THURSDAY, AUGUST 23, 1877

MAURITIUS OBSERVATORY

Reports for 1874 *and* 1875 *of the Observatory, Mauritius* (*Appendices to Minutes of Council No.* 9 *of* 1875, *and No.* 24 *of* 1876). *Mauritius Meteorological Results*, 1874 *and* 1875.

THESE Reports give an interesting account of the progress of the Royal Alfred Observatory at Mauritius. The first division is devoted to the "Buildings, Grounds, and Water Supply;" this is a more important division than may be supposed at first sight. It appears in the Report for 1874, that in an attempt to arrange the grounds extensive pits were formed which were converted, through heavy rains, into noxious pools; while in next year's Report it is mentioned, under the head "Staff," that all had acted with "great zeal and perseverance notwithstanding occasional attacks of fever from which no one here has been exempt." The cause is indicated to be in a neighbouring marsh left undrained since 1872 or 1873.

In a similar report by the director of an observatory in South India to the Government, the construction of a road from the Observatory near the sea to another on the summit of the Ghats is mentioned as having been placed under his superintendence. The surveyor, however, who had to see the trace cut out, was unable to induce the coolies to accompany him through a certain part of the country, as a tiger had there carried away different members of a hill tribe. The director requested the Government to offer a suitable reward for the death of the man-eater, but in vain; the only reward promised being that usually given, the estimated value of the skin. The worth of the thing was what it would bring. A cooly, unlike a soldier, costs nothing to make him a useful machine; if a few coolies are snapped up by a hungry tiger others can always be had equally capable at the same daily rate of hire; the finances of the State do not suffer. If the director of the Observatory, the surveyor, or any other salaried officer, should be eaten, that would be a positive gain to the Treasury, since the pension due for previous services would be at once cancelled. No one can estimate the financial loss if a healthy officer should escape in such a case!

No Government, of course, would *reason* in this way, and we feel sure that of Mauritius will do what they can to make the scientific work they have so well begun as little dangerous as possible.

There remains, however, an annual source of discomfort and mischief in countries like the Mauritius where the rainfall is heavy—the "leaking" of the roofs. This is a more serious matter, financially speaking, than the health of the staff, since the whole objects of the observatory may be defeated by the action of humidity on the different instruments, including the object-glasses of the photo-heliograph, the equatorial, and other telescopes. In the Report for 1875 it is remarked that "the roof of the main building, which leaked considerably, has been repaired on two occasions. It still leaks, however, though not nearly as much as it did in February last, when some of the rooms were flooded, and books and papers were more or less damaged," &c. The roof of the Magnetic Observatory is also noted as "now almost water-tight." We hope the importance of this matter will be thoroughly appreciated by the Government, since the preservation of the instruments and the whole value of the results to be obtained from them depends upon it.

The magnetical instruments have been placed twelve feet under ground. We are afraid that this is not a good arrangement. Dr. Lamont tried a similar plan at Munich during five years, and the damp rotted the wooden supports of the roof, &c. He was at last obliged to place all the instruments above ground. We have also tried a similar method for a short period; but the humidity in such positions, and especially where the soil is frequently saturated with water, is destructive of all satisfactory results. The great object sought is constancy of temperature, and this can be gained to a great extent by placing the instruments within an *inner* room with thick ceiling and inner walls. Such a room need be entered rarely, and with self-registering apparatus the parts requiring manipulation may be placed in an external chamber communicating with the instrument room by a small opening in the wall.

Dr. Meldrum, the able and zealous director of the observatory, has both magnetical and meteorological self-registering apparatus, and in connection with the latter he receives meteorological observations from various stations. Astronomical work is limited chiefly to certain occasional phenomena (the transit of Venus was observed). There is a time-ball; a tide-gauge is expected; sun-spot pictures are taken with the photo-heliograph; sea observations from ship-logs are studied; storm-warnings are given; a magnetic survey has been begun, and special researches are undertaken.

Among the latter are useful practical studies connected with cyclones, which merit the greatest encouragement. Dr. Meldrum has noticed in his Report for 1875 the difference of his and M. Faye's views as to cyclonic movements. The latter insists that the wind moves in circles round the centre, while the former upholds spirally inward flowing currents (see NATURE, vol. xii. p. 458). This difference involves a most important question. According to the usual rule, as M. Faye says, the centre of the cyclone is at right angles to the direction of the wind; according to the other the wind is blowing towards the centre. That is an exaggeration of Dr. Meldrum's view; but in the Report for 1875 he says (Art. 90) that if a ship runs before the wind to north-west, believing the centre of the cyclone to be to north-east, the latter may really be to north or to north by west; that is to say, may make an angle of 45° or even of only 34° with the wind direction. We cannot accept Mr. Meldrum's theory of spiral cyclonic movements with the associated ascending currents, in which we have never seen any reason to believe; but we think there is considerable evidence for affirming that the angle made by the direction of the surface wind and that of the cyclone centre is generally less than 90°; and we do not think that M. Faye, in his effort to apply mechanical principles to the movements of the aërial masses, has had all the conditions of the problem before him, a fact which will appear more evident when the results we have obtained relatively to the movements of the atmosphere and the directions of the lines of equal barometric pressure are taken into consideration.

We have need, however, of more exact observations in cyclones at different distances from the centres, as we think it not improbable that the angle which the wind makes with the direction of the centre may vary with the distance from it as well as with the wind velocity.

Dr. Meldrum has also found periods for the frequency of cyclones and for the amount of rainfall agreeing with the decennial period of sunspots. It will be difficult, we think, to obtain quite satisfactory results for the cyclones, as the amount of evidence which will prove the existence of one will vary with the individual judging. A gale with a certain amount of veering or backing experienced by some ships may belong to a cyclone or it may not, there is no precise measure in many cases where there is not a sufficiently wide distribution of ships. No measure, also, is taken of the dimensions of the cylone or velocity of the wind, which it would be desirable to include in such an investigation. Some theorists insist that all winds are cyclonic. In any case we are inclined to believe that if such a decennial period exist it will be more accurately determined by measurements of the wind velocity for several years at fixed stations in different parts of the world. The question of such a period for the rainfall will, we have no doubt, receive ultimately a distinct answer from the observations at such stations, many series of which Dr. Meldrum has already collected and discussed with results in favour of the existence of such a period.

Meteorological results for 1874 and 1875 have also been published, and these include a number of important tables relating especially to the climatology of the Island.

JOHN ALLAN BROUN

OUR BOOK SHELF

A New London Flora; or, Handbook to the Botanical Localities of the Metropolitan Districts. By E. Ch. de Crespigny, M.D. (London: Hardwicke and Bogue, 1877.)

THERE are some local floras which have more than a local value, from the interspersion of critical notes on the species and sub-species by competent authorities. Of this character are Leighton's "Flora of Shropshire," and Bromfield's of the Isle of Wight. Others, of more modest pretensions, aim only at supplying information of interest to collectors or to those engaged in investigating the facts connected with the geographical distribution of plants; and these possess the advantage that their moderate size enables them to be used as pocket-companions. To this latter category belongs the little volume we have now before us, which strikes us as being a very good volume of its kind. The greater part is occupied by a list of species (alphabetical, so as to avoid the necessity of an index) of Phanerogams and Cryptogams, with the general distribution or special habitats attached. The nomenclature is that of the "London Catalogue of British Plants of 1874," unencumbered by any disquisitions as to specific or varietal distinctions, or the limits of natural orders. Of the 1,665 Phanerogams and Vascular Cryptogams included in the "London Catalogue," no fewer than 1,250 are found within the limits of the metropolitan flora. These limits, as understood in Dr. de Crespigny's volume, are, however, somewhat vague. They are stated to include an "average thirty-mile radius," but the radius appears to extend considerably further in some directions than in others. Thus, while we find a reference to the well-known localities for *Hymenophyllum tunbridgense* near Tunbridge Wells, and *Osmunda regalis* near Haslemere, there is none to that of *Anemone Pulsatilla* near Hitchen. These irregularities are, however, no doubt partly due to the direction of the author's individual researches, which seem to have been carried out with great zeal and accuracy, and to have extended over many years. The rest of the volume is occupied by a list of seventy-five localities, the scarcest and most interesting species of the locality being included in each list, distinguishing those which are authenticated by the author himself—by far the larger number. We can confidently recommend this volume to those interested in the flora of the metropolitan district.

Ethnography and Philology of the Hidatsa Indians. By Washington Matthews. (Washington: Government Printing-office, 1877).

THE United States Geological and Geographical Survey deserves the highest credit for publishing a work which pedantic red-tapeism might have thought did not belong to its province, and Mr. Matthews deserves equal credit for the care, thoroughness and scientific precision with which he has compiled it. We hope that so good an example will find many imitators. The Hidatsa (Hidacha), or Minnetari Indians, are a branch of the Dakota family, and now form one of the three tribes whose scanty relics inhabit the permanent village at Fort Berthold. The two other tribes are the Mandans and the Arickaris, and the linguistic relations of the community form one of the most interesting and important facts ever presented to the notice of the philologist. "This trio of savage clans," says Mr. Matthews, "although now living in the same village, and having been next-door neighbours to one another for more than a hundred years on terms of peace and intimacy, and to a great extent intermarried, speak, nevertheless, totally distinct languages, which show no perceptible inclination to coalesce. The Mandan and Hidatsa languages are somewhat alike, and probably of a very distant common origin; but no resemblance has yet been detected between either of these and the Arickaree. Almost every member of each tribe understands the languages of the other tribes, yet he speaks his own most fluently; so it is not an uncommon thing to hear a dialogue carried on in two languages, one person, for instance, questioning in Mandan, and the other answering back in Grosventre (Hidatsa), and *vice versâ*. Many of them understand the Dakota, and use it as a means of intercommunication, and all understand the sign-language." It should be added, as another curious philological fact that reduplication in verbs, which is a prominent feature of the Dakota, occurs in only one instance in the closely-allied Hidatsa. As in many other savage idioms, slight differences exist between the language of the women and of the men, the former tending to substitute *r* for *d*, and the latter preferring *l* and *n*. But the ethnologist as well as the philologist will find plenty of materials for study and reflection. Polygamy is practised, and a man usually marries his brother's widow, unless she object to the arrangement. Elopement sometimes takes place, divorce very rarely. "As with other western tribes, it is improper for a man to hold a direct conversation with his mother-in-law; but this custom seems to be falling into disuse." Males sometimes have four names, all containing the same noun, but a different adjective, and the names are afterwards solemnly changed once or even oftener. Coloured beads and pendants are made of pounded glass procured from the Europeans; the process of making them is very elaborate, and the antiquity of the art may be gathered from the fact that triangular pendants were used, "not as ornaments only, but as evidences of betrothal, as long ago as the oldest men can remember." Morally, the Hidatsa seem among the best of the Indians; they are described as industrious, honest, and peaceable, with fine physiques, light complexions, and great powers of endurance.

Across Central America. By J. W. Boddam Whetham. (London: Hurst and Blackett, 1877.)

THIS is a thoroughly readable and exceedingly instructive narrative, by a capable observer, of a journey through a country not often visited by travellers, and of which English readers probably know little or nothing. Mr. Whetham gives an interesting account of some of the wonderful ruins which exist in Central America, and we can commend his work to our readers as possessing both novelty and interest.

LETTERS TO THE EDITOR

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

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

The Contractile Filaments of the Teasel

THE observations of my son Francis on the contractile filaments protruded from the glands of Dipsacus,[1] offer so new and remarkable a fact in the physiology of plants, that any confirmation of them is valuable. I hope therefore that you will publish the appended letter from Prof. Cohn, of Breslau, whom every one will allow to be one of the highest authorities in Europe on such a subject. Prof. Cohn's remarks were not intended for publication, but he has kindly allowed me to lay them before your readers.

Extract from Prof. Cohn's Letter:—

"Immediately after the receipt of your very kind letter of July 26 I went to fetch Dipsacus, several species of which grow in our Botanic Garden; and proceeding after your recommendations, I put transverse sections of the cup-like bases of young leaves, or the epidermis of these parts carefully removed from the green parenchyma, into distilled water. I thus had the pleasure of witnessing with my own eyes this most curious discovery. First I ascertained the anatomical structure of the pear-like glands which are rather elegant and remarkable. From the basal cell rises the stalk-cell, in the second story there are two cells, in the third four, and in the uppermost series eight cuneiform cells converging to the centre. But you may conceive how much I was surprised by seeing the filiform protuberances issuing from the apex of the glands; it was quite a perplexing spectacle. The filaments are, in their refrangibility, very like the pseudopodia of some Rhizopods (*e.g.*, Arcella or Difflugia). I followed their changes for some time, and remarked quite definitely, as I find described in the paper of Mr. Francis Darwin how the protuberances slowly lengthen out, crook themselves hooklike or winding, and get knobbed either at the summit or midway; I saw the knobs or beads glide down the thread, and at last be sucked into a globular mass adhering to the gland. I saw the protuberances always rise between the septa of two or more adjoining cells, but nearly as frequently between the *lateral* septa as on the apical centre. Generally there were many protuberances on the same gland, pressed forward out of different spots; sometimes I saw two diverging branches proceed from the same point like a pair of compasses, each behaving independently in its changes. But the most curious appearance in these protuberances was a constant waving undulation along their extension, sometimes slower and perceptible with difficulty, sometimes vigorous and quicker, but never ceasing; more delicate filaments appeared to me very like Vibrio, or the vibratory flagella of some Infusoria. Not finding a special description of the waving movements of the filaments in your son's paper, I asked some of my pupils if they saw anything remarkable in the filaments, without indicating what, but they all took the same impression as myself. The only facts I have not yet been able to witness of your son's discoveries are Figs. 6, 14, 15, and the moniliform contraction; nor have I yet found time to apply chemical reagents, of which your son has made such good use.

"Of course I am not able, after two days' inspection, to form a definite judgment about the true nature of the filiform protuberances. Putting aside the hypothesis of a parasitic Rhizopod, there are two probabilities which still balance in my mind, as clearly stated by your son. (1) The protuberances are secretions of some colloidal matter, absorbing water, but insoluble in it; the movements are physical (not vital ones), the elongation of the filaments depending upon the imbibition, their contraction on the withdrawal of water by different reagents. There are such substances, *e.g.*, *myeline*, which shows rather similar changes in water. Please also to repeat the experiments I performed at the meeting of the British Association last year. Into a cylindrical glass containing soluble silicate of alkali (Wasserglas), diluted with half its amount of water, put a small piece of crystallised chloride of iron; from the fragment there rises a hollow reddish tube growing upwards and moving very quickly, like an Enteromorpha. But if you put into the diluted silicate some *protochloride* of iron (the latter is usually in the form of a powder, but may easily be brought by gentle pressure of the fingers into crumb-like masses), then from the lumps there arise innumerable filaments, very delicate and transparent, very like the glass threads of Hyalonema, which rise in fascicules vertically till they reach the surface of the fluid.

"But I cannot deny that the general impression produced by Dipsacus does not contradict the hypothesis that the changes of the filaments are the vital phenomena of protoplasmic pseudopodia.

"A French biologist (whose name I cannot just now remember) has proved many years ago (I think in an early number of the *Bull. de la Soc. Bot. de France*) that the water in the cups of Dipsacus is not a simple collection of rain in a gutter, but a secretion of the leaf bases. If this be truly the case, it is quite probable that the glands may have a special adaptation for this purpose. Indeed, I should not hesitate to agree with the vital theory, if there were any analogy known in plants. But further study of the phenomenon and the repetition of the chemical reactions which your son has already indicated, will, I hope, in a short time enable me to form a more decided judgment in this perplexing dilemma.

"In the meantime I am happy to congratulate Mr. Francis Darwin and yourself on account of the extraordinary discovery he has made, and the truly scientific paper in which he has elaborated it, and which has added a series of quite unexpected facts to the physiology of plants."

In a subsequent letter, Prof. Cohn describes what appear to him as thinned points or pores in the cell wall of the glands from which the filaments seem to be protruded. He also mentions the very curious fact which he has discovered, that by adding iodine to the detached epidermis of the leaf cups of Dipsacus the whole fluid contents of the epidermis cells turn blue like diluted starch paste, although no starch grains are met with in any epidermis cell except in the stomata.[1] He adds that the basal cell of the gland becomes blue, while the rest of it and the excreted globules are stained yellow.

