THURSDAY, JANUARY 15, 1885

THE EARTHQUAKES IN SPAIN

EVEN the most conservative believer in the stability of Mother Earth must by this time have had his faith sorely shaken. Year after year, and month after month, we receive tidings of more or less serious shakings, varying from slight movements, such as merely set bells ringing and disturb the crockery on kitchen-shelves, to such shocks as convulse wide districts and bring with them disaster to life and limb as well as destruction to property. As if these tangible proofs of insecurity were not enough, we have learnt further that what we have been in the habit of dignifying with the name of the "solid" earth is really in a state of perpetual tremor. The thud of falling rain-drops, the patter of birds' feet, the tread of cattle, the gambols of children, so affect the ground on which we walk that the vibrations which they cause in it can be made clearly audible by the microphone and visible by the galvanometer. The position of the sun in the sky, the rise and fall of the tides, the thermometrical and barometrical oscillations of the atmosphere, produce in the outer parts of the earth corresponding pulsations, which, though not always certainly referable to their originating source, are perfectly recognisable, and can be registered by sufficiently delicate instruments. So that, instead of being on the whole a motionless, inert mass, the land is, in its way, almost as restless as the sea.

Fortunately, we are not sensible of these daily and hourly vibrations. It is only from time to time, by the news of earthquake-shocks from different quarters of the globe, that our attention is vividly drawn to the subject, and we are made to realise how little right we have to count on the continued stability of our own district. The daily tidings from the south of Spain, coming after so many recent chronicles of earthquake disaster in Europe, cannot but recall our thoughts to this subject. When the peace and goodwill of Christmas-tide were once more brightening the close of the year all over Christendom, the inhabitants of a wide tract of Andalusia were suddenly thrown into consternation by a succession of powerful earthquakes. The district most severely visited lies in the province of Granada and Malaga, and forms a parallelogram measuring about 70 miles from east to west and about 35 from north to south. The eastern part of the affected district passes into the great range of the Sierra Nevada, of which the highest peaks rise between 11,000 and 12,000 feet above the sea. Westwards, this range throws off some minor spurs, particularly the Sierras Tejada and Alhama, which curve round towards the north-west. The chief mass of the Sierras consists of crystalline schists stretching east and west, and flanked with Tertiary strata, from beneath which various Jurassic and other Secondary rocks emerge. The area of maximum destruction appears to be among the Western Sierras, and on the ground to the south and north of them.

The greatest amount of damage has been done at Alhama, which is almost entirely ruined. This little town stands nearly on the junction of the Tertiary rocks with the schists that rise into the more rugged ground of the mountains. A little to the south-east Abunuelas has also suffered severely. From that central area the shocks seem to have lessened outwards, but to have been felt most along the northern and southern flanks of the Sierras. According to one account the shocks have indicated earth-waves from south to north, with return movements in the contrary direction. Not improbably the actual focus of disturbance lies along the axis of the Sierras Alhama and Tejada. But the shocks have been felt over a much wider area. They have extended along the line of the mountains at least as far as Gibraltar in the west, though they are not recorded as having been marked in an easterly direction. Northwards, the towns and villages lying nearest to the centre of commotion have suffered most—Antequera, Loja, Granada. But far beyond these districts, terror was occasioned to the people of Cordova, Cadiz, and Seville, and the first shock was felt even at Madrid. No sea-wave has been chronicled as having affected any part of the coast, whence we may reasonably conclude that the earthquakes have not originated under the sea.

The Spanish peninsula has long had an evil reputation for the frequency, destructiveness, and long continuance of its earthquakes. In the present case the shocks are said to have begun three days before Christmas; but the first destructive wave arose on Christmas day. Since that date there has been an almost daily continuance of shocks of varying intensity. Such was also the case in the summer of 1863 along the great range of Sierras from Malaga to Alicante, and still earlier, in 1849, the same district continued to vibrate for several months.

Unfortunately, no accurate registers have been kept of these earth-tremors. Observations on earthquake phenomena made after the event, though useful so far, are now recognised as altogether insufficient to enable us to solve the problems presented by this interesting, but difficult, branch of geological physics. The establishment of self-registering apparatus, which was temporarily assisted many years ago by the British Association in the case of the simple instruments set up at Comrie in Perthshire, and which, more perfectly developed in Italy, has recently been so well inaugurated in Japan by Profs. Milne and Ewing, is the only satisfactory method of accumulating the necessary data. Until facts thus chronicled have been patiently gathered for some years in regions widely separated from each other, alike in distance and in geological structure, seismology must be content to remain very much at a stand. Of course, speculation will be as rife as ever, but cautious men of science will probably withhold their judgment until they are in possession of data of a kind that has not yet been systematically observed and registered.

But even before these data are gathered for the region of Andalusia, we can hardly doubt that fundamentally the shocks so often felt there arise from the process of mountain-making. The vibrations are propagated along the Sierras, and are felt with most violence near their flanks. They are probably in some way connected with the movements of the terrestrial crust that first started and have successively upraised the long parallel lines of mountainous ridge that diversify the surface of the Spanish tableland. Among the questions awaiting investigation is whether any perceptible effect on the height and form of a mountain chain can be detected after its flanks have been convulsed with earthquakes; whether its rocks have been more tilted or folded or fractured. Men are usually too overwhelmed by the losses to life and property to take heed of such matters as these, and it may seem almost cold-blooded to suggest them for practical consideration. In all mountain districts much subject to earthquakes, it would be desirable to have an accurate system of levelling carried out, so that after a time of disturbance the heights could be checked. It would also be useful to have numerous photographs of cliffs and other sections where the rocks are well exposed, and where, therefore, any change of inclination, even to a slight extent, could be ascertained and measured. In regions where, as in the Karst, the earthquakes probably arise from the giving way of the roofs of underground tunnels or caverns, likewise in volcanic districts, the precautions here suggested might be of little use. But in those tracts where mountain-making is probably still in progress, they might supply us with many suggestive facts.

There is one other feature in the present Andalusian earthquakes to which allusion should be made. It has often been asserted and often denied that the occurrence of earthquakes is connected with the state of the atmosphere at the time. There certainly seems no doubt that in Europe, at least, the crust of the earth is considerably more convulsed by earthquakes in winter than in summer. When the shock of December 25th struck terror into the provinces of Malaga and Granada, the barometer, which a fortnight before had been remarkably steady, was exceptionally low and variable. Mr. George Higgin, of Broadway Chambers, Westminster, sends us an extract from a letter received by him from one of his engineers at Albox, in the valley of the River Almanzora, province of Almeria, not far to the eastward of the scene of disturbance. The writer, who was still unaware that there had been any earthquake, states that after December 19th a severe gale sprang up, lasting four days; the barometer varied from 29·28 on December 19th to 28·52 on the 27th, and continued to oscillate to such an extent that no trustworthy levellings could be made with it. A correspondent of the *Times*, writing on Sunday last, also mentions the low state of the barometer, and that the severest and greatest number of shocks continues to be felt from 5 p.m. till 5 a.m., and that since the outset, at intervals of about a week, the movement has shown a recrudescence with each return.

There has been also the usual chronicle of secondary effects from the earthquake shocks. Landslips have occurred, with the consequent disturbance of drainage. In one place a village has slid northwards about sixty feet, leaving a deep semicircular crevasse where it previously stood. The displaced ground has intercepted the course of an adjacent stream, so that a lake is forming behind the obstruction. At Periana a mass of rock and earth, disengaged from the slopes above, is said to have demolished a church and 750 houses. Among the numerous sulphur-springs of the region there has been considerable disturbance. Some of these sources, as has often been observed at Vesuvius and elsewhere, disappeared after the first shock, but in a day or two afterwards began to flow again at a higher temperature than before.

THE STABILITY OF SHIPS

A Treatise on the Stability of Ships. By Sir E. J. Reed, K.C.B., F.R.S., M.P. (London: C. Griffin and Co., 1885.)

THE stability of ships is a subject that has attracted considerable attention of late. Many disasters have happened to ships through insufficient stability, and have caused scientific men as well as practical naval architects to apply themselves to a renewed and close investigation of the subject. The result is that the ideas which till late prevailed respecting it are seen to be often superficial and incomplete, and in some cases not entirely free from error.

Sir Edward Reed has done good service in bringing out a treatise upon stability which presents the matter in a fresh, readable, and instructive form. Singularly enough this is the only work in the English language which attempts to deal exhaustively with it. Notwithstanding the magnitude and complexity of the subject, and its vast importance to all who are responsible for the wise design and safe management of ships, its treatment has previously been of a very restricted and imperfect character. The student of naval science has required to consult works which range over the wide field of naval architecture, and numerous papers that lie entombed in the published proceedings of learned societies, in order to acquire anything approaching a comprehensive knowledge of the problem of stability. Sir Edward Reed has brought together and placed into relation to each other the investigations made at various times by eminent men of the science of the subject, and the practical developments which have resulted therefrom. Among these are included the researches of French mathematicians and naval constructors, which have hitherto been but little known in this country.

The statement that a floating body, such as a ship, when laden so as to float at a given draught of water may assume any position—upright, inclined, or upside down—or it may when floating upright and in equilibrium be capsized with ease or with difficulty, according to the character or degree of the stability it may possess is the veriest scientific truism. Many may suppose it to be unnecessary, in this shipbuilding country, to make so self-evident an observation. Yet trite and obvious as it may appear when put into this form, it has been strangely, almost culpably, ignored by many who are responsible for the safety of ships. Very few exact investigations of the stability of individual ships have been made till quite recently; and even those that were attempted have frequently been imperfect and inconclusive.

The correct principles upon which the stability of ships depends were not demonstrated till the middle of the last century. Bouguer explained the properties of the metacentre in 1746, and gave a formula by which its position may be calculated. He also showed how the initial stiffness, and height of centre of gravity, of a ship may be determined by a practical experiment; this being the method of inclining vessels which is at length becoming usual in this country. Bouguer's investigations were followed up and extended by D. Bernouilli and Euler; and it was shown how the righting moments at large angles of inclination from the upright may be determined.

Atwood brought forward the subject clearly and forcibly and at considerable length, in two papers read before the Royal Society in 1796 and 1798. He laid down the fundamental formula by which the length of the arm of the righting or upsetting couple may be determined for any angle of inclination of a ship; and he showed how the several terms contained in it may be calculated. Two of these terms, viz. the volumes of the wedges of immersion and emersion, and the positions of their centres of gravity, involved very lengthy and complicated calculations. The tediousness and complexity of stability investigations have been chiefly caused by the difficulties connected with finding by actual measurement and calculation the solid contents of these wedges and the positions of their centre of gravity.

Let Fig. 1 represent the transverse section of a ship, of which W L is the line in which the plane of flotation, when the ship is upright, is cut by the plane of the paper; the centre of gravity of the whole ship being at G. Let B similarly represent the centre of gravity of the volume of the ship's displacement, or centre of buoyancy, as it is commonly called. Now, suppose the ship to be inclined a few degrees by some external force that acts horizontally, and therefore does not alter the displacement; and let

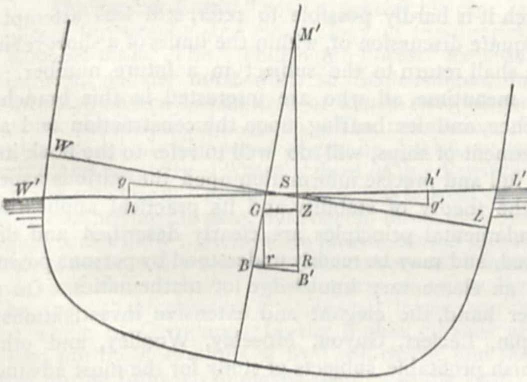


FIG. 1.

W' L' represent the new water-line. The effect of the inclination has obviously been to lift out of the water a wedge-shaped body, of which W S W' is the section, and to submerge on the opposite side of the ship another somewhat similar wedge-shaped body, of which the section is L S L'. These wedges are known as the wedges of immersion and emersion respectively. They are each bounded on the outside by the outside form of the ship, and will therefore usually differ in external form; but they must be precisely equal in volume, or otherwise the whole displacement of the ship could not remain unaltered.

The inclination of the ship through the angle W S W' has changed the position of the centre of buoyancy B to B'; and G Z is the length of the perpendicular let fall from G, the centre of gravity, upon the vertical B' M, through B'. G Z is the arm of the couple at the ends of which the weight of the ship and the upward pressure of the water act; and it is commonly called the righting arm. Atwood's fundamental formula for determining the length of the righting arm is—

$$GZ = v \times hh'/V - BG \sin \theta,$$

v being the volume of either of the wedges W S W', L' S L; $h h'$ the distance, measured parallel to W' L', between g and g', the centres of gravity of these wedges; V the volume of the ship's displacement; and θ the angle of inclination W S W'.

