of water, the more rapid is the process of decay.—Observations of the new comet Brooks III., made at the Observatory of Nice with the Gautier equatorial, by M. Charlois.—Note on the theoretic calculation of the composition of vapours, their coefficients of expansion, and vaporising heats, by M. M. Langlois. The formulas which in the author's theory give the specific heats of the gases or vapours are as under :—

	Atm.		
Molecules at	1	... ...	$C = \frac{3}{5}\frac{V\pi P_8}{9}\alpha = \frac{3}{5}A\alpha$
,,	2	... ...	$C = A\alpha$
,,	3	... ...	$C = \frac{4}{3}A\alpha$
,,	4	... ...	$C = \frac{5}{3}A\alpha$

where α is the coefficient of expansion of the vapour, V the volume occupied by 1 kilogramme of this vapour under the pressure P. The complete theory will be explained at the next Congress of the French Association at Nancy.—On the diffusion of heat and physical isomorphism, by M. L. Godard. The property of being athermochroic, hitherto supposed to be peculiar to pure common salt and sylvine (natural chloride of potassium), is shown to be also characteristic of the isomorphous and anhydrous chlorides, bromides, and iodides. These substances have the same chemical formula and crystallise in the same system, and thus is once more confirmed the analogy presented by the physical properties of isomorphous bodies.—Law of the product corresponding to the maximum of useful work in an electric distribution, by M. Vaschy. It is shown that Jacobi's law (product $= \frac{1}{2}$) is inapplicable to the case of a dynamo-generator whose electromotor force is a function of the current traversing it.—On the cyclonic whirlwind of May 12: influence of the Guadarama mountain-range on its progress through the Iberian peninsula (second note), by M. A. F. Noguès. The fresh impulse given to this Atlantic cyclone by contact with the cold dry upland currents in the neighbourhood of Madrid show that under special conditions the central Spanish plateau may be compared to certain tropical regions, producing in Spain meteoric phenomena analogous to those of the torrid zone.—On the heats of combustion of the fatty acids and of some fatty substances derived from them, by M. W. Louguinine. Completing his previous studies on the heat of combustion of the fatty acids and their derivatives, the author here treats of caprylic, nonylic, lauric, myristic, and palmitic acids, and of the trilaurine and trimyristine glycerines.—On the dissociation of the carbonate of lime, by M. H. Le Chatelier.—On a new gaseous body, the oxyfluoride of phosphorus, with the formula $PhFl_3O_2$, by M. H. Moissan.—On the direct chloridation of methylbenzoyl, by M. H. Gautier.—Action of oxygenated water on benzoic acid in the presence of sulphuric acid, by M. Hanriot. Having previously shown that oxygenated water reacts on the benzenic hydrocarburets in sulphuric solution, transforming them to phenols and diphenols, the author here extends this reaction to the aromatic acids, and especially to benzoic acid.—On jaborine, by MM. Hardy and Calmels.—Absorption of the bicarbonates of potassa and lime by the roots of beetroot during the first year's growth, and their transformation to organic acids in combination with the potassa and lime diffused throughout the different parts of the plant during vegetation, by M. H. Leplay.—On the superficial measurement of the underground parts of plants, by M. Aimé Girard. A method is proposed by which the superficial development of vegetable roots may be approximately determined within about $\frac{1}{100}$ above or below the reality.—Fresh observations on the Jurassic bilobites, by M. Stan. Meunier. Several new forms of these curious fossil vestiges are described, tending more and more to show that they are of organic origin, and not merely animal footprints.—On the existence of the Lower Eocene formation in the Chalosse district, and on the position of the Bos d'Arros strata, by MM. Jacquot and Munier-Chalmas.

BOOKS AND PAMPHLETS RECEIVED

"Report of the Second Hudson's Bay Expedition, 1885."—"Charts showing the Ocean, Monthly and Annual Temperatures of Hudson's Bay Region and Eastern Canada, September 1884 to October 1885," by A. R. Gordon.—"Algebraical Exercises and Examination Papers," by H. S. Hall and S. R. Knight (Macmillan).—"Annalen des k.k. Naturhistorischen Hofmuseums," Band i., No. 2 (Hölder, Wien).—"Indice Alfabético de la Encyclopedia Popular Ilustrada de Ciencias y Artes," by F. Gillman (Gras, Madrid).—"Embryologische Studien an Medusen, Atlas," by E. Metschnikoff (Hölder, Wien).—"Report of the Metropolitan Board of Works, 1885."—"Electric Transmission of Energy," by C. Kapp (Whittaker and Co.).—"Physiology of Plants," by S. H. Vines (Cambridge University Press).—"A West Indian Sanitorium and a Guide to Barbadoes," by Rev. J. H. Sutton Moxly (S. Low).—"A Year in Brazil," by H. C. Dent (K. Paul).—"A Year with the Birds" (Blackwell, Oxford).—"Microbes, Ferments, and Moulds," by E. L. Trouessart (K. Paul).—"Catalogue of the Birds in the British Museum," vol. xi.—"Catalogue of the Fossil Mammalia in the British Museum," Part 3, by R. Lydekker.—"A Book of Duck Decoys," by Sir R. Payne-Gallwey (Van Voorst).—"Report of Experiments in the Manufacture of Sugar at Magnolia Station, Lawrence, La., Season of 1885-86," by G. J. Spencer (Washington).—"Principles and Methods of Soil Analysis," by E. Richards (Washington).—"Methods and Machinery for the Application of Diffusion to the Extraction of Sugar from Sugar-Cane and Sorghum," by H. W. Wiley (Washington).—"Proceedings of the Windsor and Eton Scientific Society, 1885" (Oxley, Windsor).—"Hydrophobia, M. Pasteur and His Methods," by Dr. T. M. Dolan (H. K. Lewis).

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