I may add that I have heard from Prof. Hoffmann, of Giessen, that he formerly observed contractile filament of a somewhat similar nature on the annulus of *Agaricus muscarius*. He has described them in the *Botanische Zeitung*, 1853, and figured them, *ibid.*, 1859, tab. xi. Fig. 17.

CHARLES DARWIN

Down, Beckenham, August 15

[1] Abstract published in *Proc.* Roy. Soc., 1877, No. 179; published in full in *Quarterly Journal of Microscopical Science*, July, 1877.

[1] Prof. Cohn adds that the blue coloration of the epidermis by iodine occurs in the leaves of Ornithogalum.

Relations between Sun and Earth

PROF. BALFOUR STEWART in the last of his exceedingly interesting articles in NATURE (vol. xvi. p. 45) on the suspected relations between the sun and the earth, winds up with an appeal (which I should like to see promptly responded to by the Government here as well as at home) in favour of the establishment of some institution to keep a daily watch upon the luminary that is found to exercise such a marvellous control over terrestrial magnetism and meteorology. He also mentions incidentally the discovery by Dr. Hunter that the famines in Southern India have a period of recurrence which is nearly the same as that of sun-spot frequency. This is no doubt an exceedingly plausible hypothesis inasmuch as five out of the six years of drought mentioned by Dr. Hunter as preceding the years of famine during the present century fall within the group of minimum sun-spot years, the sixth (1854) being also a year of relatively few sun-spots (19 2 according to Wolf).

Dr. Hunter's avowed object, however, in writing his pamphlet was to prove that a cycle of drought sufficient to cause famine existed throughout the *whole* of Southern India, and with this end in view he has been content to show that a cycle of rainfall corresponding with the period of solar maculation existed merely for one single station, viz., Madras.

Having found a decided correspondence between the rainfall of Madras and the eleven-year period of sun-spots, he thence argues somewhat hastily that the same conditions apply throughout the whole of Southern India. This hasty generalisation from the results of one station situated in a vast continent, the rainfall of which varies completely both in amount and the season in which it falls, according to locality, has been strongly contested by Mr. Blanford, the Government meteorologist, who on making a careful comparison of the rainfalls of seven stations, three of which—Madras, Bangalore, and Mysore—are in Southern India, the others being Bombay, Nagpore, Jubbulpore, and Calcutta, finds that with the exception of Nagpore in Central India, which shows some slight approach to the same cyclical variation which is so distinctly marked in the Madras registers, the rest of the stations form complete exceptions to the rule adduced for Madras, in many of them the hypothetical order of relation being reversed. Mr. Blanford, however, shows that underlying the above irregularities a certain cyclical variation exists on the average at all the stations, the amount nevertheless being so insignificant (not more than 9 per cent. of the total falls) that it could not possibly be considered of sufficient magnitude to become a direct factor in the production of famine. It thus appears that the cycle of rainfall which is considered to be the most important element in causing periodic famines, has only been proved satisfactorily for the town of Madras. It may perhaps hold for the Carnatic and Northern Siccars—the country immediately surrounding Madras, though, owing perhaps to the want of rainfall registers in these districts, evidence with regard to this point is still wanting.

Though Dr. Hunter has thus been only partially successful, I would not attempt to detract in any way from the value of his able pamphlet, so far as it goes, an indirect effect of which has been to stimulate meteorological inquiry and research in the same direction throughout India. The meteorology of this country, from its peculiar and tropical position, is in such complete unison with any changes that may arise from oscillations in the amount of solar radiation and their effects upon the velocity and direction of the vapour-bearing winds, that a careful study of it cannot fail to discover meteorological periodicities in close connection with corresponding periods of solar disturbance. In connection with the previous remarks, and as showing what a close connection exists between solar and terrestrial meteorology, I may observe that Mr. Hill, the meteorologist for the North-West Provinces, and myself, have coincidently discovered the existence of a remarkable cycle in the *winter* rainfall of Northern India, between the latitudes of 20° and 30°, corresponding *inversely* with the period of solar spots, *i.e*, the maximum winter rainfall coincides with the minimum period of sun-spots, and *vice versâ*.

As a failure of the winter rains in the Northern Provinces in 1860-61 (*years of maximum sun-spot*) has been the cause of a severe famine, this theory, if completely established, would not be without its value in the economical administration of the North-West Provinces and the Punjab. I have not at present examined the rainfalls of all the stations in the Upper Provinces, but Mr. Hill, having readier access to them than myself, has probably done so to a larger extent, and tells me that the results of his investigations are similar to my own in bearing out the preceding hypothesis. A theory is not wanting to account for this tendency to vary inversely with the sun-spots, if we, according to opinion held by Drs. Hahn and Köppen, Prof. Piazzi Smyth, and Mr. Pogson, the Government astronomer at Madras, assume that the sun's heat is greater in years of minimum sun-spot. For in these years the anti-trade current, the descent of which upon the Himalaya and Northern India in the winter is generally understood to be the vehicle of the rain at that season, would be owing to the increased evaporation over the Southern Indian Ocean, reinforced with a larger supply of vapour than usual, while in years of maximum sun-spot the supply would be smaller. At all events, whatever be the real cause, the facts as far as we have gone, are exceedingly favourable to the existence of such a cycle. Calcutta, though lying close to the tropics, and therefore coming in for a small share of winter rainfall, still shows the preceding relation to a wonderful extent, and as its register of rainfall extends farther back than most of the other North Indian rainfalls, furnishes a more trustworthy result than many other stations whose rainfalls registered only for short periods scarcely afford more than a slight balance of probability in favour of the assumption. The following table is arranged in a double series of years occupying the same position in the spot-cycle, and gives the average rainfall for each double series for the months of November, December, January, February, March, and April, from 1837 to 1876 inclusive. I have indicated the groups containing the years of maximum and minimum sun-spot. The maximum rainfall will be seen to occur in the latter, and the n inimum in the former group.

Calcutta Rainfall during the months of November, December, January, February, March, and April.

	Years.					Average rainfall of group in inches.
11th	1876	1865	1854	1843	Group containing years of minimum sun-spot.	8·49
1st	1877	1866	1855	1844		6·44
2nd		1867	1856	1845		
3rd		1868	1857	1846	... ...	5·93
4th		1869	1858	1847		
5th	1870	1859	1848	1837	Group containing years of n·aximum sun-spot.	4·44
6th	1871	1860	1849	1838		
7th	1872	1861	1850	1839	... ...	5·03
8th	1873	1862	1851	1840		
9th	1874	1863	1852	1841	... ...	6·15
10th	1875	1864	1853	1842		
Eleventh series repeated						8·49

Further analysis only tends to render the connection still more evident, but I have no time to add anything further. In conclusion I need only remark that Jerusalem, which is situated somewhere about the same latitude as Lahore, and receives its total annual supply during the winter months alone, fully bears out the hypothesis as far as records show from 1846 to 1859.

Bankipore, Patna E. D. ARCHIBALD

Reproduction by Conjugation

IN Prof. Allen Thomson's Inaugural Address to the British Association, I find the following sentence, referring to the simplest form of sexual reproduction among cryptogams, known as conjugation:—"In more ordinary cases, as in *Spirogyra*, where the embryo is formed in one of the two cells, it seems to be indifferent in which of them it is formed." If my own experience may be taken as trustworthy and adequate, there is one fact in connection with this phenomenon which would seem to show that it may not be altogether indifferent, and that the differentiation of male and female elements may be carried back even one step further than is stated by this distinguished biologist. When two filaments—which we may call A and B—are conjugating, then, as far as my observation has gone, the direction of conjugation is uniformly the same, *i.e.*, either the contents of every cell in A pass over into the adjacent cell of B, or the reverse; we never find the contents of some of the cells of A passing over into B, and the contents of some of the cells of B passing over into A. If this is so, and if we call the filament in which the zygospores are ultimately produced A, then it is clear that we may fairly call A the female and B the male filament; and it would appear certain that there must be some hitherto undetected difference between them. My own observations in this respect relate almost exclusively to *Spirogyra*, and I shall be very glad to know if they are confirmed, or otherwise, by those of more experienced algologists.

ALFRED W. BENNETT

The Greenland Foehn

HOFFMEYER'S facts respecting spells of warm weather in the Arctic winter, as reported in NATURE, vol. xvi. p. 294, are very interesting, but his explanation of them seems demonstrably insufficient. He thinks they are a phenomenon of the same kind with the *Foehn* of the Alps, which latter he explains by saying that a wind which at its origin is saturated with moisture will, when it is forced over a mountain chain, be raised 1° Cent. for every 200 metres of height of the mountains. The heat thus gained is liberated in the condensation of the vapour. I believe this is satisfactory as regards the *Foehn*.

But this will not account for a rise of the temperature of Southern Greenland from its mean December temperature, which, according to Dove's map, is below freezing, to 14° C. A rise of 14° C. would require, according to the above law, a mountain chain 2,800 metres, or about 8,000 feet in height, and there is none in Greenland approaching this.

I used to think that great rises of temperature in the Arctic winter were due to the wind tearing up the frozen surface of the sea, and liberating the heat of the water below; but this will not account for an increase of temperature above freezing. I have no explanation to offer. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, August 13

Does Sunshine Extinguish Fire?

IT is a popular belief that a fire will not burn if exposed to the sun, and, from all I have observed, it seems well founded. Can any of your readers favour me with an explanation of the phenomenon, if true; or is it a mere superstition?

Schwarzwald, August 11 CHARLES WATSON

OUR ASTRONOMICAL COLUMN

THE OPPOSITION OF MARS, 1877.—The present opposition of the planet Mars offers conditions so nearly analogous to those of the opposition in 1862, that the many fine drawings made in that year, a number of which are contained in vol. xxxii. of the "Memoirs" of the Royal Astronomical Society, become available for comparison with such as may be made during the actual opposition. The same hemisphere of the planet is presented to the earth, and our depression from the martial equator is sensibly the same; thus, at opposition in 1862 the angle of position of the visible (southern) pole was 145°·3 and the earth's depression −22°·7, while at the opposition of 1877 the figures are respectively 160°·3 and −22° 5. The least distance of Mars from the earth in 1862 was 0·406, while in 1877 it is 0·377.

Notwithstanding Secchi observing in 1858 found the features upon the disc of Mars irreconcilable with those delineated in Mädler's drawings made under similar circumstances in 1830, it was sufficiently evident at the opposition of 1862 that these differences are to be attributed to the temporary conditions occasioned by clouds of varying density, form, and extent, in the atmosphere of the planet itself, heightened perhaps in some degree by the state of our own atmosphere at the times of the observations. A striking instance in support of this conclusion was afforded by Mr. Lockyer's observations on September 25, 1862. At 10h. 44m., when his drawing No. 14 was completed, the well-known spot *a* of Mädler was *quite invisible*, while when No. 15 was made shortly afterwards, this spot was "among the most prominent features upon the planet's disc."

There would appear now to be little doubt that the green and red portions of the disc do really represent seas and continents, and are not due to the effect of contrast, another explanation which has been suggested. During the actual favourable appearance of the planet, we may expect that measures will be made which will admit of a closer determination of the position of the axis of rotation than any yet obtained. The results at present upon record are (1) Sir W. Herschel's, which assigns for the longitude of the ascending node of the equator of Mars upon his orbit, 79° 27′ for 1872, and for the obliquity of his ecliptic 28° 42′. The reduction by Oudemann's of Herschel's measures, make these figures 79° 18′ and 20° 53′ respectively; (2) Schroeter's, as given by M. Terby, which places the south pole in 172° 54′·7, with latitude 60° 33′·2, whence we find for 1798, longitude of ascending node of equator on orbit, 84° 54′, obliquity of ecliptic 27° 57′ for 1798; and (3) Oudemann's reduction of Bessel's measures with the Königsberg heliometer, made September 28, 1830, January 21, 1835, and February 11, 1837, giving for the place of the ascending node 80° 50′, and for the obliquity 27° 17′ for 1834. With the last values which have been generally adopted, we have for the ascending node of the equator of Mars upon the earth's equator (N), and its inclination thereto (I):—

$$N = 47° 42' + 0'·50 (t - 1850)$$
$$I = 39° 52' - 0'·25 (t - 1850).$$

The following table showing the angle of position of the visible pole of Mars, and the elevation of the earth above the plane of his equator, at the oppositions between 1850 and 1880, has been calculated from the above elements, and may be of interest to some readers; the least distance of Mars from the earth is added:—

Date of opposition.	Position of visible pole.	Elevation of earth.	Least distance of Mars.
	° ′	° ′	
1852, Jan. 24	23 16	9 8 N.	0·660
1854, Feb. 26	343 46	22 6 N.	0·675
1856, April 2	35 2	23 30 N.	0·625
1858, May 15	40 45	12 4 N.	0·514
1860, July 17	192 34	10 47 S.	0·391
1862, Oct. 5	145 17	22 42 S.	0·406
1864, Nov. 30	142 37	6 29 S.	0·534
1867, Jan. 10	343 54	10 24 N.	0·636
1869, Feb. 13	7 37	21 40 N.	0·677
1871, March 19	28 35	24 53 N.	0·636
1873, Feb. 13	41 2	17 59 N.	0·563
1875, June 19	209 7	0 51 S.	0·433
1877, Sept. 5	160 14	22 31 S.	0·377
1879, Nov. 12	138 48	13 54 S.	0·482

A glance at this table exhibits a well-known condition that when Mars is nearest to the earth and when we have consequently the best opportunities of studying the features upon his disc, his southern hemisphere is always directed to the earth, and hence we are likely to be better acquainted with that hemisphere than with the northern one, which is turned towards the earth only at the greater distances of Mars.

THE SATELLITES OF SATURN.—A series of observations of all the eight satellites of Saturn by Prof. Asaph Hall, dated from Washington in December, 1876, has at last made its appearance in No. 2,145 of the *Astronomische Nachrichten*.

SATELLITES OF MARS.—A telegram from the Smithsonian Institution to M. Leverrier, received August 19, notifies the extraordinary discovery of two satellites of Mars by Prof. Asaph Hall, of the U.S. Naval Observatory at Washington. The telegram runs thus: "Two satellites of Mars by Hall at Washington, first elongation west, August 18, eleven hours, Washington distance, eighty seconds, period thirty hours, distance of second, fifty seconds."

THE BRITISH ASSOCIATION

PLYMOUTH, *Tuesday*

THE Plymouth Meeting of the British Association has not realised, as far as numbers are concerned, the success which we anticipated last week, and which was indicated by the business done on the days immediately preceding the opening of the meeting.

The attendance of the regular members from a distance has been very good indeed, and can compare favourably with meetings that have gone before it, but the visit of the British Association, while opening wide the gates of hospitality of the people of Plymouth, does not seem to have awakened the scientific interest of the community sufficiently to cause many to enlist in its ranks. It is seldom that so small a number of local members have been added to the list of members and associates at the annual meeting of the British Association. Yet Plymouth and its surroundings have a well-known scientific reputation, and the falling off in numbers of the present meeting must rather be looked for to the fact that one of the two sister-towns to Plymouth has, as a body, held aloof from the Association, than to any want of scientific interest pervading the great port of the west of England.

At the opening meeting on the evening of Wednesday last, there was a fair attendance, but the noble Guildhall was not filled. It is estimated that about 1,300 persons were present, including the members of the General Committee, who, as usual, were accommodated with seats on the platform. The business commenced by the Mayor of Plymouth introducing to the meeting the President, Prof. Allen Thomson. It was, we believe, intended as a graceful compliment to its host, the town of Plymouth, that the British Association requested the mayor to take the place of the retiring president, Prof. Andrews, who is absent through illness. The meeting went off very well and the presidential address was, notwithstanding its difficult and abstruse nature, listened to with profound attention, and commanded the respect which must be paid to anything coming from so high an authority upon embryology as Prof. Allen Thomson.

On the next morning the sectional addresses were delivered, some of which appeared in our last issue and others we give in the present number. In Section A the address by Prof. Carey Foster, F.R.S., was warmly received and elicited great applause when he spoke of the radiometer and of the great value of the researches of Mr. Crookes, notwithstanding the recent utterances of an influential mover in scientific circles which might have a tendency to depreciate the value of those researches. Prof. Haughton, of Dublin, read two papers, the first upon a method of calculating the absolute duration of geological periods, and the second, a reply to Prof. Newcomb upon the co-efficient of acceleration of the moon's mean motion as illustrated by the original account of the solar eclipse of Agathocles. Upon both papers an interesting discussion took place.