It is obvious that the labour of calculating the volumes and positions of centres of gravity of such irregularly shaped bodies as the wedges of immersion and emersion must be very great. The labour and difficulty are further increased by the necessity of drawing the inclined water lines, such as W' L', in positions which give equal volumes for these wedges. The point S, where the inclined water-line intersects the upright water-line, thus requires to be determined separately for each angle of inclination. Atwood's manner of approximating to the volumes and moments of these wedges was simplified by Mr. S. Read. The method which has commonly been adopted in recent years is, however, one brought forward at the Institution of Naval Architects, by Mr. F. K. Barnes, in 1861.

The old systems of stability calculation, even as modified by Mr. Barnes, were so excessively laborious and complex, that very few attempts were ever made to apply them to ships. The initial stiffness, as determined by the metacentric height, was practically the only element of stability that was investigated. It appears that, prior to 1867, no calculations were made which showed how the stability of a ship became affected by inclining her till the water-line came up over the deck, or at what angle the stability vanished. This was done for the first time at the Admiralty in 1867 by Mr. William John, under the direction of the author of the present work. The results of these investigations were published by Sir E. J. Reed in an interesting and instructive paper upon "The Stability of Monitors under Canvas," read before the Institution of Naval Architects in 1868. Curves are appended to this paper which show how the righting moments vary at successive angles of inclination, and the point at which they vanish. This paper proved conclusively how great are the dangers that have to be guarded against in ships of low freeboard and with high centres of gravity.

The extended application of stability calculations to cases involving greater irregularities in the volumes of the wedges of immersion and emersion than are contemplated by Atwood—such, for instance, as are caused by deck edges becoming immersed, or portions of deck erections becoming included in the volumes of the immersed wedges—created a demand for still more systematic and simple modes of calculation. This was supplied by Messrs. White and John in a paper read before the Institution of Naval Architects in 1871.

Down to the time of the *Daphne* disaster, which occurred in July, 1883, stability calculations made no further progress of importance in this country. At the Admiralty, and in some of our mercantile shipyards, the processes above described were gone through in cases where full knowledge of a ship's stability was considered requisite. Such calculations often took about a month to complete; and the results obtained were usually limited to a knowledge of how a ship's righting moment varied with angle of inclination at one or more chosen draughts of water. Even this was not considered essential when very light draughts of water were being dealt with.

The evidence given at the *Daphne* inquiry, and the report of the Government Commissioner, Sir E. J. Reed, directed attention to imperfections in this department of shipbuilding practice, and furnished a powerful stimulus to renewed inquiry. Valuable results were speedily forthcoming in the shape of more complete and general expositions of the theory of stability than had previously been given: and in a great simplification, which at the same time included an extension, of the system of calculation. One of the most useful portions of the present work is that which describes the improvements thus made in the theory and practice of the subject.

The modern improvement of the theory is shown by Sir E. J. Reed to be in the direction of considering the variation of stability with draught of water, and the amount of stability a ship will possess at light draughts. The *Daphne* inquiry showed that the danger of instability which is sometimes to be found associated with light draught of water was frequently lost sight of because of a prevailing belief that, so long as a vessel has a high side out of water, and any initial stiffness, she will have a large range of stability. This point is clearly and fully dealt with by Sir E. J. Reed in his present work; and he states a general proposition which underlies it, and which was first enunciated by Prof. Elgar in the *Times* of September 1, 1883. It is that, if any homogeneous body which is symmetrical about the three principal axes at its centre of gravity be of such density as to float in equilibrium with its lowest point at a depth x below the water, then if the density be altered so as to make it float with its highest point at a height x above the water, the righting moments will be the same in both cases at equal angles of inclination, and, consequently, the range of stability and complete curves of righting moments will be the same. Sir E. J. Reed also gives copious extracts and diagrams from a paper read by Prof. Elgar before the Royal Society in March last, in which the variation of righting moment with draught of water is shown not only for symmetrical bodies, but also for floating bodies of irregular form and for an actual ship. These investigations indicate that the effect of lightness of draught upon stability may be as prejudicial, or even more so, than that due to low freeboard.

Sir Edward Reed deals very fully with the recent practical developments of the subject, and with the improved systems of calculation that have been devised. These have for their primary object the direct construction of curves showing the variation of righting arm with draught of water at fixed angles of inclination. The wedges of immersion and emersion are no longer dealt with in the stability calculations. Atwood's formula involving the volumes and moments of the wedges of immersion and emersion is discarded, and the following one is employed (see Fig. 1) $GZ = BR - BG \sin \theta$. BR is computed by calculating the under-water volume at the inclined water-line W′L′, and its statical moment. These calculations can be made very quickly and easily with the aid of Amsler's mechanical integrator: and the complication involved by dealing with the two separate wedges, and equating their volumes, may thus be avoided. Sir Edward Reed describes the methods put forward by Mr. W. Denny—who appears to have been the first to suggest this important step—Mr. Macfarlane Gray, Mr. Benjamin, and others.

It is singular that while naval architects in this country were thus working out for themselves those extensions of the difficult problem of stability which modern requirements have demanded with continuously increasing force, the French appear to have been long in possession of a complete and admirable system. So long ago as 1863 M. G. Dargnies was making calculations of stability at Marseilles for numerous angles of inclination, and for four or five draughts of water; and in 1864 M. Reech put forward a most ingenious and perfect method for bringing all the probable stability conditions of a ship into full view and under calculation. The advantages of this method were so striking that it was not long in becoming practically adopted in France, and, in 1870, M. Risbec prepared a paper upon it, together with a calculation form for facilitating its application. Sir Edward Reed gives a concise and clear exposition of the systems of MM. Dargnies, Reech, and Risbec, together with an example of M. Risbec's calculation form. The investigations of MM. Ferranty and Daymard are also described in detail. The latter are probably better known in this country than any of the others referred to, in consequence of a paper which M. Daymard read upon the subject before the Institution of Naval Architects in April last.

There is much in this large and important work to which it is hardly possible to refer, still less attempt an adequate discussion of, within the limits of a short review. We shall return to the subject in a future number. In the meantime, all who are interested in this branch of science, and its bearing upon the construction and safe treatment of ships, will do well to refer to the book itself for full and precise information upon the various aspects of the theory of stability and its practical applications. Fundamental principles are clearly described and illustrated, and may be readily understood by persons possessing an elementary knowledge of mathematics. On the other hand, the elegant and extensive investigations of Dupin, Leclert, Guyou, Moseley, Woolley, and others furnish profitable subjects of study for the most advanced of mathematicians.

(*To be continued.*)

OUR BOOK SHELF

Natural History Sketches among the Carnivora, Wild and Domesticated; with Observations on their Habits and Mental Faculties. By Arthur Nicols, F.G.S., &c. (London: L. Upcott Gill, 1885.)

THIS little volume of some 250 pages is full of interest: treating somewhat of lions and tigers, it has a pleasant portion of a chapter about cats, but the bulk of the volume is devoted to man's faithful friend, the dog. Of the several excellent illustrations we would especially mention the life-like one of a lioness watching its prey, from a drawing by Mr. J. T. Nettleship, which is very full of vigour and muscular force, one of the black-maned African lion, by Mr. C. E. Brittain, and one of Chang, Mr. G. B. Du Maurier's Grand St. Bernard, by Mr. T. W. Wood. As one of the interesting subjects touched on by Mr. Nicols, we may allude to that treating of the sense of smell in dogs. He alludes to this in connection with the habit possessed by some dogs of rolling in decaying animal, or even vegetable, substances. On one occasion Mr. Nicols noticed his retriever vigorously anointing himself by rolling about in a clump of living fungi which emitted a particularly evil smell. This is thought to be an inherited habit, or, as Mr. H. Dalziel writes, "Taste and smell being closely allied senses, this rolling causes pleasurable sensations from association with the glorious feasts enjoyed on battle-fields and on putrid carcases of animals," and from this the author hints that possibly, and even probably, when grouse or venison come to our tables in a state of actual decomposition, this represents a taste acquired years ago by the conditions of a primitive life, and is not to be distinguished from a habit which brings upon our domestic dogs the severest reprobation and prompt chastisement. It seems a subject, however unsavoury, well worthy of being investigated, and doubtless many facts bearing on it in reference to uncivilised people are yet to be narrated. Once we call to mind a small knot of semi-civilised Africans captured in a slave dhow off Mosambique that we interrupted at a midnight feast; they were partly eating and partly smelling a mass of half-putrid fish, which seemed, to say the least, to make them uproarious. They had been under civilisation of a sort since their infant days, but seemed full of hereditary instincts. Mr. Nicols's work is full of his own careful observations, and forms a most pleasant addition to our knowledge of the habits and mental faculties of the Carnivora.

Entwickelung der Ortschaften im Thüringerwald. Von Dr. F. Regel. *Petermann's Mitteilungen*, Ergänzungsheft No. 76. (Gotha: Perthes, 1885.)

THIS is a very complete account of the origin and development of the towns and villages in the region known as "the Thuringian Forest," with a special chapter on the geology, topography, and climatology of the district, and a valuable map. The "Thuringian Forest" extends from Eisenach, on the north-west, to Schleusingen, on the south-east, and covers an area of about 1200 kilometres, with a population of 143,986. The mountains of this region are mainly composed of granite, gneiss, palæozoic strata, and porphyry. About a third of the district is still covered with wood. Formerly there was a great variety of trees, comprising the pine, oak, beech, birch, elder, maple, aspen, and willow; but now the forests consist almost entirely of pines, with a few beech woods between Friederichroda and the mediæval walled town of Schmalkalden. The average temperature is somewhat lower than that of the whole of Germany. In the higher villages neither wheat nor the finer kinds of fruit will thrive, and there is frost during from ten to eleven months in the year. The climate, however, is very healthy, and the beauty of the scenery and purity of the mountain streams attract many visitors during the summer months. The highest, and one of the most popular, of these summer resorts is Oberhof, a village at the top of the pass over the Schützenberg, of which the earliest record is in the year 1267. Only oats and potatoes can be grown here (2541 feet above the sea-level), and even the house-sparrow cannot be acclimatised. Eisenach, the capital of the district, is chiefly known on account of the confinement of Luther in the neighbouring castle of Wartburg, which was erected to guard the Thuringian frontier on the west in the years 1067 to 1070. This fortress was close to the junction of two important roads from Erfurt and Mühlhausen, and, as usual in such cases, a town rapidly grew up at the foot of the hill on which the fortress was built. Eisenach now has 13,000 inhabitants, with three churches and several factories. Other towns and villages not so favourably situated owed their development to the neighbourhood of mines, healing waters, &c. Ruhla, a flourishing town of 4500 inhabitants, was celebrated in the first half of the sixteenth century for its steel manufactures, but foreign competition and heavy taxes nearly ruined the place, and in 1748 the population had considerably diminished. The enterprising spirit of the inhabitants, however, was soon drawn into a new channel by the discovery of mineral waters and the introduction of the manufacture of carved amber and pipe-bowls of imitation meerschaum, an industry which has attained considerable proportions. A somewhat similar history is that of the manufacturing town of Ilmenau, which is first mentioned in the chronicles of the fourteenth century. It flourished as an important centre of the copper-mining district of the Ilm up to the year 1739, when the mines were flooded by an inundation. In 1752 the town was burnt to the ground, and, though partly rebuilt, it shared in the general distress caused by the seven years' war, and did not revive until the beginning of the present century, when the manufacture of glass, porcelain, and toys was introduced. In 1838 the establishment of a hydropathic institution afforded a further stimulus to the trade of Ilmenau, and the population has increased from 1972 in 1809 to 4593 in 1880. On these and other places of less note in the Thuringian Forest Dr. Regel's work affords abundant information, though it is somewhat overcharged with notes and references which serve rather to display the extent of the author's reading than to illustrate his text.

LETTERS TO THE EDITOR

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

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

River Thames—Abnormal High Tides

REVERTING to my letter of December 19, 1883, inserted in NATURE for January 10, 1884, I append an abstract of salient exceptional tides of last year similar to that accompanying my former letter, from which it will be seen that the maximum elevation of tide is eleven inches less than in 1883, and the excess over the computed rise is also less by seventeen inches than in 1883—in each year resultant on north-north-west gales. Both year's results may be said to be analogous, and each showing how sensitive is the high-water level and how easily it is affected and raised by a change from south and west to northerly winds.

High Waters referred to "Trinity"

1884	Computed	Observed	Difference	Wind
	′ ″	′ ″	′ ″	
Jan. 12 p.m.	0 3 above	1 6 above	1 3	W.N.W.[1]
,, 24 a.m.	3 0 below	0 6 below	2 6	W.N.W.[1]
,, 31 p.m.	0 10 above	2 0 above	1 2	W.S.W.
Feb. 1 ,,	0 10 ,,	2 0 ,,	1 2	W.S.W.
,, 14 ,,	0 8 ,,	2 0 ,,	1 4	W.N.W.[2]
,, 25 ,,	0 10 below	0 3 ,,	1 1	W.N.W.[2]
Mar. 11 ,,	0 2 above	1 9 ,,	1 7	N.[2]
,, 12 ,,	0 6 ,,	2 5 ,,	1 11	W.S.W.[3]
,, 26 ,,	0 2 ,,	1 3 ,,	1 1	E.N.E.
April 22 ,,	2 1 below	0 6 ,,	1 7	E.N.E.[4]
June 7 ,,	1 0 ,,	0 3 ,,	1 3	N.N.E.
,, 25 ,,	1 1 above	2 3 ,,	1 2	N.N.W.
July 8 ,,	0 10 below	0 3 ,,	1 1	S.S.E.
,, 9 ,,	0 6 ,,	0 6 ,,	1 0	S.S.E.
,, 25 ,,	1 0 above	2 0 ,,	1 0	N.N.W.[5]
Aug. 16 a.m.	2 3 below	1 0 below	1 3	S.
,, 25 p.m.	0 3 above	1 4 above	1 1	N.
Sept. 2 ,,	2 7 below	1 6 below	1 1	W.S.W.
,, 5 ,,	"Trinity"	1 6 above	1 6	W.N.W.[6]
,, 22 ,,	0 7 above	1 9 ,,	1 2	W.
Nov. 6 ,,	1 4 ,,	2 9 ,,	1 5	E.N.E.[7]
Dec. 20 ,,	0 5 below	1 9 ,,	2 2	N N.W.[8]
,, 22 ,,	0 9 ,,	0 6 ,,	1 3	N.

J. B. REDMAN

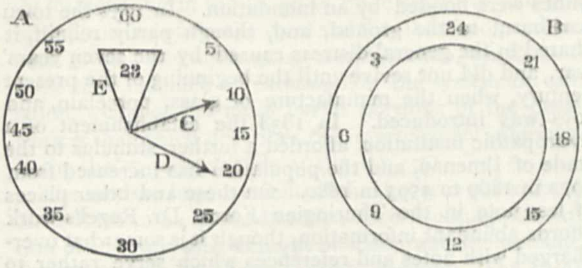
6, Queen Anne's Gate, Westminster, S.W., January 5

Our Future Clocks and Watches

IT is to be hoped that the absurd dial of which you give a drawing will not come into general use. Why not adopt the convenient shape which for more than a century has been in use

[1] Wind Influence. [2] Northerly Influence.
[3] Still felt. [4] Wind blowing right up the estuary.
[5] Sewage up to Westminster with this tide. [6] N.N.W. day before.
[7] Maximum tide of year; W.N.W. gale day before.
[8] Gale and remarkable fall of barometer = 29° 10′.

on the continent for some jewelled watches?:—A is the shape of the visible dial; C is the minute hand; D is the second-hand (sometimes dispensed with); E is an aperture in the dial through which is seen the hour, brought there by the hourly revolution of the wheel B; B is a wheel (and in watches of the size of a



shilling a series of wheels or a metallic band rolling round a drum of special construction for those tiny watches) immediately under the dial, set in motion once every hour, and bringing the corresponding numbers under the aperture E. CHATEL

Jersey, January 5

THE COAL QUESTION

IT is generally admitted that the amount of coal existing below Great Britain at such depths that it can be worked is limited, that large quantities of coal are annually used, and that even the partial exhaustion of the fields, accompanied, as it must be, by a rise in price, would seriously affect almost all our manufactures, and greatly endanger our commercial supremacy. But if we attempt to go further, and say how long our supply of coal will last, we meet with very different estimates. Nearly a hundred years ago the question was discussed by Mr. John Williams, and though the insufficiency of the data did not allow him to give a definite answer, he at least showed the vital importance of the subject.

In 1861, Mr. Hull, by taking into account the area of all our coal-fields and the thickness of the workable seams, calculated that the total available coal in Great Britain was 79,843,000,000 tons; this result was shown by a second calculation to be slightly too low. Further, he assumed that the output of coal, which was then 86,000,000 tons, could not rise much above 100,000,000, and therefore that our supply was sufficient for eight centuries.

Four years later Prof. Stanley Jevons, in an admirable essay on "The Coal Question," accepted the more important of Mr. Hull's data, but showed that they would bear a very different interpretation, and that, instead of the eight centuries spoken of by Mr. Hull, "rather more than a century of our present progress would exhaust our mines to the depth of 4000 feet." He then shows that the absolute physical exhaustion of the fields is improbable, but that before the twentieth century is far advanced the output of coal will probably be checked by a rise in price so considerable that England will be unable to compete in manufactures with other nations still enjoying the profusion of coal to which her present commercial prosperity is so greatly due. These theories and results were reviewed and strengthened by Prof. Marshall in 1878 ("Coal, its History and Uses"), with the aid of more recent statistics; and the present paper is intended to give a short and simple account of the present state of the question from the physical side, with the omission of the more difficult and dubious arguments which may be drawn from Political Economy.

The arguments of Prof. Stanley Jevons were so conclusive, and his results so alarming, that a Royal Commission, of which the Duke of Argyll was chairman, was appointed, in 1866, to investigate the probable quantity of coal contained in the coal-fields of Great Britain. In 1871 the Commission reported that the coal-fields already in use still contained 90,207,000,000 tons of coal, and that concealed coal-fields as yet unopened, near Doncaster, Birmingham, and elsewhere, probably contained 56,273,000,000 tons more, or that, in all, 146,480,000,000 tons of coal were available. Since that time about 1,780,000,000 tons of coal have been raised, leaving as the available supply in 1884 about 144,700,000,000 tons. Subsequent investigations show that this estimate is probably considerably too high.

These results were intended to include all beds a foot and upwards in thickness lying within 4000 feet of the surface, though it was rendered probable at the same time that the amount of coal below 4000 feet is not very large. The reason for excluding all beds less than a foot thick is that, at present prices, it is found unprofitable to work them, and hence, except in a few special cases, they are left untouched, though rendered worthless for the future from the disturbance of the strata occasioned by working the other beds.

Though we may assign no limit below which it is impossible to work, the cost of mining increases so rapidly with increased depth that the price of coal must rise very seriously before even the 4000-foot limit can be reached. This increase of cost depends upon various causes. The mere sinking of three shafts like those of Murton, which are said to have cost 300,000*l.*, burdens the undertaking, if it last fifty years, with an interest and sinking fund at 4 per cent. amounting to 13,965*l.* per annum. More powerful winding and pumping engines must be employed, and from the great expense of shaft-sinking, larger areas must be worked from one shaft, necessitating extra expense in underground haulage, ventilation, and supports. Further, each actual coal-hewer requires a larger amount of assistance to secure his safety and to remove his winnings in a deep pit. A coal-hewer working at an open seam on the surface of the ground would only require one labourer to wheel away the coal, while in a deep mine each hewer requires about three men to attend to the removal of the coal, the pumping, and ventilation.

The high temperature of the rock at great depths is also an important factor in the expense of deep mining. In England there is found to be a uniform temperature of 50° F. about 50 feet below the surface; but this temperature is found to increase 1° F. for every 60 feet descended, so that at 4000 feet the temperature of the rock will be about 116° F. And though this temperature is not sufficiently high to prevent working, and might be lowered a few degrees by ventilation, it will cause a considerable increase in the expense, both from the lassitude and extra pay of the men, and the larger amount of air required, which even now at Hetton amounts to 450,000 cubic feet per minute.

These difficulties account for the manifest reluctance to sink deep pits, for the high price charged for the coal from them, and for the fact that the 4000-foot limit has not yet been approached. In 1846 the Messrs. Pemberton's pit at Monkwearmouth reached 1720 feet; in 1858 the Astley pit at Dukinfield reached 2100 feet; in 1869 the Rosebridge pit at Wigan reached 2448 feet; in 1881 the Ashton Moss pit near Manchester reached 2688 feet; and though the Lambert pit in Belgium has been worked at 3490 feet, the circumstances were exceptional, and it is certain that the commercial success of such a pit in England would necessitate a price of coal far higher than it at present is.

The early estimates of the annual output of coal are so unreliable that it is useless to go back further than 1854, when "Mineral Statistics" were first carefully collected by Mr. Robert Hunt, and even in these returns the amounts for the first few years are possibly as much as three per cent. too low, from the difficulties of overcoming the fears of the coal-owners as to the uses which might be made of them. These returns have been collected and arranged by Mr. Meade, in his "Coal and Iron Industries of the United Kingdom," from which Columns I. and V. of the following table have been for the most part taken.

Since the amounts of coal used are very large, and great accuracy cannot be expected in inquiries of this nature, it is convenient to take as the unit of our calculations 1,000,000 tons of coal instead of our ordinary unit, the ton. This unit may be expressed in several different ways: a cubic yard of anthracite weighs about 2700 lbs., and of bituminous coal from 2090 to 2400 lbs., hence on an average a cubic yard of coal weighs a ton; and our unit of 1,000,000 tons is a cub cal block of coal 100 yards each way, or a bed of coal a mile square and a foot thick. Column I. in the following table gives the annual output of coal since 1854, and the total output during the thirty years, which amounts to 3,245,100,000 tons.

Amount of Coal in Million Tons

Year	I. Won	II. Calculated $64{\cdot}7+3\,(n-1)$	III. Calculated $62{\cdot}85 \times 1{\cdot}035^{n-1}$	IV. Calculated $65{\cdot}5 \times 1{\cdot}0325^{n-1}$	V. Exported
1854	64·7	64·7	62·9	65·5	3·4
1855	64·5	67·7	65·0	67·6	5·1
1856	66·6	70·7	67·3	69·8	5·9
1857	65·4	73·7	69·7	72·1	6·8
1858	65·0	76·7	72·1	74·4	6·6
1859	72·0	79·7	74·6	76·9	7·1
1860	84·0	82·7	77·3	79·4	7·4
1861	86·0	85·7	80·0	81·9	7·9
1862	81·6	88·7	82·8	84·6	8·4
1863	86·3	91·7	85·7	87·4	8·3
1864	92·8	94·7	88·7	90·2	8·9
1865	98·2	97·7	91·8	93·1	9·3
1866	101·6	100·7	95·0	96·1	10·1
1867	104·5	103·7	98·3	99·3	10·6
1868	103·1	106·7	101·7	102·5	11·0
1869	107·4	109·7	105·3	105·8	10·7
1870	110·4	112·7	109·0	109·3	11·7
1871	117·4	115·7	112·8	112·8	12·7
1872	123·5	118·7	116·8	116·5	13·2
1873	127·0	121·7	120·8	120·3	12·6
1874	125·1	124·7	125·1	124·2	13·9
1875	131·9	127·7	129·4	128·2	14·5
1876	133·3	130·7	134·0	132·4	16·3
1877	134·6	133·7	138·6	136·7	15·4
1878	132·6	136·7	143·5	141·1	15·5
1879	134·0	139·7	148·5	145·7	16·4
1880	147·0	142·7	153·7	150·4	18·7
1881	154·2	145·7	159·1	155·3	19·6
1882	156·6	148·7	164·7	160·4	20·9
1883	163·8	151·7	170·4	165·6	22·8
Totals	3245·1	3246	3245·1	3251	351·7

A few comparisons may enable the mind to grasp the real meaning of these enormous figures. It was calculated by Sir Henry Bessemer that the output of coal, 154,000,000 of tons for the single year 1881, would suffice to build 55 Great Pyramids, or to rebuild the Great Wall of China, and to add a quarter to its length! In 1883 the output was 163,800,000 tons, which would form a column a mile square and nearly 164 feet high; or would build a wall from London to Edinburgh 400 miles long, and 45 feet 9 inches high and thick, or another round the world 24,000 miles long, and 5 feet 11 inches high and thick; or, if the Straits of Dover are 21 miles across and 600 feet deep, would make an embankment across them 22 yards wide: while the total output for the 30 years would build a round column 9 feet 4 inches in diameter, which would reach 240,000 miles high, the distance of the moon.

The numbers show considerable fluctuations—as might be expected from the variety of accidental circumstances, such as new inventions, the mean annual temperature, and the state of trade, which affect the amount of coal used—but, on the whole, a very rapid increase; the output for 1875 being double of that for 1854, and that for 1883 double of that for 1862.