At the same section Prof. Osborne Reynolds read a paper (which we publish to-day) upon the rate of progression of groups of waves and the rate at which energy is transmitted by waves. The paper was illustrated by a very beautiful model in which the progression of wave-groups was made visible to the audience by means of a long series of light pendulums connected elastically with one another.

Friday was a great day in Section A as far as attendance was concerned. It had been announced the day before that Mr. Preece would read a paper on the telephone and show it at work, and that Sir William Thomson would make a communication to the section on the possibility of life on a meteoric stone falling on the earth. In anticipation of these two papers the room of Section A was crowded from an early hour, and although there were several long mathematical papers on the list, the non-mathematical visitors waited in the most patient manner for the papers they had come to hear. It so happened, however, that the papers that appeared so dry to those waiting for something else were of the very highest interest and value to mathematicians and astronomers; especially that by Prof. J. C. Adams on his discovery of original papers by Newton which proved that that great philosopher had solved some of the most important lunar problems, the solution of which has been till now attributed to a much later date, and proving most conclusively that Newton had never fallen into the error which for years had been attributed to him.

Sir Wm. Thomson's paper on the possibility of a meteorite becoming the vehicle of animal life to this earth from another planet, or heavenly body, was evidently listened to with much enjoyment. Sir William sees no difficulty in the assumption that animals or germs might without injury be conveyed to this earth by meteorites if protected in the crevices of the meteoric mass, and much amusement was caused by his saying that though the outside shell of a meteoric stone might be incandescent from the friction caused by its flight through the terrestrial atmosphere, yet within a crevice of that stone might be concealed a Colorado beetle, which, falling on the earth, might become the father of a large and prosperous family. The amusement caused by this quaint idea was increased to roars of laughter when Prof. Haughton, with his well-known wit, ridiculed the idea of the transmission of living animals by meteorites, and said that if Sir William Thomson had spoken of a Colorado beetle arriving by a meteoric stone becoming the mother of a large number of baby Colorado beetles he might have felt some sort of alarm, but he didn't care how many papa beetles came, so long as they left the mamma Colorado beetles at home.

Mr. Preece followed with his paper on the telephone. The room was crowded to excess and the paper was of the highest possible interest, and not only illustrated by diagrams and the instruments themselves, but the latter were connected by wires with the post-office at Plymouth, about a quarter of a mile off and with that at Exeter some fifty miles away. By means of Bell's articulating telephone the human voice was distinctly conveyed and conversations were carried on between the two stations. Owing to induction from the parallel wires between Plymouth and Exeter, there was a confused roar as from hail pattering on a window pane, and no words could be heard, but in his lecture in the Guildhall on the following evening, the traffic was stopped for ten minutes, and a conversation was carried on by the human voice between Plymouth and Exeter. The Guildhall on the occasion of Mr. Preece's lecture, was crammed almost to suffocation, and the discourse lasted two hours and a half; the lecture was upon telegraphy, but the telephone was undoubtedly the chief attraction.

The instrument was again described in Section G this afternoon by the inventor, Dr. Graham Bell, who arrived from Liverpool yesterday; he was received with enthusiastic applause, and a most interesting series of experiments were shown in illustration of his paper.

At the General Committee Meeting yesterday, a letter from the city of York was read by the secretary, inviting the British Association to celebrate their jubilee or fiftieth anniversary in that city in consideration of the fact that the first meeting of the Association was held at York in 1831. The invitation was unanimously accepted.

After some quiet discussion the resolution that the Association should visit Nottingham in 1879, and Swansea in 1880, was carried unanimously; whereupon Prof. Haughton rose, and, amidst great laughter, expressed his regret at the proceedings terminating so peacefully, for, as an Irishman, he never liked to see a good fight stopped. Mr. Spottiswoode is to be president at the Dublin meeting.

Some wholesome resolutions have been approved of by the Council on the regulations as to the admission of papers to be read in the various sections. With regard to the discontinuance of Section F the Council ask the General Committee to report more fully on the reasons which have induced them to recommend this step.

PLYMOUTH, *Wednesday*

[*By Telegraph*].

The following grants were passed at the meeting of the General Committee held at the Royal Hotel to-day. The names of the members who would be entitled to call on the general treasurer for the respective grants are prefixed:—

Mathematics and Physics.	£
Cayley, Prof.—Continuation of Borckhardt's Tables ...	100
Foster, Prof. Carey.—Observation of Atmospheric Electricity at Madeira	15

	£
Glaisher, Mr. J.—Luminous Meteors...	10
Joule, Dr.—Determination of the Mechanical Equivalent of Heat (renewed)	65
Thomson, Sir W.—Measurement of the Lunar Disturbance of Gravity (renewed)	50
Chemistry.	
Brown, Prof. Crum.—Quantitative Estimation of Atmospheric Ozone	10
Roberts, Mr. Chandler.—Chemical Composition and Structure of some of the less-known Alkaloids ...	25
Geology.	
Evans, Mr. J.—Kent's Cavern Exploration	50
Evans, Mr. J.—Record of the Progress of Geology ...	100
Godwin Austen, Mr.—Kentish Boring Exploration	100
Harkness, Prof.—North-West Highlands Fossils	10
Haughton, Rev. Dr.—Fermanagh Caves Exploration ...	30
Herschel, Prof. A.—Thermal Conductivity of Rocks ...	10
Hull, Prof.—Circulation of Underground Waters	15
Lubbock, Sir J., Bart.—Victoria Cave, Settle, Exploration	100
Biology.	
Dew Smith, Mr.—Table at the Zoological Station, Naples	75
Fox, Col. Lane.—Exploration of Ancient Earthworks ...	25
McKendrick, Dr.—Investigation of Pulse Phenomena by Thomson's Siphon Recorder	10
Rolleston, Prof.—Examination of two Caves and Tumuli near Tenby	25
Stainton, Mr.—Record of Zoological Literature	100
Thomson, Dr. Allen.—Transmission of Electrical Impulses through Nerve Structure	30
Statistics and Economic Science.	
Farr, Dr.—Anthropometric Committee (renewed)	66
Mechanics.	
Froude, Mr. W.—Instruments for Measuring the Speed of Ships (renewed)	50
Thomson, Sir W.—Datum Level of the Ordnance Survey	10
	£1,081

SECTION A.—Mathematical and Physical.

On the Rate of Progression of Groups of Waves and the Rate at which Energy is Transmitted by Waves, by Prof. Osborne Reynolds, F.R.S.—When several waves forming a discontinuous group travel over the surface of deep water, the rate of progression of the group is always much less than the rate at which the individual waves which compose the group are propagated. As the waves approach the front of the group they gradually dwindle down and die out, while fresh waves are continually arising in the rear of the others. This, which is a well-known phenomenon, presents itself to our notice in various ways.

When a stone is thrown on to the surface of a pond, the series of rings which it causes gradually expands so as finally to embrace the entire surface of the water; but if careful notice be taken it is seen that the waves travel outwards at a considerably greater rate than that at which the disturbance spreads.

Or, when viewing a rough sea, if we endeavour to follow with the eye any wave which is larger than its neighbours, we find, after following it in its course for a short distance, that it has lost its extra size, while on looking back we see that this has been acquired by the succeeding wave.

But perhaps the most striking manifestation of the phenomenon is in the waves which spring from the bows of a rapid boat, and attend it on its course. A wave from either bow extends backwards in a slanting direction for some distance and then disappears; but immediately behind it has come into existence another wave parallel to the first, beyond which it extends for some distance when it also dies out, but not before it is followed by a third which extends still farther, and so on, each wave overlapping the others rather more than its predecessor. Although not obvious, very little consideration serves to show that the stepped form of these columns of waves is a result of the continual dying out of the waves in front of the group, and the formation of fresh waves behind. For as each wave cuts slantwise through the column formed by the group, one end is on the advancing side or front of the group, and this is continually dying while the other is in the rear and is always growing.

So far as I am aware, no general explanation of these phenomena has as yet been given It has been shown, and I believe first by Prof. Stokes, that if two series of parallel waves of equal magnitude, but differing slightly in length, move simultaneously in the same direction over the same water so as to form a series of groups of waves separated by bands of interference, that these groups will advance with half the velocity of the individual waves. This is doubtless an example of the same phenomenon, and shows that the theory of wave motion is capable of explaining the phenomena; but it appears to leave something to be desired,—for instance, why should the bands of interference only progress with half the velocity of propagation in a deep sea, whereas in sound the corresponding bands of interference which constitute the beats move at the same velocity as the waves.

My object in this paper is to point out a fact in connection with wave transmission which appears to have hitherto passed unnoticed at all events in connection with the phenomena described above, of which it affords a clear and complete explanation. One of the several functions performed by waves progressing through a medium is the transmission of energy. Thus the energy which we receive from the sun is brought to us in the waves of light and heat; so in the case of sound the work done by the arm of the drummer is transmitted to our ears by the waves of sound. It is possible however to have waves which travel through a medium without conveying energy; such are the waves caused by the wind on a field of corn. This kind of wave may be well understood by suspending a series of small balls by threads, so that the balls all hang in a row, and the threads are all of the same length. If we then run the finger along, so as to set the balls oscillating in succession, the motion will be such as to give the idea of a series of waves propagated from one end to the other; but in reality there is no propagation, each pendulum swings independently of its neighbours, there is no communication of energy, the waves being merely the result of the general arrangement of the motion.

In this case there is no communication of energy, neither is there any propagation of disturbance. Any one ball may be set swinging without in the least disturbing the others; and what is indicated here is a general law that wherever a disturbance is transmitted through a medium by waves there must always be communication of energy. The rate at which energy is transmitted in different media, or by different systems of waves, is very different. This may be illustrated at once by experiment. If the balls just described are all connected by an elastic thread, then they can no longer swing independently. If one be set in motion then, by virtue of the connecting thread, it will communicate its motion to its neighbours until they swing with it, so that now waves would be propagated through the balls. The rate at which a ball would impart its motion, *i.e.* its energy, to its neighbours would clearly depend on the tension of the connecting thread. If this was very slight compared with the weight of the balls it would stretch, and the ball might accomplish several swings before it had set its neighbours in full motion, so that of the initial energy of disturbance a very small portion is communicated at each swing. But if the tension of the thread be great compared with the weight of the balls, one ball cannot be disturbed without causing a similar disturbance in its neighbours, and then the whole energy will be communicated. This is simply illustrated by laying a rope or chain on the ground, and fastening down one end; if then the loose end be shaken up and down the wriggle caused will travel to the other end, leaving the rope perfectly straight and quiet on the ground behind it, so that in this case it is at once seen that the wave carries forward with it the whole energy of disturbance.

The straight cord and the pendulous balls represent media in which the waves are at the opposite limits—in one case none of the energy of disturbance is transmitted, and in the other case the whole is transmitted. Between these two limits we may have waves of infinite variety, in which any degree of energy from all to nothing is transmitted. Now the waves of sound belong to the class of the cord in which all the energy is transmitted; but what I want particularly to make clear is that the waves on water are between the limits they are analogous to the waves in the balls suspended when connected by an elastic string. And I have so to show that according to the accepted theory of wave motion the waves on deep water only carry forward half the energy of disturbance.

In regular trochoidal waves the particles move in vertical circles with a constant velocity and are always subject to the same pressure. Of the energy of disturbance half goes to give motion to the particles and half to raise them from their initial position to the mean height which they occupy during the passage of the wave.

Now the mean horizontal positions of the particles remain unaltered by the waves, hence, since their velocities are constant, none of their energy of motion is transmitted; nor since the pressure on each particle is constant can any energy be transmitted by pressure. The only energy therefore which remains to be transmitted is the energy due to elevation, and that this is transmitted is obvious since the particles are moving forward when above their mean position, and backward when below it. This energy constitutes half the energy of disturbance, and this is therefore the amount transmitted.

For a definite mathematical proof that—

In waves on deep water the rate at which the energy is carried forward is ½ the energy of disturbance per unit of length × by the rate of propagation.

Let h_0 be the initial height occupied by a particle supposed to be of unit weight, h_1 the height of the centre of the circle in which it moves as the wave passes, r the radius of the orbit, and θ the angle the radius vector makes with the horizontal diameter, then the height of the particle above its initial position is $h_1 - h_0 + r\sin\theta$, adding to this the height due to its velocity we have the whole energy of disturbance—

$$= 2(h_1 - h_0) + r\sin\theta.$$

The velocity of the particle is—

$$= \sqrt{2g(h_1 - h_0)},$$

and the horizontal component of this is—

$$= \sqrt{2g(h_1 - h_0)}.\sin\theta.$$

Therefore the rate at which energy is being transmitted by the particle—

$$= \{2(h_1 - h_0) + r\sin\theta\}\sqrt{2g(h_1 - h_0)}.\sin\theta.$$

and the mean of this—

$$= \frac{1}{2\pi}\int_0^{2\pi} \{2(h_1 - h_0) + r\sin\theta\}\sqrt{2g(h_1 - h_0)}\sin\theta\, d\theta$$

$$= \tfrac{1}{2} r\sqrt{2g(h_1 - h_0)},$$

and if λ be the length of the wave, and $n\lambda$ the rate of propagation—

$$h_1 - h_0 = \frac{\pi r^2}{\lambda} \text{ and } \frac{2g}{\lambda} = 4\pi r^2,$$

∴ the mean rate at which energy is transmitted by this particle

$$= n\lambda(h_1 - h_0),$$

or the rate of propagation multiplied by half the energy of disturbance. Q.E.D.

It now remains to come back to the speed of the groups of waves and to show that *if the rate at which energy is transmitted is equal to the rate of propagation multiplied by half the energy of disturbance, then the velocity of a group of waves will be ½ that of the individual waves.*

Let P_1, P_2, P_3, P_4 be points similarly situated in a series of waves which gradually diminish in size and energy of disturbance from P_3 to P_1, in which direction they are moving. Let E be the energy of disturbance between P_1 and P_2 at time t, $E + a$ the energy between P_2 and P_3, $E + 2a$ between P_3 and P_4, and so on.

Then at the time $t + n$ after the wave has moved through one wave-length it follows that the energy between P_1 and P_2 will be—

$$= \frac{E + E + a}{2} = E + \frac{a}{2},$$

and between P_2 and P_3 will

$$= \frac{E + a + E + 2a}{2} = E + \frac{3a}{2},$$

and again after another interval, n, the energies between P_1 and P_2, P_2 and P_3 will be respectively—

$$= \frac{E + \frac{a}{2} + E + \frac{3a}{2}}{2} = E + a,$$

$$= \frac{E + \frac{3a}{2} + E + \frac{5a}{2}}{2} = E + 2a.$$

So that after the waves have advanced through two wave-lengths the distribution of the energy will have advanced one, or the speed of the groups is ½ that of the waves. Q.E.D.

Of course this reasoning applies equally to the waves on the suspended balls, when connected by an elastic string, as to water; and in this case the conclusions may be verified for, as on water, the groups of waves travel at a slower rate than the waves. This experiment tends to throw light on the manner in which the result is brought about. When a ball is disturbed, the disturbance is partly communicated to the adjacent ball by the connecting string, and part retained in the form of pendulous oscillation; that part which is propagated forward is constantly reduced in imparting oscillations to the successive balls and soon dies out, while the motion retained by the swinging pendulum constantly gives rise to succeeding waves until it is all absorbed. If the tightness of the cord be adjusted to the length of the suspending threads, waves may be made to travel along in a manner closely resembling the way in which they travel on water, the speed of the group being ½ the speed of the individual waves.

Although the progression of a group has hitherto been spoken of as if the form of the group was unaltered, this is by no means the case as a rule.

In the mathematical investigation it was assumed that the motion of the particles is circular; this, however, cannot be the case when the succeeding waves differ in size by a sensible quantity, and hence in this case the form of the group cannot be permanent. And it may be further shown that as a small group proceeds, the number of waves which compose it will continually increase, until the gradation becomes indefinitely small; and this is exactly what is observed, whether on water or on the strings.

So far as we have considered deep water, when the water is shallow compared with the length of the waves, the results are modified, but in this case the results as observed are strictly in accordance with the theory.

According to this, as waves enter shallow water the motion of the particles becomes elliptical, the eccentricity depending on the shallowness of the water; and it may be shown that under these circumstances the rate at which energy is transmitted is increased, until when the elliptic paths approach to straight lines the whole energy is transmitted, and consequently it follows that the rates of the speed of the groups to the speed of the waves will increase as the water becomes shallower, until they are sensibly the same. In which case only the groups of waves are permanent, and Mr. Scott Russell's solitary wave is possible. Besides the explanation thus given of these various phenomena, it appears that we have here a means of making some important verifications of the assumptions on which the wave theory is based; for the relative speed of the groups and the waves which compose them affords a criterion as to whether or not the particles move in circles.

SECTION D.—Biology.

Department of Anthropology.

Address by Francis Galton, F.R.S.

Permit me to say a few words of personal explanation to account for the form of the address I am about to offer. It has been the custom of my predecessors to give an account of recent proceedings in anthropology, and to touch on many branches of that wide subject. But I am at this moment unprepared to follow their example with the completeness I should desire and you have a right to expect, owing to the suddenness with which I have been called upon to occupy this chair. I had indeed the honour of being nominated to the post last spring, but circumstances arising which made it highly probable that I should be prevented from attending this meeting, I was compelled to ask to be superseded. New arrangements were then made by the Council, and I thought no more about the matter. However, at the last moment, the accomplished ethnologist who otherwise would have presided over you was himself debarred by illness from attending, and the original plan had to be reverted to.

Under these circumstances I thought it best to depart somewhat from the usual form of addresses, and to confine myself to certain topics with which I happen to have been recently engaged, even at the risk of incurring the charge of submitting to you a memoir rather than an address.

I propose to speak of the study of those groups of men who are sufficiently similar in their mental characters or in their physiognomy, or in both, to admit of classification; and I especially desire to show that many methods exist of pursuing the inquiry in a strictly scientific manner, although it has hitherto been too often conducted with extreme laxity.

The types of character of which I speak are such as those described by Theophrastus, La Bruyére, and others, or such as may be read of in ordinary literature and are universally recognised as being exceedingly true to nature. There are no worthier professors of this branch of anthropology than the writers of the higher works of fiction, who are ever on the watch to discriminate varieties of character, and who have the art of describing them. It would, I think, be a valuable service to anthropology if some person well versed in literature were to compile a volume of extracts from novels and plays that should illustrate the prevalent types of human character and temperament. What, however, I especially wish to point out is, that it has of late years become possible to pursue an inquiry into certain fundamental qualities of the mind by the aid of exact measurements. Most of you are aware of the recent progress of what has been termed psycho-physics, or the science of subjecting mental processes to physical measurements and to physical laws. I do not now propose to speak of the laws that have been deduced, such as that which is known by the name of Fechner, and its numerous offshoots, including the law of fatigue, but I will briefly allude to a few instances of measurement of mental processes, merely to recall them to your memory. They will show what I desire to lay stress upon, that the very foundations of the differences between the mental qualities of man and man admit of being gauged by a scale of inches and a clock.

Take, for example, the rate at which a sensation or a volition travels along the nerves, which has been the subject of numerous beautiful experiments. We now know that it is far from instantaneous, having indeed no higher velocity than that of a railway express train. This slowness of pace, speaking relatively to the requirements that the nerves have to fulfil, is quite sufficient to account for the fact that very small animals are quicker than very large ones in evading rapid blows, and for the other fact that the eye and the ear are situated in almost all animals in the head, in order that as little time as possible should be lost on the road, in transmitting their impressions to the brain. Now the velocity of the complete process of to and fro nerve transmission in persons of different temperaments has not been yet ascertained with the desired precision. Such difference as there may be is obviously a fundamental characteristic and one that well deserves careful examination. I may take this opportunity of suggesting a simple inquiry that would throw much light on the degree in which its velocity varies in different persons, and how far it is correlated with temperament and external physical characteristics. Before I describe the inquiry I suggest, and towards which I have already collected a few data, it is necessary that I should explain the meaning of a term in common use among astronomers, namely, "personal equation." It is a well known fact that different observers make different estimates of the exact moment of the occurrence of any event. There is a common astronomical observation, in which the moment has to be recorded at which a star that is travelling athwart the field of view of a fixed telescope, crosses the fine vertical wire by which that field of view is intersected. In making this observation it is found that some observers are over sanguine and anticipate the event, while others are sluggish and allow the event to pass by before they succeed in noting it. This is by no means the effect of inexperience or maladroitness, but it is a persistent characteristic of each individual, however practised in the art of making observations or however attentive he may be. The difference between the time of a man's noting the event and that of its actual occurrence is called his personal equation. It remains curiously constant in every case for successive years, it is carefully ascertained for every assistant in every observatory, it is published along with his observations, and is applied to them just as a correction would be applied to measurements made by a foot-rule, that was known to be too long or too short by some definite amount. Therefore the magnitude of a man's personal equation indicates a very fundamental peculiarity of his constitution; and the inquiry I would suggest, is to make a comparison of the age, height, weight, colour of hair and eyes, and temperament (so far as it may admit of definition) in each observer in the various observatories at home and abroad, with the amount of his personal equation. We should thus learn how far the more obvious physical characteristics may be correlated with certain mental ones, and we should perhaps obtain a more precise scale of temperaments than we have at present.

Another subject of exact measurement is the time occupied in forming an elementary judgment. If a simple signal be suddenly shown, and if the observer presses a stop as quickly as he can when he sees it, some little time will certainly be lost, owing to delay in nerve transmission and to the sluggishness of the mechanical apparatus. In making experiments on the rate of judgment, the amount of this interval is first ascertained. Then the observer prepares himself for the exhibition of a signal that may be either black or white, but he is left ignorant which of the two it will be. He is to press a stop with his right hand in the first event, and another stop with his left hand in the second one. The trial is then made, and a much longer interval is found to have elapsed between the exhibition of the alternative signal, and the record of it, than had elapsed when a simple signal was used. There has been hesitation and delay: in short, the simplest act of judgment is found to consume a definite time. It is obvious that here, again, we have means of ascertaining differences in the rapidity of forming elementary judgments and of classifying individuals accordingly.

It would be easy to pursue the subject of the measurement of mental qualities to considerable length, by describing other kinds of experiment, for they are numerous and varied. Among these is the plan of Prof. Jevons, of suddenly exhibiting an unknown number of beans in a box, and requiring an estimate of their number to be immediately called out. A comparison of the estimate with the fact, in a large number of trials, brought out a very interesting scale of the accuracy of such estimates, which would of course vary in different individuals, and might be used as a means of classification. I can imagine few greater services to anthropology than the collection of the various experiments that have been imagined to reduce the faculties of the mind to exact measurement. They have engaged the attention of the highest philosophers, but have never, so far as I am aware, been brought compendiously together, and have certainly not been introduced, as they deserve, to general notice.

Wherever we are able to perceive differences by inter-comparison, we may reasonably hope that we may at some future time succeed in submitting those differences to measurement. The history of science is the history of such triumphs. I will ask your attention to a very notable instance of this, namely, that of the establishment of the scale of the thermometer. You are aware that the possibility of making a standard thermometric scale wholly depends upon that of determining two fixed points of temperature, the interval between them being graduated into a scale of equal parts. These points are, I need hardly say, the temperatures of freezing and of boiling water respectively. On this basis we are able to record temperature with minute accuracy, and the power of doing so has been one of the most important aids to physics and chemistry as well as to other branches of investigation. We have been so accustomed, from our childhood, to hear of degrees of temperature, and our scientific knowledge is so largely based upon exact thermometric measurement, that we cannot easily realise the state of science when the thermometer, as we now use it, was unknown. Yet such was the condition of affairs so recently as two hundred years ago, or thereabouts. The invention of the thermometer, in its present complete form, was largely due to Boyle, and I find in his "Memoirs" (London, 1772, vol. vi. p. 403) a letter that cannot fail to interest us, since it well expresses the need of exact measurement that was then felt in a particular case, where it was soon eminently well supplied, and therefore encourages hope that our present needs as anthropologists may hereafter, in some way or other, be equally well satisfied. The letter is from Dr. John Beale, a great friend and correspondent of Boyle, and is dated February, 1663. He says in it:—

"I see by several of my own thermometers that the glassmen are by you so well instructed to make the stems in equal proportions, that if we could name some degrees, ... we might by the proportions of the glass make our discourses intelligible in mentioning what degrees of cold our greatest frosts do produce. . . . . If we can discourse of heat and cold in their several degrees, so as we may signify the same intelligibly, ... it is more than our forefathers have taught us to do hitherto."

The principal experiments by which the mental faculties may be measured require, unfortunately for us, rather costly and delicate apparatus, and until physiological laboratories are more numerous than at present, we can hardly expect that they will be pursued by many persons.

Let us now suppose that, by one or more of the methods I have described or alluded to, we have succeeded in obtaining a group of persons resembling one another in some mental quality, and that we desire to determine the external physical characteristics and features most commonly associated with it. I have nothing new to say as regards the usual anthropometric measurements, but I wish to speak of the great convenience of photographs in conveying those subtle but clearly visible peculiarities of outline which almost elude measurement. It is strange that no use is made of photography to obtain careful studies of the head and features. No single view can possibly exhibit the whole of a solid, but we require for that purpose views to be taken from three points at right angles to one another. Just as the architect requires to know the elevation, side view, and plan of a house, so the anthropologist ought to have the full face, profile, and view of the head from above of the individual whose features he is studying.

It might be a great convenience, when numerous portraits have to be rapidly and inexpensively taken for the purpose of anthropological studies, to arrange a solid framework supporting three mirrors, that shall afford the views of which I have been speaking, by reflection, at the same moment that the direct picture of the sitter is taken. He would present a three-quarter face to the camera for the direct picture, one adjacent mirror would reflect his profile towards it, another on the opposite side would reflect his full face, and a third sloping over him would reflect the head as seen from above. All the reflected images would lie at the same optical distance from the camera, and would, therefore, be on the same scale, but they would be on a somewhat smaller scale than the picture taken directly. The result would be an ordinary photographic picture of the sitter surrounded by three different views of his head. Scales of inches attached to the framework would appear in the picture and give the means of exact measurement.

Having obtained drawings or photographs of several persons alike in most respects, but differing in minor details, what sure method is there of extracting the typical characteristics from them? I may mention a plan which had occurred both to Mr. Herbert Spencer and myself, the principle of which is to superimpose optically the various drawings and to accept the aggregate result. Mr. Spencer suggested to me in conversation that the drawings reduced to the same scale might be traced on separate pieces of transparent paper and secured one upon another, and then held between the eye and the light. I have attempted this with some success. My own idea was to throw faint images of the several portraits, in succession, upon the same sensitised photographic plate. I may add that it is perfectly easy to superimpose optically two portraits by means of a stereoscope, and that a person who is used to handle instruments will find a common double eye-glass fitted with stereoscopic lenses to be almost as effectual and far handier than the boxes sold in shops.

In illustration of what I have said about photographic portraits, I will allude to some recent experiences of my own in a subject that I have still under consideration. In previous publications I have treated of men who have been the glory of mankind, I would now call your attention to those who are its disgrace. The particular group of men I have in view are the criminals of England, who have been condemned to long terms of penal servitude for various heinous offences.

It is needless to enlarge on the obvious fact that many persons have become convicts who, if they had been afforded the average chances of doing well, would have lived up to a fair standard of virtue. Neither need I enlarge on the other equally obvious fact, that a very large number of men escape criminal punishment, who in reality deserve it quite as much as an average convict. Making every allowance for these two elements of uncertainty, no reasonable man can entertain a doubt that the convict class includes a large proportion of consummate scoundrels, and that we are entitled to expect to find in any large body of convicts a prevalence of the truly criminal charactistics, whatever these may be.

Criminality, though not very various in its development, is extremely complex in its origin: nevertheless, certain general conclusions are arrived at by the best writers on the subject, among whom I would certainly rank Prosper Despine. The ideal criminal has three peculiarities of character; his conscience is almost deficient, his instincts are vicious, and his power of self-control is very weak. As a consequence of all this, he usually detests continuous labour. This statement applies to the criminal classes generally, the special conditions that determine the description of crime being the character of the instincts; and the fact of the absence of self-control being due to ungovernable temper, or to passion, or to mere imbecility.

The deficiency of conscience in criminals, as shown by the absence of genuine remorse for their guilt, appears to astonish all who first become familiar with the details of prison life. Scenes of heartrending despair are hardly ever witnessed among prisoners; their sleep is broken by no uneasy dreams—on the contrary, it is easy and sound; they have also excellent appetites. But hypocrisy is a very common vice; and all my information agrees in one particular, as to the utter untruthfulness of criminals, however plausible their statements may appear to be.

The subject of vicious instincts is a very large one; we must guard ourselves against looking upon them as perversions, inasmuch as they may be strictly in accordance with the healthy nature of the man, and, being transmissible by inheritance, may become the normal characteristics of a healthy race, just as the sheep-dog, the retriever, the pointer, and the bull-dog have their several instincts. There can be no greater popular error than the supposition that natural instinct is a perfectly trustworthy guide, for there are striking contradictions to such an opinion in individuals of every description of animal. All that we are entitled to say is, that the prevalent instincts of each race are trustworthy, not those of every individual. A man who is counted as an atrocious criminal by society, and is punished as such by the law, may nevertheless have acted in strict accordance with his instincts. The ideal criminal is deficient in qualities that oppose his vicious instincts; he has neither the natural regard for others which lies at the base of conscience, nor has he sufficient self-control to enable him to consider his own selfish interests in the long run. He cannot be preserved from criminal misadventure, either by altruistic or by intelligently egoistic sentiments.

It becomes an interesting question to know how far these peculiarities may be correlated with physical characteristics and features. Through the cordial and ready assistance of Sir Edmund Du Cane, the Surveyor-General of Prisons, who has himself contributed a valuable memoir to the Social Science Congress on the subject, I was enabled to examine the many thousand photographs of criminals that are preserved for purposes of identification at the Home Office, to visit prisons and confer with the authorities, and lastly to procure for my own private statistical inquiries a large number of copies of photographs of heinous criminals. I may as well say, that I begged that the photographs should be furnished me without any names attached to them, but simply classified in three groups according to the nature of the crime. The first group included murder, manslaughter, and burglary; the second group included felony and forgery; and the third group referred to sexual crimes. The photographs were of criminals who had been sentenced to long terms of penal servitude.

By familiarising myself with the collection, and continually sorting the photographs in tentative ways, certain natural classes began to appear, some of which are exceedingly well marked. It was also very evident that the three groups of criminals contributed in very different proportions to the different physiognomic classes.

This is not the place to go further into details: indeed my inquiry is far from complete. I merely quote my experiences in order to show the way in which questions of character, physiognomy, and temperament admit of being scientifically approached, and to give an instance of the helpfulness of photography. If I had had the profiles and the shape of the head as seen from above, my results would have been much more instructive. Thus, to take a single instance, I have seen many pencil studies in outline of selected criminal faces drawn by Dr. Clarke, the accomplished and zealous medical officer of Pentonville Prison; and in these sketches a certain very characteristic profile seemed to me conspicuously prevalent. I should have been very glad of photographs to corroborate this. So, again, if I had had photographic views of the head taken from above, I could have tested, among other matters, the truth of Prof. Benedict's assertion about the abnormally small size of the back of the head in criminals.

I have thus far spoken of the characters and physiognomy of well-marked varieties of men: the anthropologist has next to consider the life history of those varieties, and especially their tendency to perpetuate themselves, whether to displace other varieties and to spread, or else to die out. In illustration of this, I will proceed with what appears to be the history of the criminal class. Its perpetuation by heredity is a question that deserves more careful investigation than it has received, but it is on many accounts more difficult to grapple with than it may at first sight appear to be. The vagrant habits of the criminal classes, their illegitimate unions and extreme untruthfulness, are among the difficulties. It is, however, easy to show that the criminal nature tends to be inherited while, on the other hand, it is impossible that women who spend a large portion of the best years of their lives in prison can contribute many children to the population. The true state of the case appears to be that the criminal population receives steady accessions from classes who, without having strongly marked criminal natures, do nevertheless belong to a type of humanity that is exceedingly ill-suited to play a respectable part in our modern civilisation, though they are well-suited to flourish under half-savage conditions, being naturally both healthy and prolific. These persons are apt to go to the bad; their daughters consort with criminals and become the parents of criminals. An extraordinary example of this is given by the history of the infamous Jukes family in America, whose pedigree has been made out with extraordinary care, during no less than seven generations, and is the subject of an elaborate memoir printed in the thirty-first annual report of the Prison Association of New York, 1876. It includes no less than 540 individuals of Jukes blood, among whom the number of persons who degraded into criminality, pauperism, or disease, is frightful to contemplate.