If we assume that the increase in annual output would be constant were it not for accidental circumstances, we can represent the actual numbers, with fair accuracy, by an arithmetical series of which the first term is 64·7, and the last 151·7, the increase in annual output being 3, and the total amount 3246 (Column II.). Further it has been shown that the coal still available in 1884 is 144,700,000,000 tons, and we may assume that the output in 1884 will be at least as great as that in 1883, or 163,800,000 tons. Hence, if the output of coal continues to increase at the rate of 3,000,000 tons annually, our supply will last for 261 years, or will be exhausted about A.D. 2145.

But this calculation is open to several objections, and the numbers as shown by Prof. Stanley Jevons may bear a much more serious significance.

It is improbable that the annual difference should always remain the same, and in fact, in the calculated series (Column II.), while all the early terms are higher than the real outputs, the later terms are lower, showing that the difference itself probably increases. If we calculate the series backwards we have no output at all about 21 years before 1854, a result we cannot agree with, and for all years before 1833 a negative output, a result we cannot understand. Hence it is probable that the results may be better expressed by another kind of series.

Theory and experience show that the same causes always produce the same effects, unless fresh circumstances intervene to modify the effects produced. Thus the population of England, which was about 9,000,000 in 1801, became 18,000,000 in 1851, or doubled in 50 years; hence, if no new causes intervene, we should expect it to double again in the next 50 years, or to become 36,000,000 in 1901. This is usually expressed by saying that social statistics in general show uniform multiplication in uniform periods, or obey the compound-interest law, or form a geometrical series. As an example of this law let us examine a little more closely the population of England and Wales. The increase for each 10 years since 1801 is itself perpetually increasing, or the numbers must be expressed by a geometrical series of which the ratio is nearly 1·147, and not by an arithmetical series.

Year	1,000,000 Inhabitants	Increase in Ten Years	Calculated $8{\cdot}89 \times 1{\cdot}147^{(n-1)}$
1801	8·89		8·89
1811	10·16	1·27	10·20
1821	12·00	1·84	11·70
1831	13·90	1·90	13·42
1841	15·91	2·01	15·39
1851	17·93	2·02	17·65
1861	20·07	2·14	20·24
1871	22·71	2·64	23·22
1881	25·97	3·26	26·63
Sum...	147·54		147·34

From the dependence of the numbers representing the annual output of coal upon the number of inhabitants, it might be expected that they also can be expressed by a geometrical series, and this has been shown by Prof. Stanley Jevons to be the case. According to his calculations the ratio of the series is about 1·035, or the rate of increase of the output is about 3½ per cent per annum, and it may be assumed for the reason before given that the sum of all the outputs is likely to be more approximately correct than the single output for 1854 The annual outputs calculated from these data are given in Column III., and show a fair approximation to the actual numbers, though the first term is rather low, and the last six terms are nearly as much above the true results as those in the arithmetical series were below them. In fact, either from a prolonged fluctuation in trade, or from the operation of the cause we are discussing, the outputs for the last six years have not increased so rapidly as the previous numbers would lead us to expect. The outputs for the years 1854-77 are very fairly expressed by a series of which the first term is 63·9 and the ratio 1·0355, but this series makes the last six terms far too high.

Again the ratio 1·03 gives 71 as the first term, and makes all the early terms considerably too high. In short, the fluctuating numbers in Column I. seem to be best expressed by a series of which the first term is 65·5 and the ratio 1·0325; the outputs calculated from these data are given in Column IV.

It is easy also to calculate backwards and obtain earlier terms in the same series, thus for 1840 an output of 43,000,000 tons is given, and for 1800 one of 11,700,000, instead of Mr. Hull's conjecture of 36,000,000 and 10,000,000 tons respectively. And taking the true output of 163,800,000 of tons in 1883 and the ratio 1·0325, we can calculate the probable output for any future year. Thus for 1901 we obtain 282,000,000 tons instead of 331,000,000 as calculated by Prof. Stanley Jevons. Further, a well-known formula gives the sum of any number of terms of the series, or we can calculate in how many years the amount of coal raised will be equal to any given amount, say to the 144,700,000,000 tons remaining in 1884. Making the calculation, we find that if the present rate of increase in the consumption of coal of 3¼ per cent. per annum continues, or, in other words, if our output of coal continues to double every 22 years, our total supply will be exhausted in 106 years from 1884, or about A.D. 1990.

Of course no one can suppose that our consumption will continue to increase until it comes to a sudden and final end, but only that within a comparatively short period our output of coal must reach a maximum, and then gradually diminish as it becomes more scarce and expensive.

These calculations, then, seem to force upon us one of four possible conclusions:—Some new source of energy may be found to supply the place of coal; a larger proportion of the energy contained in our coal may be utilised, so that an output as large as the present one may produce a much larger amount of useful work; coal may be imported from other countries to supply our deficiencies; or lastly, the commerce and manufactures of England may pass into a stationary or retrograde condition.

Coal is used directly as a source of heat in our domestic fireplaces, as a source of mechanical energy indirectly in our steam- gas- air- and electric-engines, and as a heating and reducing agent in our metallurgical furnaces. A pound of fairly good coal will heat about 13,000 lbs. of water through 1° F., and in an ordinary steam boiler about 8000 of these units of heat are utilised, which suffice to turn rather more than 7·3 lbs. of water at ordinary temperatures into steam. But the unit of heat is able to do work to the extent of raising 775·4 lbs. through one foot in opposition to gravity. Hence, by burning one pound of coal, rather over 10,000,000 foot-pounds of work may theoretically be obtained. A first-rate steam-engine does effective work to the extent of about one-ninth of the theoretical amount. Hence, in round numbers, a pound of coal will do 1,000,000 foot-pounds of work, or as much work as is done by 32 ordinary men in ascending the 202 feet to the top of the Monument. According to Péclet, a pound of average coal contains ·804 lb. carbon, ·0519 lb. hydrogen, and ·0787 lb. oxygen, and would therefore theoretically suffice to reduce 8¼ lbs. of hematite with formation of 5¾ lbs. of iron. Any complete substitute for coal must be able to perform each of these three duties of coal.

It seems improbable that any new source of energy on the large scale will be discovered, though possibly small engines may be driven by some form of explosive, and hence tides, winds, and waterfalls alone, have to be considered as substitutes for coal. According to Sir William Thomson, energy in the form of electricity might be conveyed for 300 miles through a copper rod with a loss of only 20 per cent. from such a waterfall as Niagara, and stored up in secondary batteries for distribution. It is only necessary, without going into details of expense, to point out that we have no monopoly of winds, tides, or torrents, such as we have had of coal, and in fact, were they the sources of energy, we should compete with our neighbours rather at a disadvantage.

The next point to consider is how far more economical methods of obtaining and using our coal may reduce the output. It has been already pointed out that, as with coal at its present price it is not commercially possible to work seams less than a foot thick, all such coal is wasted. Large quantities of coal also are more or less unavoidably wasted in the processes of cutting and carrying, and it seems as if any great reduction in this amount must be accompanied by a considerable rise in price.

The uses to which our coal is applied, may, for the purposes of this inquiry, be roughly grouped under four heads—mining and metallurgy; manufactures, and locomotion on land and sea; domestic uses, including the supplies of gas and water; and lastly, for export. Under the first three heads, no doubt, large saving is possible, but it is not likely to be begun except under the pressure of a scarcity of coal, when the high price of the coal will cause the introduction of more expensive and more efficient machinery.

By far the most important metallurgical operation is the production of iron, which may therefore be taken as an example of the others. In 1788, 7 tons of coal were used per ton of pig-iron produced, which sank to 5 tons about 1800. The introduction of the hot blast in 1829 caused a further drop to 3½ tons in 1840; and that of regenerators in 1857 caused a further fall to 2½ tons in 1875. But the increase in the quantity of iron manufactured renders the actual saving of coal very small. In 1881, 18,300,000 tons of coal were used in making 8,300,000 tons of pig-iron, and a nearly equal amount of coal was required to convert five-eighths of the pig into wrought iron and steel. So that, in all, the iron-works required 34,700,000 tons of coal.

Experience seems to show that, though our best steam-engines give an efficiency of one-ninth, and the efficiency of air- and gas-engines is even higher, except in special circumstances, it is commercially preferable to use less efficient engines; the saving of coal at present prices being more than compensated for by the higher cost of the better engine. It is possible, however, that in the future electric engines may be used of far greater efficiency than our present steam-engines. On the other hand, the high rates of speed now demanded both for passengers and goods necessitates the consumption of large quantities of coal. Thus on a level railway a ton of load requires a pull of about 16½ lbs. to draw it at the rate of 29 miles per hour, while, if the rate be increased to 50 miles per hour, the pull is nearly 33 lbs. Hence the 13,500 locomotives in Great Britain will require much more coal to drag the same loads at the higher rate. Our merchant navy also is being rapidly converted from sailing into steam vessels; in the 14 years 1866-1879, the number of sailing vessels *decreased* 5600, while the steamers *increased* 2200; and the steamers engaged in the foreign trade used in 1881 5,200,000 tons of coals, in 1882 5,600,000, and in 1883 6,400,000.

The aggregation of people in towns requires the use of coal for the production of gas or electric lighting, frequently for the removal of sewage and refuse, and for the supply of water. Possibly the most wasteful use to which coal is applied is our common domestic fireplace. But it would require an enormous increase in the price of coal to induce the average Englishman to convert his genial, wasteful, open fireplace into the dull, though economical Continental stove.

The trade in coal and coke, especially to France, Germany, Russia, and Sweden, has reached very considerable dimensions, and is, in fact, the fourth most important of our exports. In Column V. it will be noticed that the 3,400,000 tons exported in 1854 have become in 1883 22,800,000 tons, worth more than 8,000,000*l.*, or in thirty years the export of coal has multiplied more than six times. Any considerable lessening in this amount would of course seriously affect the balance of our trade with other countries.

It seems hardly necessary to meet the objection that when our own stores are exhausted we may import coal from other countries. A few considerations will show the fallacy of such reasoning. The nearest stock of coal on which we can hope to draw is that in Canada and the United States. The former supply is plentiful, but much of it is badly situated for exportation. In the United States coal is found in Virginia, Utah, and the Western States, and the basin of the Mississippi and its tributaries contains coal-fields estimated to cover 200,000 square miles, and to contain about 38 times as much available coal as Great Britain. According to Mr. Hull, these fields could as easily supply an output of 2,704,000,000 tons as we can one of 90,000,000.

Putting aside the commercial difficulties dwelt on by Prof. Stanley Jevons in the way of converting a large export trade in our staple raw material into an immensely larger import trade, the fact that even now the rivalry with the ingenuity and perseverance of the American manufacturers, aided though we are by their high tariff, demands all our skill and energy, and the almost universal law that manufactures cluster round the source of power, the physical difficulties of such a traffic would be enormous. Suppose a steamer similar to the *Faraday* capable of carrying 6000 tons, and so swift as to be capable of making 13 trips from America in the year; she would annually bring 78,000 tons of coal, or it would require a fleet of 2100 such ships to supply even our present requirements. And if the coal could be supplied to our shipping in American ports at 10*s.* a ton, we should have annually to pay America 81,900,000*l.*, an amount not far below our present national income. The further cost of carriage across the Atlantic and delivery in English towns, must raise the price of coal to many times what we at present pay.

We are brought, then, face to face with the last of the four above-mentioned possibilities. Before very many years are past we must expect that the scarcity of coal in England will cause a considerable rise in price, which will directly affect all such branches of trade and manufactures as depend upon coal, and indirectly all other branches.

What this means in the former case will be evident from a brief consideration of the uses to which coal is applied, a few instances of which have already been given. Let us take one instance of the latter class—the importation of food-stuffs. The increase in the population of England per square mile, which was 37 in 1066, 75 in 1528, 140 in 1780, 241 in 1831, and 443 in 1881, higher than any civilised country except Belgium, has taken place far more in manufacturing than in agricultural districts, and has necessitated a great change in our supply of food. Previous to 1780, though luxuries were imported, the staple food-stuffs, corn, meat, cheese, &c., were produced at home; now, on the other hand, we import more than one-third of our meat, half of our cheese, and nearly two-thirds of our wheat. Owing to our luxuriousness and to this large importation of food, averaging 212 lbs. annually per head, the average annual cost of food per head in England, 13*l.* 9*s.*, is higher than that in any other country. When by the scarcity of our coal our pre-eminence in cheapness of manufactures becomes a thing of the past, the means of paying for this food will gradually cease, and the pressure of population, together with the increased cost of the necessaries of life, by emigration, by an increased death-rate, and by a reduced birth-rate, will change the England of to-day into a country like the England of 1780,—a country with a comparatively scanty population, with few manufactures, supporting themselves by the produce of their fields, and looking back on the England of to-day as the Spaniard now looks back on the Spain of Philip II.—of Philip, the husband of Mary of England, the ruler of Spain, Portugal, the Netherlands, the Milanese, of Malabar, Coromandel, and Malacca—of Philip, whose father had sent Cortez to conquer Mexico, and Pizarro to Peru, and who himself, by the conquest of Portugal, had annexed the valuable province of Brazil. Looking at such a picture, is it impossible that the England which now rules over 8,600,000 square miles, containing 283,000,000 inhabitants, should shrink to its former limits of 122,000 square miles, with 8,000,000 inhabitants?