It is difficult to summarise the results in a few plain figures, but I will state those respecting the fifth generation, through the eldest of the five prolific daughters of the man who is the common ancestor of the race. The total number of these was 103, of whom thirty-eight came through an illegitimate grand-daughter, and eighty-five through legitimate grandchildren. Out of the thirty-eight, sixteen have been in gaol, six of them for heinous offences, one of these having been commited no less than nine times; eleven others were paupers or led openly disreputable lives; four were notoriously intemperate; the history of three had not been traced, and only four were known to have done well. The great majority of the women consorted with criminals. As to the 85 legitimate descendants, they were less flagrantly bad, for only five of them had been in gaol and only thirteen others had been paupers. Now the ancestor of all this mischief, who was born about the year 1730, is described as having been a hunter and a fisher, a jolly companionable man, averse to steady labour, working hard and idling by turns, and who had numerous illegitimate children, whose issue has not been traced. He was, in fact, a somewhat good specimen of a half-savage, without any seriously criminal instincts. The girls were apparently attractive, marrying early and sometimes not badly; but the gipsy-like character of the race was unsuited to success in a civilised country. So the descendants went to the bad, and the hereditary moral weaknesses they may have had rose to the surface and worked their mischief without a check. Cohabiting with criminals and being extremely prolific, the result was the production of a stock exceeding 500 in number, of a prevalent criminal type. Through disease and intemperance the breed is now rapidly diminishing; the infant mortality has of late been horrible among them, but fortunately the women of the present generation bear usually but few children, and many of them are altogether childless.

This is not the place to go further into details. I have alluded to the Jukes family in order to show what extremely important topics lie open to inquiry in a single branch of anthropological research and to stimulate others to follow it out. There can be no more interesting subject to us than the quality of the stock of our countrymen and of the human race generally, and there can be no more worthy inquiry than that which leads to an explanation of the conditions under which it deteriorates or improves.

SECTION G.—Mechanical Science.

The following is an abstract of the address of the president, Mr. E. Woods, C.E:—The president selected the question of railway brakes as his topic. He said that the provision of adequate brake power to control trains was a subject which had latterly much engaged the attention of railway companies and of the Government. In the summer of 1874 a Royal Commission was appointed to inquire into the causes of accidents on railways, and the possibility of removing them by further legislation. One branch of the inquiry naturally led to the consideration of accidents caused by collision; and it appeared from the evidence taken before the Commissioners that trains were generally provided with insufficient controlling power, and that the distance within which, when running at high speed, they could be stopped by the brake ordinarily in use had not been ascertained with any approach to accuracy. It was under these circumstances that the Commissioners applied to the railway companies to institute a definite series of experiments to test the value of hand-brakes, and the effect of various systems of continuous brakes. In conjunction with Col. Inglis, R.E., he was intrusted by the Commissioners with the supervision of the experiments, to the satisfactory conduct of which the railway companies contributed in the most liberal manner. With few exceptions, and up to a comparatively recent period, the companies had remained content with the brake appliances which were common forty years ago. These, no doubt, were sufficient to control the trains in those early days, few as they were in number, and limited in weight and speed. The brakes were applied separately, and by hand-power, always to the tender, and usually to some few of the carriages and to the guard's van or vans, if such accompanied the train. As long ago as 1858 the Board of Trade called the special attention of the railway companies to the fact that the amount of brake power then habitually applied was insufficient to prevent frequent accidents occurring from collisions, many of which they considered might be averted. Particular reference was made to two systems which had come into daily use on the East Lancashire and the Lancashire and Yorkshire railways, namely, the brakes of Newall and of Fay, by means of which trains of ninety to 100 tons weight, running fifty miles an hour, could be effectually controlled by driver or guard, even when proceeding down steep inclines, and brought up within a moderate distance. It was certainly matter for surprise, seeing the advantage of continuous brakes, that the railway companies should have so long tolerated the old system, and been so slow to adopt a method which, instead of being dependent for its due action on the attention of several persons, was effectually placed under the control of one. This lethargy prevailed, too, throughout a period when increased speed had come to be demanded, when augmenting traffic required heavier trains, and when, consequently, more ponderous and powerful engines had to be used—circumstances which ought to have induced the companies to effect simultaneously a readjustment of their brake appliances. After the year 1850 many attempts were made to supersede the ordinary type of brake, some of the brakes introduced being self-acting and put into operation by the momentum of the train, while others acted as sledges or shoes. None, however, proved successful. The continuous breaks of Newall and Fay simply involved a wider distribution of power over the different vehicles of the train, and gave the means of applying that power by one, or, at most, two attendants. It was in that direction that the ingenuity of inventors had recently been turned, and there were now several systems of continuous brakes in successful working on the leading railways, each claiming some special advantages over its rivals, whether as more simple in construction, less expensive in application, or effecting more complete control of the train. The Royal Commissioners desired that attention should be primarily directed to the following points:—1. The distances within which trains running at various speeds could be stopped by the system of brakes in ordinary use on the different lines of the United Kingdom; (2) what results could be obtained by the additional application of brake power; and (3) how far a very large amount of brake power could be suddenly resorted to with safety in heavy trains running at high speeds. For the purpose of the experiments a portion of the Nottingham and Lincoln branch of the Midland Railway was selected as offering a piece of line comparatively level and free from any sharp curves. Six companies furnished eight complete trains, which represented as many systems of continuous brakes comprehended in four classes, namely, (1) Clarke's and Webb's and Fay's brakes, applied by ordinary mechanical gear; (2) Smith's and Westinghouse's vacuum brakes, actuated by atmospheric pressure produced by exhaustion of air; (3) Westinghouse's and Steel McInnes's air brakes; and (4) Clarke's and Barker's hydraulic brakes. The experiments extended over a week, and comprised several series. It was demonstrated that the friction of a complete train, in which the weight of the engine and tender constituted, say one-fourth of the gross weight, inclusive of the atmospheric resistance it encountered in its course, was 42-100ths per cent., or about 9½ lbs. per ton. This result confirmed what long experience had led them to anticipate. It was discovered further that, on a level line, a train running at the rate of forty-five miles an hour could be stopped by hand brakes within 1,000 yards, or, if at the rate of sixty miles, within 1,700 yards. The necessity for some greater control over fast passenger trains was thus rendered obvious. Through the want of a larger amount of brake power much time was lost on a journey, when the stoppages were frequent, the drivers being compelled to slacken speed at long distances from the stopping-places. It seemed, indeed, scarcely to admit of question that a system which was deemed necessary in special cases might be advantageously applicable in all cases; that to render the control of a train complete, brakes should be applied to all, or nearly all, the wheels; and that, at least, the driver, if not the guards, should possess the power of promptly bringing the whole into action. The truth of the principle was now very generally admitted by the leading companies, some of whom had already adopted continuous brakes, while others were preparing to do so. Rather startling disparities were disclosed during the experiments. Some of the disparities were attributable to the contrivances being of comparatively recent origin, but others were clearly owing to the principle upon which the action of the brake was founded. As between the air-pressure and the vacuum brakes there was a loss of 6½ seconds, which in a train running sixty miles an hour was equivalent to 180 yards additional space traversed in the stop. Three of the experiments involved the application of all available power for stopping. Sand was used, and was found to add sensibly to the stopping power. On an average it made an addition of 1·30 per cent. to the retarding force otherwise brought into play. The trials proved in a very striking manner the great advantage of continuous brakes, for even in their least effective form they afforded more than double the stopping power of the usual hand brakes, whilst in their most effective form the power was quadrupled. He was of opinion that no system could be considered satisfactory which did not produce a retarding power of at least 8 to 10 per cent. of the entire weight of the train, in other words, a power by which fast trains could be stopped in from one-third to one-fourth less time than at present. Obviously the stopping distance was primarily influenced by two considerations:—(1) The length of the interval which elapsed between the brake being put into operation and its taking an effective grip on the wheels; and (2) the amount of pressure brought to bear on each wheel, and the constancy or otherwise of the action after the blocks had gripped the wheels. The unpleasant sensation often experienced during quick stoppages was produced by intermittent and fitful action. After the brakes had been made to bite the wheels their hold became relaxed, a slip took place, followed by successive bites and slips, the latter giving rise to sudden accelerations of speed. The action of a perfect brake should exactly resemble that which gravity would cause if an ascending incline of uniform gradient could be suddenly placed in front of the train to prevent its motion. Under such conditions no inconvenience or danger need be apprehended from the stoppage being accomplished within even a shorter distance than any that was effected during the experiments. A valuable addition of power, under the immediate control of the driver, would be afforded by the fitting of brakes to the engine, and he was glad to find that the recommendation of the Royal Commissioners in this respect had met with prompt attention at the hands of the railway companies. The question of the best material for brake blocks had of late received a good deal of consideration, and it would seem that cast-iron, and even steel, was fast superseding wood. It generally happened that wheels did not become skidded until the speed of the train had been materially reduced. It seemed desirable, therefore, that for ordinary stops the brake pressure should be applied so as to act just short of skidding the wheels, the full skidding power being only used in cases of imminent danger. The general adoption of an effective system of continuous brakes on carriages which had to run from one line to another would be productive of much advantage, for then, in breaking-up and re-making a train at any junction station, the carriages would be found ready-fitted with the requisite appliances for working. If allied companies could only agree to adopt the same system, brake improvements would proceed with far greater rapidity than at present, and public convenience would thereby be promoted. The time had arrived not only when each system should be scrutinised and tested in the most complete manner, but when the companies should clearly set before themselves the conditions which a good continuous brake ought to supply. A study of the different methods which came under his (the lecturer's) notice during the experiments pointed to the following considerations as necessary in view of the provision of perfect brake power for heavy fast trains:—1. The brake power should be applied to all the wheels of all the vehicles throughout the train. 2. The power by which the blocks were forced upon the wheels should be adequate for skidding the wheels on the speed becoming moderately reduced. 3. The driver should have the whole of the brake power completely under his command, and be able to apply it at a moment's notice, as he was the first person likely to discover any obstruction ahead, and was primarily responsible for the regard of the danger signals. He could thus stop the train at once, and no time would be lost by his having to signal danger to the guard. 4. The guards should individually possess the like means of applying the continuous brake, so that they might be able to stop the train without reference to the driver, on an emergency which might manifest itself to them but not to him, such, for instance, as a broken axle, or a carriage getting off the line. 5. The power in hand should be so susceptible of modification that the driver should be able to apply a moderate amount only for effecting ordinary stops, while he kept in reserve a proper excess to be used only on emergencies, or on slippery rails. 6. Full brake application should not require more than a very moderate effort on the part of either driver or guard. 7. The pressure should be steady, and distributed as equally as possible over all the wheels, and, with the intervention of some elastic medium, should act upon the wheels in such a way as to prevent too sudden stopping or the snapping of chains, which produced discomfort and inconvenience to the public. 8. The machinery should be of simple construction, not likely soon to get out of order, and admitting of being easily repaired. 9. Indication should be constantly afforded to driver and guards that the brakes were in proper condition to work or otherwise. 10. The power of working the tender brakes and the van brakes by hand might be advantageously retained. 11. The brakes should be self-acting in case of the severance of the train. 12. Automatic action being provided, means should be furnished the brake attendants for modifying that action instantaneously, according to the circumstances in which the train might be placed after an accident. 13. It would be dangerous, and therefore unadvisable, to give to passengers any power over the brakes. Such seemed to be the principal conditions necessary for realising the conception of a perfect brake—a brake which would constitute an invaluable instrument in contingencies of almost daily occurrence at some place or another in the great railway network of the country.

REMARKABLE PLANTS

III.—The Sensitive Plant (*Mimosa pudica*).

In our ordinary popular conception of the difference between the two kingdoms into which the organic world is divided, we are apt to attribute to one a power of spontaneous motion dependent on the possession of a certain internal mental faculty to which we apply the term voluntary power; while a similar property is not considered to be inherent in the members of the other kingdom. The most recent researches throw, to say the least, considerable doubts on the universal applicability of this test to distinguish animals from plants. Now that the Desmidieæ and the Oscillatorieæ are, by universal consent, relegated to the vegetable kingdom, and that many bodies described by Ehrenberg as animals are found to be particular stages in the life-history of certain vegetable organisms, this character seems but to follow in the wake of others which have one by one been abandoned as absolute discriminating tests between the members of the two kingdoms. Among the more commonly-occurring and familiar movements of vegetable tissues, the dependence of which on external mechanical causes is at present but imperfectly understood, are those motions of the leaves and other parts of plants which are comprised under the common designation of Movements of Sensitiveness or Irritability. It has been well shown by Sachs[1] that these movements are of three different kinds, viz.:—

1. Those periodic movements which are produced entirely by internal causes, without the co-operation of any considerable external impulse of any kind. Such movements may be termed *automatic* or *spontaneous*,

[1] "Text-Book of Botany," English edition, Book III., chap. 5.

and are illustrated by the rhythmical movements of the small lateral leaflets of the trifoliolate leaf of the Indian "telegraph-plant," *Desmodium gyrans*.

2. Those apparently spontaneous motions of leaves and petals which are due to *alternations in the intensity of light and heat*, and therefore obviously to external causes. It is motions of this kind which give rise to the varying diurnal and nocturnal position of the leaves of some plants, and to the closing of certain flowers in the evening or in wet weather.

3. Those movements of foliage-leaves, or in certain cases of organs belonging to the flower, which are due to *sensitiveness to touch or concussion*. A familiar example of this class of movements is furnished by the well-known irritability of the leaves of the Sensitive Plant; and it is to this class that we propose to confine our attention in the present paper.

Two preliminary remarks may be made, which are applicable not only to the special class of movements now

Sensitive Plant (*Mimosa pudica*, D.C.).

under discussion, but also to the two others to which we have alluded above. All these three kinds of movements are manifested only when the parts in question are perfectly mature, and when the peculiarity of their internal structure, which renders the phenomenon possible, is fully developed. In this respect they afford a remarkable contrast to another class of movements exhibited only when the part of the plant is in active growth, of which we have illustrations in the singular phenomena of climbing stems and tendrils described in detail by Darwin in his "Movements and Habits of Climbing Plants." Another peculiarity common to all the three kinds of movements, and again distinguishing them from the movements of climbing plants, is that they belong entirely to the foliar or appendicular organs, *i.e.*, leaves in the wide botanical sense, as including foliage-leaves, sepals, petals, stamens, and carpels, and not in any case to axial structures or stems and branches.

With regard to the anatomical structure of the parts which exhibit the phenomena in question, it is seen that in almost all cases a mass of very succulent parenchyma (small-celled cellular tissue), several layers of cells in thickness, envelopes an axial or central fibro-vascular bundle, or a few such bundles running parallel to one another, these bundles not being sufficiently lignified to be hard, and therefore remaining flexible and extensible, and permitting the upward and downward flexions in which alone the movement generally consists; the whole is enveloped by an only feebly developed epidermis. The best known illustrations of these movements are furnished by the two species of "Sensitive Plant," *Mimosa pudica* and *sensitiva*, but are also exhibited by the leaves of several other *Mimosas*, and of species of *Oxalis*, *Robinia*, *Desmanthus*, and *Smithia*; by the stamens of several species of *Berberis* and of many Compositæ, and by the stigmas of *Mimulus*, *Martynia*, *Goldfussia*, *Stylidium*, and *Megaclinium*. The following account of the mechanical forces which set in motion the phenomena in question is taken mainly from the very laborious researches of Pfeffer.[1]

The very succulent parenchyma is, when the plant is in active growth, always in a very turgid condition; *i.e.*, the cells are absorbing sap freely through their permeable cell-walls by endosmotic force; and in so doing tend to stretch the axial bundle, as well as the epidermis which presents an opposing resistance. The sensitiveness or irritability resides entirely in the parenchyma, either on one or both sides of the fibro-vascular bundle. The irritability depends on a two-fold cause: firstly, the parenchymatous cells are perpetually absorbing water by endosmose, and thus placing the cell-walls in a state of tension; and secondly, a slight impulse imparted to the sensitive cells causes a portion of the absorbed fluid to be driven out through their cell-walls. The cause of the movement itself is believed by Pfeffer to be this: that at the moment when the turgid cells are giving off water, the elasticity of their tense cell-walls comes into play, causing them to contract in proportion to the amount of water expelled. Inasmuch as this water escapes into the intercellular spaces of the sensitive tissue, and from thence is partially transferred to other non-sensitive portions of the plant, the sensitive tissue decreases in volume, while the non-sensitive portion in some other part of the organ becomes correspondingly expanded, the epidermis of the sensitive portion at the same time contracting from its elasticity. This side therefore becomes concave, the other convex; and the sensitive organ in consequence bends, carrying with it whatever other organs it may bear, which therefore rise or fall according as the concavity of the curvature is on the upper or under side of the organ. Immediately after this has taken place the organ is no longer sensitive, the flaccid cells having too little turgidity to allow of the escape of any more water. But after a short time they again absorb water; their turgidity increases; their cell-walls become again stretched or tense; and the previous sensitive condition, as well as the original position of the parts, is again restored.