Finally, let us consider if anything can be done to defer or mitigate this change in the condition of our descendants. After discussing and rejecting the expediency of limiting or taxing our output or export of coal, on the ground that any such measure would impose a serious burden upon our manufactures and commerce, and in fact produce the very result we are trying to avoid, Prof. Stanley Jevons proposed that instead of relieving ourselves by the remission of taxation, we should relieve our descendants by making a serious effort to pay off the National Debt. The amount of the debt, which was 900,000,000*l.* in 1815, was 839,918,443*l.* in 1857, and 756,376,519*l.* in 1883. Thus in 68 years about 144,000,000*l.* have been paid off. He proposed that the probate, legacy, and succession duties, as being in reality capital and not income, should be applied to this purpose. These duties amounted in 1883 to about 5,600,000*l.*, and would suffice to pay off the National Debt in about 55 years. These proposals have been in part carried out. The amount of taxes remitted has of late years been considerably reduced, and in 1883 terminable annuities were created, which in 20 years will reduce the debt by 173,000,000*l.*

On the other hand, the rapid increase in local obligations to some extent renders nugatory this attempt at national economy. It is somewhat difficult to obtain accurate data on these points, but the bonds of the Metropolitan Board of Works, of Liverpool, of Manchester, and of Leeds, quoted on the Stock Exchange, represent a sum of 34,000,000*l.*, and no doubt other towns are following far too rapidly in the same direction. Of course some of this expenditure represents profitable enterprises, such as the supply of gas and water, but it is to be feared that a considerable amount has been spent in ways less directly or indirectly remunerative.

If, then, we are unable to arrest the action of those physical and commercial laws which will press with more and more severity on our descendants, let us do what we can to mitigate their fate by using every exertion to avoid unnecessary increase in our obligations, and to reduce those transmitted by our fathers. It would probably be well also to appoint a fresh Royal Commission to investigate more accurately than has yet been done the various data upon which these calculations depend, to make more widely known any improvements made during the last thirteen years which may prolong the duration of our coal, and to consider the most important financial questions which are involved in this inquiry.

And at last, when the worst comes to the worst, we may take comfort from the thought that, beyond the four seas, new Englands, as yet hardly conscious of their capacities, stretch east and west, and that the New Zealander, who a few years hence may moralise on the last stone of London Bridge, will mingle reverence with his philosophy, for he will be no dark-skinned, far-off cousin, but a ruddy, healthy grandchild.

SYDNEY LUPTON

INVIGORATION OF POTATOES BY CROSS-BREEDING

SOME interesting experiments on the potato were tried at Reading last summer. Most persons are aware that changes which are called "improvements" from a commercial point of view have been effected among the plants of the farm and garden in recent years by "hybridising," and that the usual result of hybridising plants is to invigorate them. Mr. Darwin explains the law which horticulturists avail themselves of in the improvement of plants when he says, "All forces throughout Nature tend towards an equilibrium, and for the life of each organism it is necessary that this tendency should be checked" ("Animals and Plants under Domestication," vol. ii. p. 130). He adds, hence "the good effects of crossing the bre d, for the germ will be thus slightly modified or acted on by new forces." The invigoration consequent on changing seed corn from one district to another is due to the same causes, as well as the "evil effects of close interbreeding prolonged during many generations, during which the germ will be acted on by a male having almost identically the same constitution."

It would not be easy to ascertain the history of cross-breeding in gardens. Hybridisation has been called "a game of chance played between man and plants." All the great breeders of florists' flowers, and of fruits and vegetables, have practised the art successfully, but as regards the potato recent investigations have shown that the law of "changed conditions" has not been obeyed. The term "hybridising," as used by horticulturists, is a relative expression, referring sometimes to the crossing of widely distinct forms, and in other cases to the injurious union of closely connected forms. Hitherto the breeding of potatoes has involved this vicious principle of too close interbreeding, no other plant of the farm having been more constantly intercrossed.

Some years since the cross-breeding of English and American potatoes was extensively practised, and to some extent, undoubtedly, the "conditions of life" of the varieties which were brought together from either side of the Atlantic were changed; but the cultivated potatoes both of England and America belong to the same species, and having both alike become enfeebled and subject to the same disease, the experiment of interbreeding failed in its object.

Under these circumstances a veteran breeder wrote, "I have come to the end of my tether!" and he gave up the breeding of potatoes in despair. This year he has recommenced it, working hopefully with the aid of a new species, and owing this new departure to the suggestion of the eminent botanist Mr. J. G. Baker, F.R.S., of Kew.

Mr. Baker undertook a scientific examination of the various tuber-bearing species of Solanum, for the purpose of ascertaining whether *S. tuberosum*, the cultivated potato, might not possibly be invigorated by hybridising it with some other species of the family. Writing in the *Journal* of the Linnean Society, Mr. Baker says:—

"The subjects of the differential characters, the relationship to one another, and the climatic and geographical individuality of the numerous types of tuber-bearing Solanums are of great interest both from a botanical and economic point of view. As there are many points which are still to be unravelled, I propose in the present paper to pass in review the material which we possess in England bearing on the question. It was at the instigation of Earl Cathcart that I undertook the inquiry; and in carrying it out I have gone through all the dried specimens at Kew, the British Museum, and the Lindley Herbarium, have carefully studied the wild types which we grow in the herbaceous ground at Kew, and have visited the extensive trial-grounds of Messrs. Sutton and Sons at Reading, whose collection of cultivated types in a living state is probably the most complete in existence."

Bearing in mind that the potato, the most productive of our food-plants, has become the most uncertain among them in regard to its annual produce, it is not surprising that it should have been the subject of voluminous writing and continual inquiry. But, in spite of all the pains which have been expended on this stricken esculent, no one but Mr. Baker seems to have recognised the outrage of in-and-in breeding to which it has been subjected. It seems doubtful whether the numerous breeders were aware that the cultivated potato had been made the subject of continual in-and-in breeding, since it had never been crossed out of its own family during the 250 years of its highly artificial treatment in this country as a cultivated plant. Yet this has been the case, as Mr. Baker shows in his enumeration of the six tuber-bearing species of the plant. As the habitat as well as the distinctions of species of Solanum affect the subject, the following brief details have been taken from Mr. Baker's paper:—

"(1) *S. tuberosum.*—Andes of Chili, Peru, Bolivia, Ecuador, and Columbia; also in the mountains of Costa Rica, Mexico, and the South-Western United States.

"(2) *S. Maglia.*—Shore of Chili, down south as far as the Chonos Archipelago; also likely Peru.

"(3) *S. Commersoni.*—Uruguay, Buenos Ayres, and Argentine Territory, in rocky and arid situations at a low level.

"(4) *S. cardiophyllum.*—Mountains of Central Mexico, at an elevation of 8000 to 9000 feet.

"(5) *S. Jamesii.*—Mountains of South-Western United States and Mexico.

"(6) *S. oxycarpum.*—Mountains of Central Mexico."

According to Bentham and Hooker, the great genus of Solanum—the largest in the world—consists of decidedly distinct species, and if we omit some of the so-called species which are really only varieties of *S. tuberosum*, these six species alone bear tubers.

In attempting improvement by crossing the cultivated potato, it is useless to continue the system of interbreeding with its own varieties; and, on the other hand, the lesser forms of wild potatoes, such as *S. Jamesii*, a plant of eight or ten inches in height, must be rejected. Mr. Baker recommends two species as best for the breeders' purpose, *S. Maglia* and *S. Commersoni.* Both these kinds yield good crops of fair quality under cultivation, and they possess the advantage of coming from a moist climate. This is a point of great importance. When Mr. Darwin, a young naturalist in 1835, was writing his account of "The Voyage of the *Beagle*," he mentioned having seen the potato growing wild on the shores of the islands of the Chonos Archipelago, in South America, and he thought it surprising that the same plant should be found in the damp forests of those islands and on the sterile mountains of Central Chili, where a drop of rain does not fall for more than six months. The explanation of this anomalous circumstance is that the potato of the islands and lowlands belongs to a different species from that of the mountains, the latter being identical with the cultivated potato of Europe and America, while the former is *S. Maglia*, which is at any rate hardy, vigorous, and healthy, and in all respects apparently well suited for crossing with the cultivated sorts. This is the potato which Mr. Baker recommends. Earl Cathcart had asked him for any suggestions that a botanist might be able to offer to breeders founded upon scientific knowledge of the potato generally and of the geographical distribution of the family.

On this part of his inquiry, Mr. Baker observes that potato-growers work upon the assumption that the one purpose of the plant's existence is the production of potatoes, which is in fact only an incident in its life. *S. Maglia* has been grown at Kew among the herbaceous plants since 1862, and in that dry sandy soil, without manure, it produces few if any tubers, or only of small size. On the other hand, two tubers were sent to Chiswick and grown there in the gardens of the Royal Horticultural Society in richly-manured land, and the produce proved abundant, yielding, the first year, 600 tubers as large as pigeons' eggs. The constitutional effects of the abnormal production of tubers which high farming occasions have been often noticed. On this point Mr. Baker says: "Any plant brought to the tuber-bearing state is in a disorganised, unhealthy condition, a fitting subject for the attacks of fungus and aphides."

It frequently happens, moreover, that the cultivated potato loses its power of producing flower and of reproducing itself by means of seed. The illustrious horticulturist, Thomas Andrew Knight, discovered the relationship of tuber to fruit, and demonstrated with great clearness the principle that, in proportion as plants or animals waste in one direction, they must economise in another. Knowing the difficulties that lay in the path, Lord Cathcart intrusted some tubers of *S. Maglia* from the coast of Chili to those eminent potato-breeders, whose collection of varieties Mr. Baker refers to as the largest in the world, Messrs. Sutton and Sons of Reading. After very careful treatment of the tubers, which were about the size of walnuts, the young plants were committed to the open ground, where, making our story as short as possible, they grew vigorously and produced numerous blossoms having white corollas, which are characteristic of wild potatoes, the corollas of cultivated breeds being purple and lilac. But whatever the seed-bearing capabilities of *S. Maglia* may be at Valparaiso and in the Chonos Archipelago, when growing in a state of nature, it did not produce a single seed in Messrs. Suttons' trial-grounds, except in the case of some blossoms which were hybridised. It is needless to describe the particular means by which this delicate operation was effected. It happens, however, that the manipulator was the same veteran breeder who had grown despondent about potatoes until this new departure had been achieved. Last winter he had reached the end of his tether. Since then he has hybridised *Solanum Maglia*, and is anticipating the conquest of new potato worlds in his old age.

The crop at Reading this first year is good, and the tubers are as large as those of ordinary potatoes. The foliage is luxuriant, growing as high as a common table. Certain other sorts have shown no capacity for "improvement." *S. Jamesii*, for example, grows at Reading only eight or ten inches high, and would scarcely be recognised as a potato except by a botanist. *S. Commersoni*, known by the synonym *Ohrondi*, from the name of a French naval surgeon who brought it to Brest from Goritti Island, at the mouth of the Rio de la Plata, was obtained last spring by Messrs. Sutton from M. Blanchard of the Gardens of the Naval Hospital at Brest. Messrs Sutton have wisely acted throughout these trials under scientific advice, and *S. Commersoni* had been named by Mr. Baker as one of the few species which are known at present to have shown a capability of "improvement." Unfortunately it resisted all the attempts that were made last summer at Reading to hybridise it with the cultivated sorts. We may hope, however, to become possessed of this and other hybrids before breeders have travelled far on the road which has now been opened to them. Previous attempts to overcome the potato disease had been mainly directed to the doctoring of the soil, or plant, and to direct attacks upon the disease. Every gardener and farmer may now welcome the birth, so to speak, of a hybrid, which, we may hope, will enable the potato plant to resist the attack of parasites, and especially those of the devastating fungus *Peronospora infestans*. H. E.

ON THE EVOLUTION OF THE BLOOD-VESSELS OF THE TEST IN THE TUNICATA

IT is well known that the test or outer tunic in most Simple Ascidians is penetrated by a system of tubes containing blood. These "vessels" were shown in 1872 by Oskar Hertwig [1] to be developed as ectodermal evaginations containing prolongations from one of the blood-sinuses of the underlying mantle. Each vessel is divided longitudinally into two distinct tubes by a septum of connective tissue, and after ramifying through the test may be found to terminate, generally close to the outer surface, in one or more rounded enlargements or bulbs which are usually known as the "terminal knobs" (Fig. 5, B). The two blood-tubes join in the terminal knob where the septum ends, and this allows the blood which flows outwards through the one tube to turn in the bulb and flow back

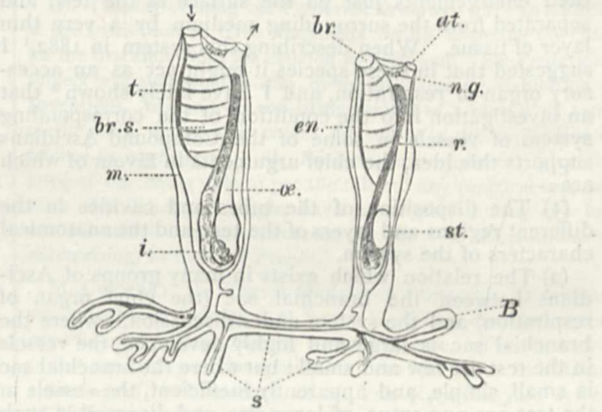


FIG. 1.—*Clavelina lepadiformis.* Enlarged from a specimen dredged off Dartmouth. *br.*, branchial aperture; *at.*, atrial aperture; *br.s.*, branchial sac; *t.*, test; *m.*, mantle; *œ.*, œsophagus; *st.*, stomach; *i.*, intestine; *r.*, rectum; *en.*, endostyle; *n.g.*, nerve ganglion; *s.*, stolon; B, part of the stolon becoming enlarged to form a bud.

along the other tube. Thus temporarily the one tube acts as an artery and the other as a vein, but of course they exchange functions at each reversal of the heart's action.

This system is usually regarded as being merely the blood-supply to the test; but Lacaze-Duthiers [2] has pointed out that the hair-like projections from the test to which sand-grains adhere in most Molgulidæ, are merely special developments of the terminations of the vessels, and I have suggested [3] that they are also homologous with the vessels in the stolon of the Clavelinidæ from which buds are produced (Fig. 1).

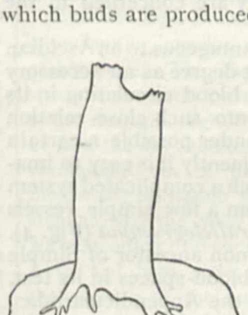


FIG. 2.

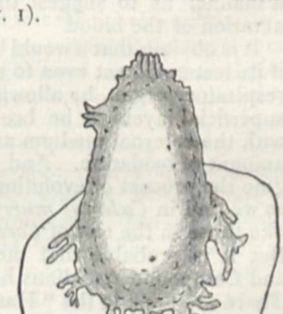


FIG. 3.

FIG. 2.—*Ciona intestinalis* from Lamlash Bay, Arran. Natural size.
FIG. 3.—*Ascidia aspersa* from Lamlash Bay, Arran. Natural size.

The extent to which this blood-system of the test is developed varies greatly in the different species of Simple Ascidians. In some, such as *Ascidia plebeia* and *Corella parallelogramma* (Fig. 4), it is very rudimentary, if indeed it can be said to be present; while in others, such as *Ascidia mentula*, *Ascidia meridionalis*, and *Ascidia*

[1] "Untersuchungen über den Bau und die Entwickelung des Cellulose-Mantels der Tunicaten," *Jenaische Zeitschrift*, Bd. vii. p. 46.

[2] *Archives de Zoologie expérimentale et générale*, t. iii. p. 314, 1874; and *Comptes Rendus*, t. lxxx. p. 600, 1875.

[3] *Proc. Roy. Soc. Edin.* 1879-80, p. 719.

reptans, the test is penetrated in all directions by a well-developed system of tubes with large and numerous terminal bulbs. A series of Simple Ascidians could be formed showing all conditions between these two extremes, and also exhibiting very varied arrangements in regard to the disposal of the vessels in the test, their modes of branching, and the relative numbers and sizes of the terminal bulbs. But perhaps the most interesting modifications of all are those met with in some of the members of the remarkable deep-sea genus *Culeolus*. There we find a great development of the vessels and their enlargements just on the surface of the test, and separated from the surrounding medium by a very thin layer of tissue. When describing this system in 1882,[1] I suggested that in these species it might act as an accessory organ of respiration, and I have lately shown[2] that an investigation into the condition of the corresponding system of vessels in some of the Compound Ascidians supports this idea, the chief arguments in favour of which are :—

(1) The disposition of the tubes and cavities in the different regions and layers of the test, and the anatomical characters of the system.

(2) The relation which exists in many groups of Ascidians between the branchial sac (the chief organ of respiration) and the system under discussion,—where the branchial sac is large and highly developed, the vessels in the test are few and small; but where the branchial sac is small, simple, and apparently inefficient, the vessels in the test are numerous, of large size, and disposed in such a manner as to suggest that they are concerned in the aëration of the blood.

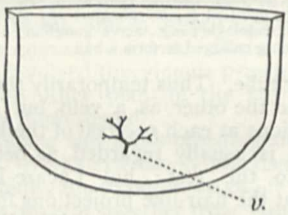


FIG. 4.—*Corella parallelogramma*. The posterior part of the left side of the test of a specimen from Loch Fyne. Twice the natural size. *v.*, the system of vessels.

It is obvious that it would be advantageous to an Ascidian if its test could act even to a slight degree as an accessory respiratory organ, by allowing the blood circulating in its superficial layers to be brought into such close relation with the external medium as to render possible a certain amount of oxidation. And consequently it is easy to imagine the process of evolution of such a complicated system as we find in *Culeolus murrayi* from a few simple vessels like those in the test of *Corella parallelogramma* (Fig. 4). But it is probable that the common ancestor of Simple and Compound Ascidians had no blood-spaces in its test. There are none in the "Haus" of the Appendiculariidæ; and in *Clavelina*, which may be regarded as nearer to the first Simple Ascidian than any other form known, there are no vessels in the test except those of the stolon. Some structure must therefore be looked for from which the first respiratory blood-system of the test may have been evolved, and such a structure is to be found, I believe, in the gemmiparous stolon of the Clavelinidæ.

Clavelina (Fig. 1), which from other independent evidence I regard as the most primitive form of Simple Ascidian known to science, is one of the so-called "Social" Ascidians in which the members of the colony are united by a creeping stolon containing "vessels" (that is a prolongation of the ectoderm and the mantle, and a blood-tube) which place the circulatory systems of the various members in communication, and from the ends of which, in prolongations of the test (as at B, Fig. 1), new members are produced by gemmation. It is possible that this system may act in some slight degree as a respiratory organ, but its chief function, and probably its only one, is the asexual production of new individuals.

[1] "Zoological Reports of the *Challenger* Expedition," Part xvii. pp. 90 and 279.

[2] *Proc. Lit. and Phil. Soc.*, Liverpool, session 1884-85.

The ancestors of the remaining Simple Ascidians diverged from the ancestors of the Clavelinidæ, and lost the power of reproducing by gemmation, but in many of the least modified of the Ascidiidæ we still find processes from the posterior end of the test which contain vessels, and so closely resemble the stolon of *Clavelina* in all particulars that there can be no doubt that they are persistent rudiments of that structure.

In *Ciona*, which is certainly one of the most primitive of the Ascidiidæ, vessels are only present in the posterior part of the test, and here we frequently find them drawn out into long processes of the test, which have the greatest possible resemblance to stolons (Fig. 2), and are doubtless their homologues, although they no longer function as bud-producing organs. They are useful as adhering organs, and they have probably to a slight extent commenced to perform a respiratory function.

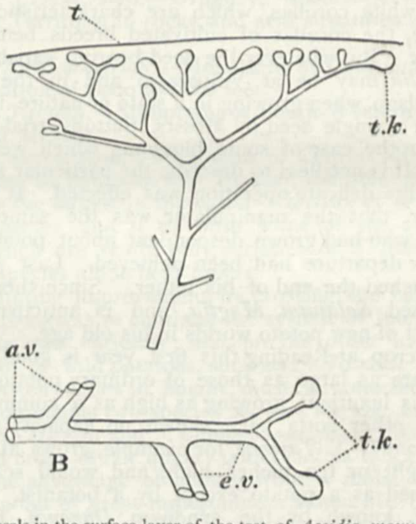


FIG. 5.—Vessels in the surface layer of the test of *Ascidia mammillata* as seen in a section magnified about 40 diameters. B, small part of the system more highly magnified; *a.v.*, afferent vessel; *e.v.*, efferent vessel; *t.k.*, terminal knob; *t.*, surface of the test.

I imagine then the first stages in the evolution of the "respiratory" vessels to be as follows :—As the ancestors[1] of the Ascidiidæ lost the power of reproducing by gemmation, the vascular stolons became rudimentary, until they were useful merely as adhering organs. For some time they would only be produced at the posterior end of the test (their original position in the Clavelinidæ), but in course of time they would extend further forwards along the left side of the body (the side upon which most Simple Ascidians lie) so as to anchor the animal more securely, and we even find them occasionally in this condition in *Ciona intestinalis* and in *Ascidia aspersa* (Fig. 3).

They would then probably (in some not very remote ancestor of *Ciona*) begin, while still acting as adhering organs, to be of some slight use in respiration, and would, consequently, by the action of natural selection, be evolved gradually into a larger system of vessels extending over a wider area of the test. And here might be shown a series of the Ascidiidæ passing from *Ciona* (Fig. 2) through *Corella* (Fig. 4), and *Ascidia plebeia*, in which the system is still very feebly developed and confined to the posterior half of the left side of the

[1] See phylogenetic table in "*Challenger* Reports," part xvii. p. 286.

test, by gradual stages to *Ascidia mammillata* (Fig. 5), where the vessels are numerous all over the test, branch freely in its outer layer, and terminate close to the surface in large ovate bulbs, which are usually found filled with blood-corpuscles.

The only part of this history which presents any difficulty is the passage from the Clavelinid to the Cionid arrangement, from the gemmiparous stolon to the first traces of a respiratory system of vessels. This can, I believe, be most satisfactorily explained by assuming that the rudimentary stolons after they had lost their primary function became useful as adhering organs (Figs. 2 and 3), and consequently were retained or possibly increased by the action of natural selection, until their respiratory function became established.

I hope to work out the modifications of the system throughout the various groups of Ascidians in detail, and the results will probably be given in Part II. of the Report on the *Challenger* Tunicata.

W. A. HERDMAN

NOTES

THE Council of the Royal Astronomical Society have awarded their gold medal to Dr. W. Huggins for his researches on the motions of stars in the line of sight and on the photographic spectra of stars and comets. The presentation takes place at the annual meeting next month. This is the second time that Dr. Huggins has received the medal, he having, in 1867, in conjunction with the late Prof. Miller, received it for his researches in astronomical physics.

THE will of Mr. George Bentham, who died in September last, has been proved by Sir Joseph Dalton Hooker and the Right Hon. Sir Nathaniel Lindley, the executors, the value of the personal estate amounting to over 23,000*l*. The testator bequeaths, among other sums, 1000*l*. each to the Linnean Society of London and the Royal Society Scientific Relief Fund. The residue of his real and personal estate is to be held upon trust to apply the same in preparing and publishing botanical works, or in the purchase of books or specimens for the botanical establishment at Kew; or in such other manner as his trustees may consider best for the promotion of botanical science.

AT the meeting of the Colonial Institute on Tuesday, Gen. Sir Henry Lefroy read a paper on the meeting of the British Association in Canada. Sir Lyon Playfair, M.P., referred to the visit of the British Association as marking a point in the advance of civilisation. Canada's position of having federated, not under the pressure of war, but in a time of profound peace, was unique in the history of the world. The science of Great Britain belonged to the Empire, and it was right that Canada should be the first to try to federate the science of the United Kingdom, and distribute it over the Empire. What Canada wanted was not pure science, but applied science, to bind together her vast territory by railways. But knowing that applied science did not come except pure science preceded it, Canada had had the forethought and wisdom to welcome that pure science to the Dominion. Sir Lyon gave a humorous account of an adventure he had in a wild part of Ottawa with a Scotch mining manager. It turned out that the manager, when in Scotland, had attended the Mechanics' Institute at Glasgow, and afterwards the evening classes at the Andersonian Institution, obtaining a knowledge of chemistry and mineralogy, which had stood him in good stead on emigrating to Canada. From his compatriot he (Sir Lyon) heard of many other Scots of a like type, all of whom had got on well, from the scientific education they had acquired at similar institutions. For such men he did not know any better country than Canada to find openings for getting on in the world. Prof. G. T. Bonney spoke at some length of the interesting geological formation of Canada, and said he believed that the district north of the St. Lawrence was rich in valuable minerals, and that exploring parties for their discovery should be organised to supplement the systematic geological survey which was being slowly conducted. He condemned the wasteful treatment of the forests that was going on in some of the parts he had visited, and suggested that it was a matter which should engage the attention of the Dominion Government.