The following is Sachs' and Pfeffer's description of the anatomy of one of the common Sensitive Plants, *Mimosa pudica*. The leaf is bi-pinnate, consisting of a petiole from 4 to 6 centimetres long, with two pairs of secondary petioles 4 to 5 cm. in length, and on each of these from fifteen to twenty pairs of leaflets 5 to 10 millimetres long and 1·5 to 2 mm. broad. All these parts are connected with one another by the contractile organs described above; every leaflet is immediately attached to the rachis by such an organ from 0·4 to 0·6 mm. long, and this

[1] Pfeffer, Physiologische Untersuchungen, Leipzig, 1873.

again to the primary petiole by another similar organ from 2 to 3 mm. long and about 1 mm. thick. The base of the petiole itself is transformed into a nearly cylindrical contractile organ or "pulvinus," 4 to 5 mm. long and 2 to 2·5 mm. thick, furnished, like those of the secondary petioles, with a number of long stiff hairs on the under side, the upper side being only slightly hairy or entirely glabrous. The pulvinus consists of a succulent parenchymatous tissue of the kind already described. The cells of the under side are thin-walled, those of the upper side have walls about three times as thick. Each cell contains a moderate quantity of protoplasm, a nucleus, small grains of chlorophyll, starch, and, in addition, a large globular drop consisting of a concentrated solution of tannin surrounded by a pellicle.

A somewhat slight concussion of the whole plant causes the contractile organs of the primary petioles of all the leaves to curve downwards, those of the secondary petioles forwards, those of the leaflets forwards and upwards, closing like the wings of a butterfly at rest. After irritation the pulvinus is flaccid, and more flexible than before. A light touch on the hairs on the under side of the pulvinus of the primary and secondary petioles is sufficient to produce the movement; in those of the leaflets the lightest touch on the glabrous upper side. When the temperature is high and the air very damp, the irritability is much greater, and any local irritation incites movements in the neighbouring organs, often in all the leaves of a plant, a phenomenon which has been termed "conduction of irritation." If one of the uppermost leaflets is cut off by a pair of scissors, or its pulvinus touched, or if it is placed in the focus of a burning-glass, the irritation immediately takes place, and this irritation is communicated to the next lower pair of leaflets, and in succession to those at a greater distance; after a short time the leaflets of an adjoining secondary petiole begin to fold together from below upwards, and the same with the other secondary petioles; finally, and often after a considerable time, the primary petiole bends downwards; the phenomenon is then conducted to the primary petiole of the next leaf below, as well as to the next one above. It sometimes happens, however, that particular parts appear to be less susceptible, and do not display the phenomena in question until after they have been once passed by. If the plant is left to itself, the leaflets again expand, and the petioles reassume their erect position after a few minutes; the contractile organs are then again irritable.

That the phenomena of irritability are connected with a displacement of water from the succulent tissue and its replacement by air, is shown by the evident and immediate change in colour; the expulsion of the air from the intercellular spaces and its replacement by water causes the whole organ to assume a darker colour. If, moreover, one of the large contractile organs is cut or punctured, a drop of water immediately escapes from it, and if placed in water it again absorbs it eagerly. A variety of experiments by Sachs, Pfeffer, and Brücke also appear to prove conclusively that the sensitiveness resides in the under, and not in the upper side of the organ.

With regard to external conditions which interfere with the sensitiveness of the leaves of *Mimosa*, they become rigid or insensitive from cold when, the conditions being otherwise favourable, the temperature of the surrounding air remains for some hours below 15° C. (59° F.); the lower the temperature falls below this point, the more quickly does the rigidity set in. With regard to the upper limit, the leaves of the sensitive plant become rigid within an hour in damp air of 40° C. (104° F.), within half an hour in air of 45° C. (113° F.), in a few minutes in air of 49° or 50° C. (122° F.). In water the rigidity from cold sets in at a higher temperature, viz., in a quarter of an hour between 16° and 17° C. (62° F.), and the rigidity from heat at a lower temperature than in air, viz., in a quarter of an hour, between 36° and 40° C. A plant immersed in water of from 19° to 21°·5 C. remains sensitive for eighteen hours or more. The maximum degree of sensitiveness appears to be reached at 30° C. (86° C.), at which temperature the plant is so sensitive that the movement is communicated to a number of leaflets almost simultaneously. During the rigidity from heat, whether in air or water, the leaflets are closed, as after irritation, but the petiole is erect, and when irritated, turns downwards.

If placed in the dark, the irritability to touch is not at first affected, but disappears completely if the darkness lasts for a day or more; when again exposed to light, the sensitiveness is restored after some hours. The position of the parts is, however, very different from that in the insensitive condition caused by heat; the leaflets remain quite expanded, but the secondary petioles are directed downwards, and the primary petiole nearly horizontal. The same effects are caused, though in a less degree, when the supply of light is defective. M. Paul Bert states that the irritability of the leaves of *Mimosa* is destroyed by placing the plant under a bell-glass of green glass almost as completely as if placed in the dark; the plants were entirely killed in twelve days under blackened, in sixteen days under green glass; plants placed beneath white, red, yellow, violet, and blue glasses were still perfectly healthy and sensitive, though varying in the rapidity of their growth.

Drought also causes temporary rigidity. If a plant is left unwatered for a considerable time, the sensitiveness of the leaves perceptibly diminishes with the increasing dryness, and an almost complete rigidity ensues, the primary petiole assuming a horizontal position, and the leaflets expanding; watering the soil causes a return of the sensitiveness after two or three hours.

The same effect is produced if respiration is prevented by exhausting the air. If a plant of *Mimosa* is placed under the receiver of an air-pump and the air gradually exhausted, the leaves first of all fold up, no doubt in consequence of the concussion; but the leaflets then expand, the petiole becomes erect, and, while the leaves assume the same position as after prolonged withdrawal of light, they now remain rigid, resuming their sensitiveness when again brought into the air.

Finally, with regard to the effect of poisonous substances, J. B. Schnetzler has pointed out that the substances which destroy the contractility of animal sarcode also destroy the irritability of the leaves of *Mimosa* and other sensitive organs of plants. Curare has no prejudicial effect in either case, while nicotine, alcohol, and mineral acids destroy both. The vapour of chloroform causes transitory rigidity either in the expanded or in the folded position resulting from irritation.

The genus *Mimosa* is a very large one, forming, together with *Acacia*, the greater part of the sub-order Mimoseæ of Leguminosæ, and embracing about 200 species, natives mostly of tropical America, extending also south of the tropics, and into tropical Africa and the East Indies. They have definite stamens (not more than twice the number of petals), anthers not tipped by a gland, and a pod, the valves of which, when ripe, are either detached entire or break into transverse joints. They are mostly herbs, under-shrubs, or climbers; a few erect much-branched shrubs; one or two trees; a large number are spiny. It is only some of the species that are sensitive. *M. sensitiva*, which is also grown in our greenhouses, differs from *M. pudica* in the leaves having only two pairs of pinnæ, and each pinna only two pairs of ovate leaflets, the inner leaflet of the lower pair being always very small. *M. albida*, another sensitive species occasionally seen in hothouses, has elegant flower-heads of a pale pink colour. Our illustration of *M. pudica* is taken, by permission of Messrs. Longmans, from Thomé's "Textbook of Botany," English edition.

A. W. B.

NOTES

THE health of M. Leverrier is so far restored as to enable him to stay at Dieppe during the bathing season. Learning that he intended to travel for his health, the new Minister of Public Instruction offered M. Leverrier a special credit for expenses, on the ground that "it is the national interest to preserve a man who is an honour to the nation."

THE programme of excursions of the French Association has been published in the Havre papers. It includes visits to Fécamp, a town which is rich in memorials of William the Conqueror; to Villiers-sur-mer and Trouville, and to Balbec, Tancarville, and Lillebonne, where a Roman circus has been discovered; a visit to Havre and vicinity, and an excursion to Rouen and a visit to its manufactures and monuments. In his inaugural speech M. Broca, the president, will deal with the same subject as Prof. Allen Thomson at Plymouth. We regret to state that M. Kuhleman, who had been elected president for 1878 at Clermont-Ferrand, has resigned. The Association will have again to choose a president for 1878, and also for 1879; the latter will act as vice-president next year. According to a decision agreed to last year, the 1878 meeting will take place at Versailles during the International Exhibition, the rules not allowing any meeting to be held in Paris. The organisation of that exceptional meeting, and the measures for the reception of foreign members and associates, will require much consideration.

THE *Denver Tribune* of August 2 announces the arrival in that city of the Hayden scientific party, of which Dr. Hayden, Sir J. D. Hooker, Gen. Strachey, and Prof. Asa Gray form part. Southern Colorado had been explored, and the mountains above George-town and Berthoud's Pass, &c., were then to be visited, when the party were to move on to Utah, Nevada, and California.

PROF. WANKLYN has been elected to the chair of Chemistry and Physics of St. George's Hospital, vacated by the death of Dr. Noad, F.R.S.

THE official paper of the French Republic has gazetted the organisation of the jury and the scheme for distribution of awards for the forthcoming Universal Exhibition. Independently of works of art 100 great prizes and exceptional allocations in silver will be distributed by a special jury composed of the presidents of all the juries; 1,000 gold medals, 4,000 silver medals, 8,000 bronze medals, and 8,000 honourable mentions will be distributed by a number of class or sectional juries. The juries will be appointed by the several Governments in proportion to the number of exhibitors.

THE *Frigorifique*, fitted up for the transportation of meat on the Tellier system with methylic acid, has arrived at Havre, from Brazil, with its cargo in an excellent state of preservation. It is stated that a banquet of the meat will be served during the forthcoming session of the French Association at Havre.

MR. G. S. BOULGER, Professor of Natural History in the Cirencester College, reprints from the *Proceedings* of the Cotteswold Naturalists' Field Club, a pamphlet entitled "Notes Preliminary to a Proposed Flora of Gloucestershire." As the title implies, there is no attempt to arrive at an estimate of the vegetable productions of the county, and the publication would appear to have for its main object the inviting of information on the subject (addressed to Mr. Boulger at the Scientific Club, Savile Row) from those who have in any way worked at its flora.

THE last Annual Report of the Smithsonian Institution relating to the year 1875, contains much of great scientific importance. The institution continues to carry on, with admirable efficiency its two great classes of operations—1st, those relating to the immediate objects of the bequest, viz., the increase and diffusion of knowledge through researches, publications, and exchanges, and 2nd, those which pertain to the care and management of the Government collection in natural history and ethnology constituting the United States National Museum, of which the Institution is the custodian. Under the care of the institution this museum bids fair to become one of the finest in the world. During 1874 important meteorological researches were undertaken by the Institution, and its publications embrace valuable works in nearly all departments of science. Among the papers printed as an Appendix to the present Report, are Arago's Eulogy of Volta, De Candolle's Probable Future of the Human Race, Prof. Prestwich's inaugural lecture on the Past and Future of Geology (which appeared in NATURE at the time), a paper on the Refraction of Sound, by Mr. W. B. Taylor, a paper on an International Code of Ethnological Symbols, and Dr. Abbott's elaborate memoir on the Stone-Age in New Jersey.

SOME of our readers may be interested to know that the Ipswich Museum, under the curatorship of Dr. Taylor, contains a very fine collection of crag fossils. Prof. Ray Lankester, in a letter to a local paper, states his conviction, founded upon wide knowledge of such collections, "That the combination of Mr. Canham's collection with the valuable and unique specimens already presented to the museum by Mr. Alderman Packard, when mayor, and by other public-spirited men, has rendered the collection of crag fossils, shells, teeth, bones, box-stones, and clay nodules, by a long way the most complete in existence. I doubt," Prof. Lankester says, "if any other town possesses—certainly no English town does—so complete and valuable a series of specimens illustrative of its local geology."

PETERMANN'S *Mittheilungen* for September will contain a map of considerable interest at the present time, but also of the highest permanent value,—is a map of the region between and including Bulgaria, S.E. Servia, and the Balkans. This is the result of many journeys made by the author, F. Kanitz, between the years 1860 and 1875, and is accompanied with a detailed account of the results obtained. This same number will contain the conclusion of Güssfeldt's travels in the Arabian Desert, and of Polakowsky's paper on the Vegetation of Costa Rica.

THE *Bulletin* of the Paris Geographical Society for June contains a long paper by M. J. Dupuis on his journey in Yunnan.

COL. GORDON, Governor-General of Upper Egypt, has made a contract with Messrs. Yarrow and Co., of Poplar, for the construction of four very light draft steel steamers, for use on Lake Albert Nyanza, and for opening up the navigation of the rivers in Central Africa. These steamers will be carried on land on the backs of negroes, and consequently Messrs. Yarrow and Co. have to sub-divide the packages in such a manner that none shall exceed 200lb. weight. It is estimated that no less than 4,000 men will be employed for the porterage of these vessels.

WE have received No. 3 of *Appalachia*, the journal of the Appalachian Mountain Club, which contains several papers of general interest.

STANFORD'S Library Map of Africa, originally constructed by the late A. Keith Johnston, and of which a new edition is just out, is as fine a specimen of map construction as we have seen. The scale is so large as to admit of exhibiting minute features, and the map not too large to be hung on a wall. It is brought up to the latest date, which is saying a great deal in respect of Africa, and so far as we have tested it, shows everything that such a map ought to do.

OUR agricultural readers would do well to procure a circular issued by the Science and Art Department, South Kensington, giving directions for the collection and forwarding collections of wheat, barley, and oats, the growth of 1877, required to show the variations in quality existing in these descriptions of corn according to the circumstances and conditions influencing their growth. Such a collection is important both from a practical and a scientific point of view.

WE have received a very interesting catalogue of a collection of great interest to archæologists and collectors generally to be sold by Mr. Stevens, of King Street, Covent Garden, at the Alexandra Palace, on Tuesday and Wednesday next. This is the collection known as the Whitfield collection, containing many fine specimens of implements, weapons, ornaments, clothing, &c., from the South Sea Islands and other regions, as well as a number of natural history objects. Those of our readers wishing to form or to complete collections would do well to get a catalogue and attend the sale.

PROF. PIAZZI SMYTH, of the Royal Observatory, Edinburgh, writing to the *Scotsman* under date August 19, 4 P.M., states that in the twenty-seven hours elapsed since the 18th, at one o'clock P.M., the amount of rainfall was 1·349 inch—a greater amount than has been registered at Edinburgh before, within the same length of time, during the present year. "Twice only, on January 1 and July 16, did the day's record just rise above one inch; but each of those days was a Monday's record, summing up a forty-eight hour, in place of the usual twenty-four hour, interval. On each of these occasions, however, of undoubtedly heavy rainfall, as well as the present extra one, the direction of the wind was east. That is not an ordinary direction from which to expect rain, but when it does come from that quarter it has the characteristic, only recently ascertained, of producing a particular band in the prismatic spectrum of sky-light, by which its approach may often be usefully predicted, and by any and every private observer for themselves, even in cases where the barometer may fail."

AMONG the subjects on which papers are to be read during the present session at the Bradford Scientific Association, are—On Colour, by Henry Pocklington; The Structure of Stems, by Mr. J. Abbott; On Grasses, by Mr. W. West; Indigo, by Mr. Whittaker; Pyroxiline, by Mr. J. A. Douglas; Field Geology, by Mr. A. Crebbin.

THE Yorkshire Naturalists' Union paid a visit to Goole Moors recently, where they had a field-day and a general meeting, which appear to have been in all respects successful.

THE leading article in the August number of the *American Naturalist* is an exceedingly pungent address on "Catastophism and Evolution," by Clarence King, who treats the subject with animation and force. Both evolutionists and their opponents will read the article with interest.

WE have received from a Ceylon correspondent an interesting account of the Colombo Museum, which we regret being unable to publish in full. He also sends us a photograph of the museum, which, we believe, is the finest building in the island, not excepting Government House, indeed will compare favourably with similar buildings even at home. This is a work with which the name of Sir W. H. Gregory, who has just completed his term of government in the island of Ceylon, will always be associated. The colony has been increasing in wealth at an unprecedented rate during the last five years, and the governor has done his best to make the intellectual and moral elevation of the people equal their material prosperity. There are few countries where the aids of science are so necessary. There are few countries where those aids have been so greatly neglected. Sir Wm. Gregory saw this, and tried to give to the people themselves those tastes which alone could lead to the proper remedy. With this view the museum was built at Colombo, to be a sort of nucleus for the spread of general scientific education. The Colombo Museum occupies a commanding position in the Cinnamon Gardens, a favourite evening resort. The collection within is a very scanty one, as might be expected from an institution only five months old and in a place where a general taste for science has yet to be cultivated. Most important collections as yet relate to the history, antiquities, and superstitions of the island. A large room is filled with specimens of native manufacture. In the abundant vegetable wealth with which Ceylon has been favoured, the treasures that may lie hidden beneath in its rocks have been treated with comparative neglect. Very little has been done for its geology, as will be evident from a glance at the one glass-case devoted to specimens of Ceylon rocks. We trust, however, that in time a collection will be formed worthy of the building and the island. We ought not to omit mentioning that the museum contains a magnificent collection of snakes (Ceylon) by Mr. W. Ferguson, of Colombo. A catalogue would be of great service and might be made eminently instructive. We hope that the public of Ceylon will soon fill the empty shelves in token of their appreciation of the generosity shown by the Government in giving them a free museum.

WE are pleased to notice that the new building for the Peabody Museum of American Archæology and Ethnology is so far finished as to enable Mr. F. W. Putnam, the Director, to begin work there, and he has now removed the collections forming the Museum from Boylston Hall, where they have been in temporary quarters, to the upper rooms of the new building, which is located near the Zoological Museum, and will eventually form a part of one grand structure. The new Museum is fire-proof, and the building is only to be used for the purposes of the trust, viz., a museum and library (and lecture-rooms eventually) of Archæology and Ethnology. The present portion will cost, when cased, not far from 60,000 dols., and a building fund of 50,000 or 60,000 dols. will still be left for its completion. The original fund for the building was 65,000 dols., and it is proposed always to retain at least 50,000 dols. as a building fund for the future. The present building will supply the wants of the Museum probably for the next ten years. We are also interested to know that the collection of Peruvian articles, obtained about thirty years ago by Mr. John H. Blake, of Boston, and which has been consulted by so many writers on Peru, has just been presented to the Peabody Museum, and will form a valuable addition to the already large Peruvian collection given by the late Prof. Agassiz and his son Alexander.

DR. HORNSTEIN, of Prague, has communicated a paper to the Vienna Academy on the probable connection of the wind with the period of sun-spots. He shows that in Prague, as in Oxford, the average yearly direction of the wind, in the time of minimum to maximum sun-spots, progresses in the direction from south to west, and on the other hand, in the time from maximum to minimum sun-spots, it shows an opposite variation. Dr. Hornstein finds further, that the average wind-strength in Prague likewise exhibits a connection with the eleven-years' period of sun-spots, inasmuch as both phenomena reach their maxima and minima simultaneously. This research is based on 240,000 observations.

THE obvious importance of photography to explorers lends considerable interest to a new process devised by M. Deyrolle, in virtue of which the baggage of an explorer who might wish to carry 300 negative plates measuring 24 ctm. by 18, would only be increased by a weight of six kilogrammes, all included, instruments, plates, developers, and accessories. Glass plates are dispensed with, being replaced by paper coated with a layer of prepared wax, capable of bearing 75° without fusion. The paper is covered with sensitive collodion, prepared so as to retain its properties for two years or more. The development after impression is very simple; into a litre of water is put 20 grammes of citric acid, as much acetic acid, and 3 grammes of pyro-gallic acid; an atom of nitrate of silver is added. The negative is placed in this developer and left in it till the coloration of the image becomes sufficiently intense; then it is passed into a bath of hyposulphide of soda, then washed and dried between leaves of blotting paper. It is then proof against heat and moisture, and may be kept indefinitely in an album. The apparatus itself is so constructed as to be capable of remaining two days in water, even in sea water, without deterioration.

THE most important papers read at the meetings of the Kharkov Society of Naturalists during 1876 are:—"On the Mechanism of the Respiration of Birds," by N. Byeletsky; "On Respiration of Roots," by A. Zaykevich; two entomological papers on the province of Kharkov, by P. Ivanov and V. Yaroshevsky; "On the Arachnidæ *Areneæ*, and on the Conjunction of *Chlamydomonas pulvirulus* and *Stigloclonium*," by L. Reinhard; and the continuation of the "Flora of Ukraina" (*Compositeæ* to *Salsolaceæ*), by K. Gornitsky.

MR. THOMAS S. CAYZER, head-master of Queen Elizabeth's Hospital, Bristol, known as the author of one thousand arithmetical tests and of other approved school-books, has made a complete collection of the principal passages in Latin authors that refer to our island, and editing them with vocabulary and notes, is about to issue the volume through Messrs. Griffith and Farran, as a Latin reading-book, illustrated with many woodcuts and a map, under the title of "Britannia."

THE additicns to the Zoological Society's Gardens during the past week include a Slow Loris (*Nycticebus tardigradus*) from India and a Cape Hedgehog (*Erinaceus frontalis*) from West Africa, received in exchange; a Wedge-tailed Fruit Pigeon (*Treron sphenura*) from India, presented by Mr. A. H. Jamrach; an Egyptian Gazelle (*Gazella dorcas*) from Barbary, presented by Capt. J. Graham.

AN ALGERIAN INLAND SEA

AS our readers are aware several schemes have recently been before the public for the creation of an inland sea in North Africa, one of the most ambitious and most impracticable of these being the flooding of a great part of the Sahara. Another scheme which has engaged the attention of the French Government for some time is much more feasible and likely to be attended with good results. The Report of a Commission on the plan proposed by M. Roudaire for the creation of an inland Algerian sea was recently presented to the French Academy of Sciences by M. Favé, and as it contains several points of scientific interest, we propose to lay it before our readers.

Since the French domination was extended in the province of Constantine as far as the town of Biskra, the attention of several observers has been turned to the very marked depressions of the soil, which commence at about 50 kilometres to the south of Aurès, that is, to the border of the Sahara, and extending from east to west. M. Virlet d'Aoust supposed, in 1845, from the measurement of the slope of a river discharging into the Chott (or marshy lake) Mel-Rir, that the bottom of that chott must be below the level of the Mediterranean. In 1849 M. Dubocq, a mining engineer, proved, by a very numerous series of barometric observations, published in 1853, that singular anomaly, which Capt. Vuillemot confirmed in 1856. It was reserved to Capt. Roudaire, to render the fact incontestable and to determine the depth with almost complete accuracy.

After having taken for his starting-point the *embouchure* of one of the two small streams which fall into the sea at the bottom of the Gulf of Gabès, M. Roudaire traversed the steppe of Gabès, 46 metres high, then arrived at the depression of a chott the surface of which he estimated, at sight, at 5,000 square kilometres. He then reached, by crossing a second elevation of 45 metres, that of Kritz, the depression of the Chott Rharsa, situated to the east of the Chott Mel-Rir, from which it is separated only by two elevations of small height. These two slight elevations bound the Chott Asloudj, the surface of which does not exceed 80 square kilometres. The surface of the Chott Rharsa has been estimated at 1,350 square kilometres; that of the Chott Mel-Rir, which has been surrounded by a polygon of levelling, contains 6,700 square kilometres. The three basins which form the Chotts El Djerid, Rharsa, and Mel-Rir have not yet been surveyed in all directions; but M. Roudaire has concluded from various observations that the mean depth of the two Chotts Mel-Rir and Rharsa must not be below 24 metres. The small Chott El Asloudj, which is intermediate, has a mean depth of only from one to two metres, which makes him regard it as a slightly elevated barrier between the two great lakes. If it be admitted that this barrier could be pierced by a trench of suitable depth, and that the water of the sea were led from the Gulf of Gabès to the entrance of the Chott Rharsa, the sea would fill that chott, as also the Chott Mel-Rir, and the depth of water would be sufficient in the two lakes for the navigation of all vessels. Articles of commerce could be transported thence to all parts of the world without any re-embarkation.

Such is the starting-point of a project for an inland sea which M. Roudaire has had constantly in his mind during all his labours: he is confident that the execution is an easy matter, without allowing himself to be discouraged by any obstacle. The enterprise, supposing it to be realised, would certainly not present commercial advantages comparable in any respect to those resulting from the canalisation of the Isthmus of Suez. The products of Central Africa, transported by camels across the desert do not seem to be sufficiently abundant to furnish freight for a large number of vessels. There is no doubt, however, that if the products of Central Africa had no longer to bear the expense of so long a carriage by land, their price would be notably lowered and their consumption increased. But indeed it would be impossible to estimate the benefits which in the future would result from the creation of such an inland sea. Considerations of another kind leave no doubt, M. Favé thinks, as to the improvements which would result from an inland sea covering 13,230 square kilometres, from a clima'ic point of view and in relation to the fertility of the soil.

Prof. Tyndall was engaged for some years in determining the action which the vapour of water exercises upon radiant heat. He has proved that even with complete transparency to light, the vapour of water absorbs radiant heat to a very notable extent. The vapour of water possesses that absorbent property much more than the air with which it is mixed, in however small a proportion; and its absorbent power increases very nearly in proportion to its mass. Prof. Tyndall has not failed to bring out the influence which the invisible vapour of water contained in the air exercises upon temperature, both during day and night, and he has been able hence to draw immediate conclusions as to its influence upon the life of plant.. After having measured directly the quantity of heat absorbed by very minute quantities of vapour of water mixed with air in his experimental tubes, he feels authorised to speak thus:—"Considering the earth as a source of heat, it may be admitted as certain that at least 10 per cent. of the heat which it tends to radiate into space is intercepted by the first six feet of moist air which surrounds its surface." Prof. Tyndall hence draws this conclusion:—"The suppression, during a single night of summer, of the moisture contained in the atmosphere which covers England would be accompanied by the destruction of all the plants which frost kills."

It is not only the cold of night which is increased at the surface of the ground by the dryness of the air, but also the heat of day; so that the variations of temperature produced in twenty-four hours are sometimes very great and very prejudicial to the vegetation of a great number of plants. We may apply these considerations to the region of the chotts, where M. Roudaire, in his expedition of 1874-5, found heat of 25° (C.) during the day, and cold of 8° below zero during the night. After that we need not be longer surprised that the lands comprised between the slopes south of Aurès and the chotts produce very little, however favourable in themselves they may be to vegetation. If we admit with M. Roudaire, agreeing in this point with all explorers cf the chotts, that their cavities have at one time formed salt lakes, dried up gradually during the historic period, we shall obtain an explanation of the changes in the production of the soil of the province of Constantine, and of Tunis since the epoch of Roman domination, when the province of Africa was much more populous and much more fertile than at present.

M. Roudaire has sought to find results of observations from which he might conclude what would be the depth of the bed of water evaporated after the creation of the inland sea. He has found this information in the experiments made at the Bitter Lakes traversed by the Suez Canal. At the time of the filling-up of the Bitter Lakes, a waste-weir was constructed intended to regulate the introduction of the water of the Mediterranean. From July 7 to 14 the weir was wrought with only a small number of sluices raised, and the level of the lakes remained stationary. The introduction had been regulated to about 3,540,942 cubic metres, or, in round numbers, 4,000,000, cubic metres per day. This figure, then, gives the quantity of water absorbed by evaporation which, according to the extent of surface, produced a lowering of the level of from ·003 m. to ·0035 m. during twenty-four hours, and that in the hottest month of the year. All the observations made since that time have given essentially the same results, and we must admit, with the engineers of the Suez Company, a general mean of ·003 m. per day, or 1 m. per year. M. Roudaire has added, as a conclusion to be drawn from this bearing on his project:—"The basin of the chotts and the Isthmus of Suez being situated nearly under the same latitude, and possessing a climate absolutely analogous, we must admit that the evaporation which will be produced on the inland sea will be the same as that which has been observed on the Bitter Lakes. The figure ·003 m. is the general mean of the year. The observations which we have made in the chotts with Piche's evaporometer have proved to us that this figure is at least doubled during the sirocco."

Not only would the vapour of water thus diffused through the air serve as a reservoir for the heat emanating from the earth or the sun, but it would have still another mode of action for effecting climatic modifications. The air and its vapour brought into contact with the elevated and therefore cool parts, the Aurès mountains, and other mountains of Algeria, would have their temperature lowered on account of that cause, and the effect would be increased by the radiation of the vapour of water into space; for that radiation would operate almost without check at a height where the air from above, and therefore less dense, is cold and dry. Under the influence of this double cause the moisture would be condensed into rain or snow, and would serve to feed the watercourses which would permanently flow in the beds at present dry during a great part of the year. We should see issuing from the ground, from the same cause, sources which do not now exist. The moisture, discharging itself along the lines of watercourses, would extend its influence on the two slopes of the mountains to countries at a distance from the chotts. We can perceive by calculations the volume and the weight of the masses of water set in motion by evaporation, that these considerations are not chimerical. The 13,230 square kilometres give 39,690,000,000 kilogrammes of water per twenty-four hours, raised by evaporation, *i.e.*, 39,690,000 cubic metres. It will be seen that there is here something to form sources and feed streams or rivers. M. Roudaire has calculated that the quantity of vapour diffused in air whose barometric pressure is ·760 m., and the temperature 12° C., would cover the surface of Tunis and Algeria with a layer of half-saturated air, 24 metres in height. Let us remark that this calculation includes only the quantity of vapour formed during twenty-four hours. The south wind known as the *sirocco*, at present so destructive because it is exceedingly dry, would produce on the surface of the lakes an evaporation much greater than that mean, and would, moreover, lose many of its hurtful effects. In fact, this same wind, which destroys the vegetation of Algeria, has a fertilising influence on the territory of France, because of the moisture with which it becomes charged in crossing the Mediterranean.

Advantages so considerable, which would result from the introduction of the water of the sea into the chotts, explain and justify the perseverance with which M. Roudaire has pursued the idea without allowing himself to be arrested by any of the difficulties which have presented themselves. The greatest of the difficulties, M. Favé thinks, proceeds from the fact that the Chott El-Djerid, the nearest to the Gulf of Gabès, has not, like the others, the bottom of its basin below, but above, the level of the sea. The surface of the ground is undulating; it rises to 20 metres, or even more, at certain points, and descends to zero at other points. M. Roudaire has estimated, somewhat vaguely, that the mean height of the bottom may be about 6 metres above sea-level. Notwithstanding this obstacle, M. Roudaire does not renounce the hope of being able to make the water of the sea reach the Chott El-Djerid in order to turn it afterwards into the other two chotts. He believes he has found a support for this in the nature of the bottom, or, to speak more exactly, in the existence of a water-bearing bed situated at a small depth below the ground.

The Commission, of which M. Favé is the mouthpiece, without pronouncing definitely on the project of M. Roudaire, sufficient data for this not being forthcoming, strongly recommend that active steps be taken to obtain more accurate measurements and other data. The facts which he has adduced they think sufficient to justify serious attention being paid to his proposal, and recommend that the thanks of the Academy be accorded to M. Roudaire for his valuable labours. To these recommendations the Academy agreed.