ON Tuesday evening Sir Frederick Bramwell gave an address at the Institution of Civil Engineers on his assuming the chair for the first time since his election as president. Sir Frederick's subject was suggested to him by the forthcoming Exhibition of Inventions, his address consisting mainly of a review of some of the most remarkable recent inventions in the application of science to engineering. Sir Frederick has apparently given up hope of our being able to put the tides to any practical use, and hints that Khartoum might have been relieved long ago had our aëronauts been as inventive, or our War Department as enterprising, as those of France.

M. COCHERY, the French Minister of Posts and Telegraphs, was present, on January 2, at Rouen to witness some interesting experiments in telephoning to a great distance. The object was to test the results of the application between Rouen and Havre, a distance of 90 kilometres, of M. Van Rysselberghe's system of instantaneous transmission. The experiment was perfectly successful, and during more than one hour, messages were exchanged between Rouen and Havre. The Minister announced, on leaving Rouen, that the communication would be open to the public in about a fortnight. Since January 1 the first telephonic offices have been open in Paris, and it is probable that communication will soon be established between Paris and Rouen.

MR. LANT CARPENTER lectures on Sunday at the Sunday Lecture Society, on "The Life and Work of Sir William Siemens," illustrated by experiments, diagrams, and the oxy-hydrogen lanterns. Mr. Carpenter has, we understand, obtained some special materials, of which he will make use in his lecture.

REPORTS from Brussels state that the Spanish earthquake, or a similar simultaneous earthquake, was felt at the Royal Observatory there. The Observatory is stated not to be provided with special instruments for recording earthquakes, as these phenomena are so rare and slight in Belgium. It is said that on December 26 last, the day succeeding the first great shock of the Spanish earthquake, one of the astronomical clocks in the principal meteorological station in the Boulevard de l'Observatoire was stopped, and the other went irregularly. The officer charged with attending to them perceived that the pillars on which they rested had been displaced, and were no longer vertical. On the evening of the same day, M. Lagrange, when about to make some observations, noticed that the large telescope was also displaced. It appears from this that the undulations of the crust of the earth, which have had such disastrous effects in Spain, extended as far as Brussels, and although their effects were not generally appreciable in the latter city, yet they were noticeable in the case of delicate instruments, such as astronomical clocks. It would be interesting to have a precise, authentic statement on this subject, and also to learn whether similar effects were noticed anywhere else in Europe during the last week of the old year.

AT a recent meeting of the German Asiatic Society of Japan a paper was read by Dr. H. Muraoka of Tokio, on the magic mirror of Japan. It is generally supposed that its magical quality was discovered only recently; but it was, says Dr. Muraoka, known for a long time in Japan. Old ladies have told him that in their youth, fifty years since, they frequently noticed, when at toilet, that the reflection of the sun from the mirror on the wall or ceiling contained the figures or letters on its back. It is said to have been known to the Romans in connection with some of their mirrors, and any one concealing a mirror possessing this quality was arrested as a sorcerer; but the authority for this statement is not given. The subject is engaging considerable attention, as will be seen from the fact that in recent years a list of fourteen writers on the subject is quoted, from Stanislas Julien, in 1847, to Messrs. Ayrton and Perry quite lately; and, as the subsequent discussion showed, there are omissions even in this list. These writers, especially the two latter, have demonstrated beyond doubt that unequal convexities in the mirror beget its magical quality. The polished surfaces are convex, but the convexity is not continuous, and is broken in certain places. After going over what had already been done on the subject, and its results, the author described his own investigations. The riddles of the mirror are far from being all answered by the discovery of unequal convexity. For example, how is the inequality caused—by pressure, heat, or by changes in the molecular tension of the metal plates? The writer tried many experiments to answer the question, and he succeeded by means of chemical agents in drawing lines on the flat back of a mirror, which were reproduced on a reflected image from the front. His results are: That the irregularity in the convexity is caused by the grinding, which alters the molecular tension, that the magic mirror may be produced at will (it was generally supposed to be the work of chance alone), and that the magical quality attributed to it is not confined to Japanese bronze, but is common to all firm, elastic substances. A curious process employed by mirror-workers is described by Dr. Muraoka: it appears to be one of the secrets of the craft. If the surface of a mirror has been made concave by mechanical pressure, the injury is not repaired, as might be expected, by hammering the other side, or otherwise forcing the metal back into its place. The workman takes an iron tool with rounded, but slightly rough, top, and rubs the concave portion of the mirror in all directions, until a fine network of scratches has been formed. The place then rises of itself, and, instead of being concave, becomes more convex than the rest of the surface. This convexity is then shaved away with a knife made for the purpose, until it becomes even with the rest of the mirror. When this is done the whole surface is again ground, polished, and amalgamated.

A STRANGE Japanese custom has, according to the *Japan Mail*, been brought to light by the working of the conscription law. The head of a certain family was instructed that the time had come for his son, whose name was on the census list, to undergo medical examination prior to actual enlistment. The father lost no time in informing the authorities that the individual referred to, though bearing a male name, was his daughter. He explained that having lost two daughters, both about one year old, he had been driven to this expedient to keep the third alive. It appears, further, that in many districts of Japan people still resort, in their anxiety to prolong the lives of their children, to the custom of bestowing upon their offsprings names ordinarily given to infants of the opposite sex, whenever death has made frequent visits to their households. The present case occurred in the capital.

AN important memoir by Lieut. Casey on the North American species of beetles of the sub-family *Stenini* has just been published. It extends to over 200 octavo pages, and describes in minute detail nearly 170 species, of which the greater part are new, and should form one of the most important contributions to systematic entomology in the States that have appeared. "*Stenus*," in the broad sense, is well defined as a whole, but is notoriously difficult in detail. When genera become unwieldy owing to the mass of species included, it is a convenience to students if they can be split up by recognisable divisional characters. Acting on this idea, Casey has split "*Stenus*" into *Stenus* and *Areus*, on tarsal structure. This subdivision equally affects European (and even British) species.

MR. ALDERMAN W. H. BAILEY, as President of the Manchester Society of Engineers, gave an interesting inaugural address on the 10th inst., his subject being "The Reign of Law in Relation to the Unification of Engineering Work." "The reign of law," Mr. Bailey stated, "is imperial in the domain of the engineer. He deals with forces which have definite, fixed values. If he perceives a quantity or a force he knows that he can identify the same measure or quantity of the like whenever he meets with its equivalents under equal conditions. We know that chance does not rule, and if there be conditions that are indefinite or obscure to us it is not because there is no law, but because we are ignorant of its records." This text Mr. Bailey illustrated by reference to the necessity of exact measurement, supporting his position by numerous examples.

PROF. F. ELGAR is about to deliver a special course of evening lectures, in the University of Glasgow, upon "The Buoyancy and Stability of Ships." The course will consist of twelve lectures, commencing on the 22nd inst. These lectures are intended not only for students of this branch of the science of naval architecture, but also for the convenience of draughts men and others who are employed in shipyards during the day, and who are unable to attend the regular University classes.

IN the report of the Meteorological Service of Canada for 1884, attention is again called to the advisability of establishing a marine department in connection with the Meteorological Service for the purpose of organising a system of observations on the ocean by steamers crossing the Atlantic and by those trading with ports in Brazil and the West Indies. Canada, having great shipping interests, should, it is thought, take her part in the great international work now going on of charting the meteorological conditions prevalent over the Atlantic, and in the general development of ocean meteorology. Such observations in the North Atlantic would, it is stated, be of great value, especially in perfecting knowledge of the movements of a particular class of storms. Recent investigations on the subject of the climatic relations of Canada to European countries show that the Dominion has the latitudes of Italy, France, Germany, Austria, the British Islands, Russia, Sweden, and Norway, and has as many varieties of climate as have those countries. There is greater cold in winter in many of the latitudes of Canada than in corresponding latitudes in Europe, but the summers are about the same. The most southern part of Canada is on the same parallel as Rome, Corsica, and the northern part of Spain; it is farther south than France, Lombardy, Venice, or Genoa. The northern shores of Lake Huron are in the latitude of Central France, and vast territories not yet surveyed lie south of the parallel of the northern shores of Lake Huron, where the climate is favourable for all the great staples of the temperate zone.

WITH the new year *Cosmos*, the well-known French scientific journal, will enter on a new period. The size will be increased, in order that larger illustrations may be introduced. It will in future consist of 64 columns, two on a page, each of which will contain more matter than its present page.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, a Macaque Monkey (*Macacus cynomolgus* ♀) from India, a Vulpine Phalanger (*Phalangista vulpina* ♀) from Australia, presented by Mr. J. Church Dixon; a Mouflon (*Ovis musimon* ♂) from Corsica, presented by H.R.H. the Duke of Edinburgh, K.G.; a Vulpine Phalanger (*Phalangista vulpina* ♂)

from Australia, presented by Mr. B. C. Parr; a Short-toed Eagle (*Circaetus gallicus*) from Suez, presented by Capt. H. E. Robbins; a Lacertine Snake (*Cœlopeltis lacertina*) from North Africa, presented by Mr. R. F. Sibbald; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, deposited; a Black and Yellow Hawfinch (*Mycerobus melanoxanthus*) from Yarkland, a —— Pastor (*Sturnia* ——) from the Andaman Islands, four Starred Tortoises (*Testudo stellata*) from India, a Tuberculated Iguana (*Iguana tuberculata*) from South America, purchased.

OUR ASTRONOMICAL COLUMN

THE NAVAL OBSERVATORY, WASHINGTON.—The Report of the Superintendent of this establishment, Commodore S. R. Franklin, to the Navy Department, for the year ending October 31, 1884, has been issued. Great stress is laid upon the importance of commencing the buildings for the new Observatory. The present site is stated to be notoriously unhealthy, and the buildings are in a dilapidated state, and, as the ground for the new Observatory has been purchased and the plans made and approved, the Superintendent urges that Congress should be appealed to during the coming session for a portion at least of the funds required for the new Observatory. His estimate "For the purpose of erecting a new Naval Observatory and necessary buildings upon the site purchased under the Act of Congress, approved February 4, 1880," amounts to 586,138 dollars, or approximately 120,000*l*. The 26-inch equatorial was chiefly employed in observations of the satellites of Neptune, Uranus, Saturn, and Mars; in the case of Uranus, the observations were confined mostly to the two outer satellites, and have now been discontinued, as the favourable time for determining the position of their orbits has passed. Since this instrument was mounted in 1873 observations of the faint satellites of the planets have constituted its main work, and the laborious discussion of the observations, with the view to the correction of orbital elements, was commenced in earnest in August 1883, and is now in a very advanced state, particularly as regards the satellites of Saturn. A report from Prof. Harkness, in charge of the work for the Transit of Venus Commission, is appended: the measurements of the negatives obtained at the various stations was completed last August; the number of photographic plates giving satisfactory results is 932 for the northern and 639 for the southern hemisphere. Prof. Harkness enters into details with respect to these measures, and the method of conducting them, for which reference must be made to the report. The Superintendent regrets that the printing of the Washington observations is not so advanced as is desirable, and proposes applying to Congress for a sum of 1000*l*. annually for a few years, in order to bring up work to date, after which a smaller sum would allow of the due publication of the observations.