We should state, however, that MM. Dumas and Daubrée, members of the Commission, are not able to give their entire consent to the recommendation of M. Favé's report. They think that the obstacles to the accomplishment of the scheme are much more serious than have been estimated, and regard the industrial and climatic results anticipated as, to a considerable extent, hypothetical. M. de Lesseps, however, gives his entire concurrence to the scheme of M. Roudaire, and believes in its practicability and the favourable results that would follow its realisation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

SCIENCE AND ART DEPARTMENT.—The Committee of Council on Education have just issued an important circular on instruction in practical chemistry and in physics. My Lords direct that §§ XLV. and LXXI. of the Science Directory be cancelled and that the following rules be substituted:—1. Payments of 1*l*. 10*s*. and 1*l*. for the first and second class in the elementary stage, and of 4*l*. and 3*l*. for the first and second class in the advanced stage and honours, will be made on the results of instruction in practical chemistry. They will be claimable according to the same rules, and subject to the same deductions on account of previous success as the ordinary payments. These payments will be made on condition—(*a*) That there be a good laboratory—being a room, or part of a room, exclusively devoted to the purpose of the study of practical chemistry—properly fitted with gas and water supply. (*b*) That the student on whom the payment be claimed have received twenty-five lessons at least in laboratory practice since his last examination, each lesson being an attendance of at least one hour and a half's duration on a separate day. (*c*) That a register of the attendance of the students at the instruction in practical chemistry be kept duly posted up from day to day. 2. *Elementary Stage.*—In this stage the knowledge of the students will be tested by special questions set with the ordinary examination paper; but no payments will be made if the laboratory be not furnished with all the apparatus necessary for the individual practice of each student in practical chemistry, and if systematic instruction in practical chemistry be not given. Any student on whom it is intended to claim payments in this stage may be called on by the Inspector of the Department, when visiting the laboratory, to repeat some of the experiments, specified in the Science Directory in the syllabus for the first stage of inorganic chemistry, which he has had an opportunity of witnessing. 3. *Advanced Stoge and Honours.*—The results of the instruction in these stages will be tested by a special examination in qualitative analysis to be held on a Saturday during the ordinary May examinations, and lasting, for the advanced stage from 6 P.M. to 10 P.M., and for honours from 2 P.M. to 10 P.M. Payments can only be claimed in these stages provided—(*a*) That the laboratory be fitted up with a separate working place for each student. (*b*) That each student be provided with a complete set of apparatus and chemical tests (as enumerated in Science Form No. 402) kept separate, and in good working order, on the shelves, and in the cupboard or drawers at his own table. (*c*) That the laboratory be also furnished with apparatus for general use, consisting of at least the articles of which a list will be found on Science Form No. 402. From the reports of the examiners and of the inspectors it appears that instruction still continues to be given in physics without a sufficient amount of apparatus to illustrate the teaching of these experimental sciences. My Lords cannot allow examinations to be held in schools where instructions of such a superficial and perfunctory nature is given. They therefore direct that in 1878 no classes be examined which are not furnished with apparatus at least sufficient to illustrate some of the more important experiments; which apparatus the teacher may be called upon by the Inspector of the Department to show his ability to use.

Bristol.—From the prospectus for session 1877-78 of University College we are glad to see that that institution is rapidly attaining a position to afford a complete education both in literature and science. The chairs of chemistry, experimental physics, and botany are now filled up, and as the other branches of physical science are down in the programme of the coming session, no doubt professors for them will soon be appointed. The medical school in connection with the University is now fully organised, and we are confident that ere very long Bristol will become one of the chief centres of University education in the kingdom. A very satisfactory report has been presented to the London Clothworkers' Company on the chair of Technical Education founded by funds provided by them.

A Northern University.—At a recent meeting of the Leeds Town Council a deputation from the Yorkshire College of Science waited upon them to urge them to take steps to obtain Government sanction to found a university for the northern counties of England. This step was undertaken in consequence of the action of Owens College to obtain a charter for the erection of that institution into a university. The Leeds Town Council drew up a memorial to the Privy Council, in accordance with the prayer of the petition, and the Parliamentary Committee was instructed to watch the further progress of the matter.

Sydney.—The University of Sydney has applied to the Colonial Government for an increase of endowment from 5,000*l.* to 9,000*l.* With this increased income the university would add, among other subjects, to its present course, all the education necessary for the medical profession, a complete course of natural philosophy, coupled with mechanics and engineering, the addition of organic chemistry and metallurgy to the chemical school, and biology. The salaries attached to these chairs would be 1,000*l.*, with assistants at 250*l.* each. The proposal is still under the consideration of the government, but we cannot doubt, if they have the best interests of the Colony at heart, they will grant the petition of the University.

SCIENTIFIC SERIALS

American Journal of Science and Arts, July.—Contributions to meteorology, being results derived from an examination of the United States Weather Maps and other sources, by E. Loomis.—Germination of the genus *Megarrhiza*, Torr, by A. Gray.—The absorption of bases by the soil, by H. P. Armsby.—Double-star discoveries with the 18½-inch Chicago refractor, by S. W. Burnham.—Relations of the geology of Vermont to that of Berkshire, J. D. Dana.—On certain new and powerful means of rendering visible the latent photographic image, by M. Carey Lea.—On the possibility of transit observation without personal error, by S. P. Langley.—Observations of comets made at the Litchfield Observatory of Hamilton College, by C. H. F. Peters.—On complex inorganic acids, by W. Gibbs.

Annalen der Physik und Chemie, No. 6, 1877.—On the electric currents which arise in the flow of liquids through tubes, by M. Edlund.—On metallic reflection, by M. Eisenlohr.—Contributions to an adequate determination of the plane of vibration of polarised light, by M. Ketteler.—On electric induction on non-conducting solid bodies, by M. Wüllner.—On the thermo-electric properties of gypsum, diopside, orthoclase, albite, and pericline, by M. Hankel.—On the magnetic behaviour of nickel and cobalt, by M. Hankel.—On the relation of friction of gases to temperature, by M. Puluj.—On electric smoke figures, by M. Antolik.—Apparatus for determination of the focal distance of spherical lenses and lens systems, by M. Meyerstein.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, t. xxiii., No. 4.—Eighty-six silver coins with Pehlewy inscriptions, by M. Dorn.—Observations of planets at the Academic Observatory of St. Petersburg; determination of the inclination of the orbit of the planet Neptune to the ecliptic, by M. Sawitsch.—Influence of depressor nerves on the quantity of the lymph, by M. Velıky.—Influence of temperature on the galvanic resistance of Siemens wires, by M. Lenz.

Archives des Sciences Physiques et Naturelles, July.—Cretaceous fauna of the Rocky Mountains, by M. Delafontaine.—On chemical equivalents and atomic weights as bases of a system of notation, by M. Marignac.—Observations on some fossil plants of South Tessin and on the deposits which contain them, *àpropos* of the glacial controversy, by M. Sordelli.—On the relations between the intensity of irritation of the sciatic nerve, the height of the muscular contractions, and the time elapsing between irritation and contraction, by M. Lautenbach.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti. Vol. x. Fasc. VII.—Two new parasitic mycetes on vines, by M. Cattared.—On a cause little estimated in pathogenesis of some female diseases, by M. de Giovanni.—The molecular velocity of gas and the corresponding velocity of sound, by M. Brusotti.

Fasc. XII.-XIV.—On more economical composition of electromotors capable of a given effect, by M. Ferrini.—Experimental researches on heterogenesis (second paper), by MM. Cantoni and Maggi.—On the existence of monera in Italy, by M. Maggi.—On a particular reaction of saliva, by M. Solera.—On the state of sulphur in milk and on the normal existence, in vaccine milk, of sulphates and sulphocyanates, by M. Masso.—On a Selachian recently caught in the Mediterranean, by M. Pavesi.—On a new differential function in the theory of elliptic functions, by M. Brioschi.—On differential equations, by M. Casorati.—Quali-quantitative researches on carbonic anhydride, by M. Pollacci.—*Résumé* of meteorological observations at Milan in the Brera Observatory in 1876, by M. Frisiani, jun.

SOCIETIES AND ACADEMIES

London

Royal Society, June 21.—"The Relationships of the Nerve-cells of the Cortex to the Lymphatic System of the Brain." By Bevan Lewis, F.R.M.S., Pathologist and Assistant Medical Officer at the West Riding Asylum. (Communicated by Dr. Ferrier, F.R.S.)

The anatomical relationships of the nerve-cells of the cortex to their immediate environment, and especially to the surrounding lymphatic structures, is a subject of such weighty importance to the pathologist and physiologist that too much consideration cannot well be paid to what must necessarily be involved in the solution of those mysterious problems connected with the statics and dynamics of the brain. The author of this paper has detailed the results of personal investigations, in which he has been able to confirm the observations of Obersteiner.[1] He alludes to the confusion on this subject traceable in the writings of several English histologists, some of whom, whilst recognising the existence of peri-cellular spaces, do not attempt an explanation of their significance, others openly express their dubiousness with regard to their import, whilst a limited class regard them as morbid productions due to the atrophy and shrinking of the nerve-cell. His attention was first attracted to their significance by (*a*) "the presence in certain morbid conditions of numerous nuclei arranged in definite directions around the nerve-cell, (*b*) the presence of undoubted lymph-corpuscles in clear spaces around the nerve-cells, and (*c*) the appearance of peri-cellular spaces in healthy brain occasionally when the cells appeared perfectly normal, and certainly not atrophic."

This disposition of nuclei (*a*) is most strikingly evident around the nerve-cells of the third layer, and around the still larger cells found at a lower level in the ascending frontal and parietal convolutions of man which have been termed "giant-cells." These "giant-cells," the hypertrophied cells of some writers, are stated by Mr. Lewis to be undoubtedly *normal*, and to a great extent *constant*, elements in these regions. In order to appreciate the significance of this arrangement of nuclei, the non-nervous elements of the cortex are considered, allusion being made to the proliferation of connective elements so frequently met with. These latter are shown not to be *free* nuclei, but to have a delicate investment of protoplasm around them. The non-nervous cellular or nuclear elements are described as disposed in three definite situations: (*a*) irregularly in the neuroglia network; (*b*) regularly around the nerve-cells; (*c*) following directly the course of capillaries.

In the two last positions they are shown to be connected with the lymphatic channels and sacs surrounding the blood-vessels and nerve-cells, and the author regards them as originating in the endothelial elements of these structures. The spindle-cells of the deepest cortical layer in the frontal region are said to be peculiarly prone to the growth around them of these attendant satellites. He continues: "The recognition of these

[1] "Ueber einige Lymphräume im Gehirne" (Sitzb. d. k. Akad. d Wissensch. 1 Abth., Jan. Heft, 1870).

connective and endothelial elements, and the varying conditions imposed upon them by their distinct functional endowments is of essential import when we are dealing with the morbid brain." The peri-cellular sac is then described fully, as well as its varied contour dependent upon the form of the inclosed cell, method of preparation, thinness of section, and the various physiological and pathological conditions existing before death. The close proximity of a capillary to these sacs was invariably observed, and on close examination a connection betwixt the peri-vascular and peri-cellular sheaths was clearly seen. Sections of the cortex in new-born animals were then described, in which a linear arrangement of the cells along the peri-vascular sheaths was observed, each nerve-cell being separated by a clear space from the surrounding neuroglia, the peri-vascular sheaths in the kitten being widely distended. The nerve-cells in these cases were pyriform, and apparently connected to their limiting sacs by a narrow stalk-like process. The writer next dwells briefly upon the developmental bearing of these facts. With regard to the explanation afforded by some observers of the significance of these spaces in senile atrophy, it is shown that whilst the large size and defined contour may be due to shrinking of the degenerated protoplasm of the nerve-cell, "yet the important point is to recognise these spaces as natural structures in an unnaturally distended condition, for their large size appears to me to be due not only to wasting and recession of the inclosed cell, but to a large accumulation of lymph, the lymphatic channels, peri-cellular and peri-vascular, being in a distended condition throughout." It is next shown how readily the lymph current may be obstructed in its flow towards the pia-mater, and how seriously such conditions would affect the nutritive and depurative changes proceeding in the lymph-sac—changes of so vital an importance in the maintenance of the functional activity of nerve-cells. The methods employed in this investigation by Mr. Lewis, include ordinary chrome hardening, the teasing process described by him in the *Monthly Microscopical Journal*, and the examination of films of cortex obtained by his new freezing microtome. His paper is illustrated by six drawings of the microscopic structure of the cortex.

PARIS

Academy of Sciences, August 13.—M. Peligot in the chair.—The following papers were read:—Communication from the Bureau des Longitudes on new operations of astronomical geodesy, by M. Faye. This relates to the astronomico-telegraphic junction of Paris with Neuchatel, Geneva, and Lyons.—Engraving representing the aureola of Venus as seen from the Island of St. Paul, by M. Mouchez. The phenomena is given at three different stages.—A general law of geometric curves concerning the common intervention of each point of a curve and the tangent of this point, in questions of geometrical positions or enveloping curves, by M. Chasles.—New considerations on the localisation of cerebral centres regulating the co-ordinated movements of written language and articulated language (continued) by M. Bouillaud. He replies to some recent objections by Dr. Fournié against localisation of speech in the left cerebral hemisphere.—On the reproduction, by photography, of the rice-grains of the solar surface, by M. Janssen. He has succeeded in this in his solar photographs of thirty centimetres by means of a very short exposure, combined with strong development.—On an example of reduction of Abelian integrals with elliptic functions (continued), by Mr. Cayley.—On the best conditions of employment of galvanometers, by M. du Moncel. He gives an experimental verification of some mathematical deductions.—Note on the central obturator inflamer, by M. Cosson. The state of dryness of the powder seems to have (other things equal) an exceptional importance for the author's apparatus. The Pyrenees mark the true line of separation between the eocene and miocene portions of the tertiary epoch, by M. Leymerie.—A message of sympathy was sent to M. de Lesseps on account of his recent accident.—The system of Sirius, by M. Flammarion. The orbit calculated for the companion of Sirius differs from the orbit observed; the latter crossed the former in 1869 (having left it in 1862) and going beyond it, has followed quite a different curve, wider and less eccentric. M. Flammarion supposes that either the companion will accelerate its motion and return to the west in 1892, or that there is another disturbing body nearer and more rapid, not yet discovered.—Remarks, *à propos* of M. Faye's communication on the relation between the sun-spots and variation of the magnetic declination, by M. Wolf. The anomalies of the one class of phenomena are reproduced in the other, a strong evidence that both are produced by the same cause.—On the equation of Riccati, by M. Genocchi.—Note on the curves which have the same principal normals, by M. Niewenglowski.—On the slipping (*patinage*) of the wheels of locomotives, by M. Rabeuf. The phenomenon is much more general and complex (he finds) than is commonly supposed. The slipping is almost *nil* in ascending an incline, and very pronounced in descending. It increases rapidly with the speed, but appears to be greater, with equal velocity, on descents than on ascents. In descents it varies between 13 and 25 per cent. Its suppression, if possible, would realise a corresponding economy in fuel and wear of machinery.—The *régime* of the winds, and evaporation in the region of the Algerian chotts, by M. Angot. It is shown from figures that the winds favourable to M. Roudaire's project (viz., south, south-west and south-east) are to the unfavourable winds in the ratio of 1 to 9·4. Their vapours would be almost wholly carried towards Sahara instead of Algeria. The average layer of water estimated as removed in twenty-four hours from the projected sea is about 6 mm. This would raise to seventy-eight millions of cubic metres the quantity required to be brought by the canal of communication daily to keep the lake-level constant.—On the vapour of hydrate of chloral, by M. Troost. A second method (for determining equivalent in volume) consists in first vaporising hydrate of chloral, then introducing into the vapour a body capable of removing part of the free vapour of water it may contain (pure neutral oxalate of potash was used completely dehydrated in a stove at 100°). This method led to the same conclusion as the first, viz., that hydrate of chloral exists in the gaseous state, and so that its equivalent corresponds to eight volumes.—Note on some properties of sulphide of cadmium, by M. Ditte.—On some general properties of metallic sulphides, by MM. de Clermont and Guiot. The decomposition (here proved) of sulphides by water at 100° with formation of metallic oxide and sulphuretted hydrogen, is thought a fresh reason for regarding hydrogen as a metal; it displaces true metals in these reactions, and forms a more stable sulphuretted compound.—On some points of the organisation of Bryozoa, by M. Joliet.—On the fecundation of Echinoderms, by M. Giord.—Pyrophosphates in therapeutics; their mode of action, by MM. Pacquelin and Joly. Pyrophosphates, far from being reconstitutive, as commonly supposed, are purely foreign bodies for the system, and their ingestion can only increase its expenditure in the work of elimination, which their presence necessitates. Any reconstitutive value attached to them is probably due to impurities.—On the physiological action of Pau Pereiro (*Geissosperrmun lœve*, Baillon), by MM. Bochefontaine and De Freitas. The active principle is a paralysing poison, which appears to abolish the physiological properties of the central grey nervous substance, and especially of the grey bulbo-medullary axis.—On anthracic *bacteridies*, by M. Toussaint.

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