THE DEARBORN OBSERVATORY, CHICAGO.—The report of the Director of this Observatory, Prof. G. W. Hough, dated June 18, 1884, has been received within the past week. The work with the 18-inch equatorial was confined, as usual, during the previous year to the observations of a few special objects, including Pons's comet of 1812 on its reappearance, difficult double-stars, the planet Jupiter, and the satellites of Uranus. Thirty-two new double-stars, most of which are difficult, were detected. The companion of Sirius was measured by Prof. Hough on eleven nights, and by Mr. Burnham on ten nights, the mean result being

1884·185 ... Position, 36°·6; Distance, 8″·45.

which, with the observations of recent years, seems to indicate that the period of revolution of the companion is longer than that indicated by theory. The disk of Jupiter was observed on every favourable occasion, and micrometric measures made on the principal spots and markings, including the great red spot first remarked in 1878. With best vision the colour of this object in 1883-84 was "unmistakably a pale pink." The spot is stated to have maintained its size, shape, and outline during the five years it has been observed at Chicago; in this respect experience there has not fully accorded with the impressions of some observers, that the spot had "lost its outline, and become merged in a faint belt on the following end." The most marked change has been in its degree of visibility, but it was seen at Chicago as long as the planet was observable. Prof. Hough adds that from 1879 to 1883 the spot had a retrograde drift in longitude upon the surface, or, in other words, the apparent rotation of Jupiter was increased from 9h. 55m. 34·0s. in 1879 to 9h. 55m. 38·4s. in 1883. During the last opposition this drift appears to have nearly ceased. The mean period from September 12, 1883, to June 11, 1884, comprising 660 rotations, is 9h. 55m. 38·5s., and the mean for the whole five years of observation is 9h. 55m. 37·0s. The report is accompanied by six tinted lithographs of the appearance of Jupiter's disk. Saturn was frequently examined with the view to detecting markings on the rings, but all observations so far in this direction have been negative. While the rings have been sharply defined, and even the boundary of the dark ring well seen, "nothing indicating a division in the outer ring has ever been noticed." This is not in accord with the conclusion of many other observers provided with telescopes of less optical capacity than the Dearborn refractor.

GEOGRAPHICAL NOTES

A SO-CALLED "envoy" of the Mayor of Timbuktu, lately arrived in Paris, has been received by the French President, and introduced to the Geographical Society at its last meeting. On this occasion it was stated that there is no Sultan or military authority in this famous metropolis of Negroland, but only a body of merchants who yearly elect a kind of mayor from amongst themselves. This statement is not quite correct, and, as little is known regarding the internal affairs of the city, the following facts will be acceptable:—For over 200 years Timbuktu has been administered by a "Kahia," a kind of burgomaster, originally appointed by the Emperor of Marocco from the Moorish Andalusian family of Er-Rami some time after the expulsion of the Arabs from Spain. The office became hereditary in this family, and the present Kahia, or "Amir," as he now affects to call himself, is Muhammed Er-Rami, whose Negroid features are the result of long alliances with the surrounding Souhray population. He commands little influence, and is practically a mere puppet in the hands of whichever of the rival Arab, Imosharh (Berber) or Fulani (Fulah), factions happens for the time being to have the upper hand. The Imosharhs command the whole district between Timbuktu and Arawán, and their Sheikh or "Sultan," Eg-Tandagumu, seems to draw his chief supplies from the plundered caravans passing through his territory. The Arabs, as in the time of Barth, are still ruled by the head of the illustrious El-Bekay family, a branch of the Kuntza tribe, whose present chief is Sheikh Abadin. His policy has long been to side with the Fulani, whose power here, as elsewhere in the Western Sudán, is constantly on the increase, and who threaten to become absolute masters of Timbuktu unless this place falls into the hands of some European power advancing from the west or penetrating up the Niger valley from the south.

ACCORDING to the *Turkestan Gazette*, Dr. Grishimailo, the traveller and entomologist, has concluded his investigations into the natural history of Turkestan for the present. He began his travels in the Fergana Valley, and from thence he went into the Altai region, which he examined thoroughly. In the course of the summer he visited Osch, Arawan, Nankat, Utch-Kurgan, Shahimardan, Karakazyk, Koksu, Tekelik, the River Balykty, Karamuk, and Zanku; on his return he visited Karamuk, Jirgetal, Sarzbulak, Koksu, Altyumazar, and went on foot through the Trans-Altai Mountains to Bordooba and Karakul. The geological collections are very considerable. In lepidoptera alone there are 17,000 specimens, amongst them being many new kinds. The expedition was also a success from an ethnographical and anthropological point of view. Many heights were measured and thermometrical observations made throughout the whole journey. The traveller met many evidences of the existence of a glacial epoch in Central Asia: amongst these are mentioned the presence of forms in Thian-shan, which hitherto have only been found in Labrador, Greenland, Lapland, and the Swiss Alps. Next year Dr. Grishimailo contemplates visiting the western offshoots of the Thian-shan range, because this locality has never yet been examined thoroughly from a geological point of view.

AT the last meeting of the Geographical Society of St. Petersburg, M. Beliaffsky made a communication respecting the journey which he undertook in order to explore the central road leading to the interior of Central Asia. This road is much shorter than the usual route, but was considered until very lately as the worst and most difficult. But upon examining the obstacles presented by the road, and principally the alleged impossibility of effecting a passage through Mertvy, Koultouk, Oust-Oust, &c., M. Beliaffsky found the assertion to be erroneous, and therefore pronounces himself in favour of the road he has explored. In order to render it still more easy, he proposes that regular communication should be established on the Caspian Sea between Astrakhan and Cesarewitch Bay, that two lighthouses, at least, should be constructed; that a steam navigation service should be established on the Amu-Doria, and a road practicable for vehicles made through the sands between the Amu-Doria and Khiva.

THE last (xi.) of Mr. Lansdell's series of interesting letters from Central Asia in the *Times*, describes his journey by boat down the Oxus, from Charjui to Khiva. In referring to the fish of the Oxus, he mentions the *Scaphyrincus*, a kind of sturgeon, the discovery of which in Central Asia, a few years ago, made quite a flutter among the students of ichthyology by reason of its resemblance to one of the North American sturgeons, which was found for a long time in the Mississippi only, until Fedchenko discovered one in the Syr Daria, and subsequently M. Bogdanovitch found another species in the Lower Oxus. The Oxus fish is known as *Scaphyrincus kaufmanni*. M. Bogdanovitch points out its interest from a geological point of view. "In the Palæozoic period," he says, "the ganoid fishes used to inhabit all the waters of the world in a great number of forms, comprising almost entirely the ichthyological fauna of that period. At the period of the Devonian formation this group of fishes seems to have reached its highest development, and in the strata of this formation are preserved the most numerous remains of its representatives. In the succeeding geological period this group appears to fall and die out, giving place to a group of *Teleostei* or bony fishes, which inhabited at that time all the waters of the world in a number of forms."

ON December 3, 1884, was celebrated, in the Scandinavian kingdoms, the bi-centenary of the birth of Ludwig Holberg, "the northern Molière" Prof. Erslev took advantage of the occasion to bring to the notice of the Danish Geographical Society the services to geography of the great dramatic poet in his generation. When Holberg was appointed Professor of History and Geography in 1730, the latter science was in a bad plight everywhere, and especially in Denmark. According to the curriculum, the Professor had to hold a reading once a fortnight on geography, but it is not known whether these readings actually took place. Holberg's great interest in geography is evident, not only from his own geographical writings, but also from many of his observations elsewhere. He betook himself with much eagerness to the study of the subject; in a preface to Van Howen's "Journey to Russia" (1743) he recommended others to write similar descriptions of their journeys. His own first geographical work was a description of Denmark and Norway (1729), the second "An Account of the Celebrated Norwegian Commercial City, Bergen" (1737), which is said to be useful even still. His third work was a geographical textbook in Latin, entitled "Ludovici Holbergii Compendium Geographicum in usum Sudiosi Juventulis," of which there were several editions both in Copenhagen and Leipzig. The work was translated into English in 1758, with a small universal history by Holberg. Some editions of it belong now to the class of bibliographical rarities. His work was edited after his death by Pastor Jonge, but Holberg's fifty-eight small obtavo pages grew into seven large quarto volumes.

CAPT. WILLARD GLAZIER, of the United States Navy, has communicated to the English Royal Geographical Society his discovery of the true source of the Mississippi. This has long been a vexed question, and in June, 1881. Capt. Glazier organised and led an expedition with the object of finally settling the matter. The expedition proceeded in canoes *viâ* Leech Lake to Lake Itasca, and, accompanied by an old Indian guide, pushed forward to the south; and the captain was rewarded by the discovery of another lake of considerable size, which proved to be, without the shadow of a doubt, the true source of the Mississippi. It is in lat. 47° 13′ 25″, and the lake is 3 feet above Lake Itasca, the hitherto supposed source of the river. The Mississippi may, therefore, be said to originate in an altitude 1578 feet above the Atlantic Ocean, and its length, taking former *data* as the basis, may be placed at 3184 miles. The tract of country in which the river originates is a remote and unfrequented region.

AN embassy of two hundred and fifty representatives of the aboriginal tribes of Western China, which recently arrived at Pekin, has led a writer in the *North China Herald* to give some information with regard to these little-known peoples. These tribute-bearers are under the charge of native chiefs, who are responsible to the Chinese authorities of the province for the maintenance of order, and the fulfilment of all recognised obligations, one of which is that of visiting Pekin once in twelve years with tribute. The localities from which they come are scattered over the country from Yennan to Kansu, all along the Thibetan border of Sze-Chuan. At one time their name, Tu Sze, or "aboriginal officers," embraced all the aboriginal tribes in Western and South-Western China. The Chinese never had the aid of ethnology to guide them in discriminating between subject peoples by their languages, customs, physical characteristics, and religious beliefs, but they have collected the materials for judging, and we now know, generally speaking, in what category to place the different races met by travellers in Western China. The Lolos of Sze-Chuan are allied to the Burmese, the tribes represented at Pekin, who are also called Hsi Fans, are Thibetans. Both may be called the Mon-Bod family, or Western Himalaic, according as the ethnological inquirer prefers to determine his nomenclature by mountain chains, or by the most prominent race-names prevailing among the people themselves. The Thibetans and Hsi Fans prefer Bod for their race-name, as the Burmese do Mon. The rest of the aboriginal tribes in Western China and in the southern provinces, whether Miao, Yao, or Tung, seem all to belong to the Eastern Himalaic branch, or that of the Siamese, the Laos tribes, the Shan tribes of the Indo-Chinese peninsula, the Li tribes of Hainan, and the Cambodians and Cochin Chinese. The Lolos, as described by M. Baber, live in their own mountains apart, and seem to be a nation, while the Hsi Fans live in scattered tribes whose natural home is Thibet. They are short of stature, fond of red clothing, and, as to shape, adopt Chinese fashions in no small degree. Their faces are rounder than the Chinese, their heads smaller, their noses less stunted, and, while small, stand out to a point. Their eyes are small, placed in a line, and have a bright black lustre. They are a quiet race now; but history shows that they struggled bravely against the all-conquering Chinese. Details respecting the twelve Hsi Fan tribes of Sze-Chuan are to be found in numerous Chinese books, and there are also many official and private accounts of the wars which ended in their subjection.

DR. DOMENICO LOVISATO's paper on Tierra del Fuego, reprinted from a recent number of Guido Cora's *Cosmos*, adds considerably to our knowledge of that inhospitable region and its inhabitants. The division of the latter into three distinct groups, Ona in the east, Alaculuf in the west, and Yahgan in the south, is fully confirmed. But the two latter appear to be fundamentally one, constituting a single type of "Asiatic" descent, while the first mentioned is certainly of Tehuelch (Patagonian) stock. The Onas, all hunters, number about 20 0; the Yahgans, mainly fishers, perhaps 3000; the Alaculufs, hunters and fishers, 3000; giving a total population of not more than 8000 to the whole archipelago. All seem to present more or less indications of degeneracy from a higher state of culture, due probably to long isolation in this unfavourable environment since its separation in early quaternary times from the mainland. That it was inhabited by the ancestors of the Yahgans and Alaculufs even before the opening of Magellan Strait, appears evident, especially from the numerous kitchen-middens, some of vast size and great antiquity, scattered over the archipelago. Those of Elizabeth Island, by far the largest, the oldest, and in every respect the most interesting, run in one direction a distance of nearly a mile to a deep barranca, or ravine, beyond which they again stretch away for an interminable length along the coast. They stand at an elevation of from twenty to twenty-five feet above the present sea-level, and consist of a lower stratum of shells, bones, and other refuse, succeeded by a layer of fine sea-sand forty-five to fifty inches thick, above which comes an accumulation of rich vegetable humus overgrown with an abundant herbaceous vegetation. Whether the layer of sea-sand has been washed up or was deposited during a temporary subsidence of the land cannot be determined without further research. But in either case its presence bespeaks a vast antiquity for the lower stratum of refuse, which has an average depth of over three feet, and which contains the shells of *Mytilus pata-*

gonicus, of *Aulacomya magellanica*, of *Patella magellanica*, fragments of *Otaria jubata*, and a few other mammals, but no human remains, no traces of pottery, no bones split for the extraction of the marrow, no arms or manufactured objects beyond a few rude spear- or arrow-heads. All this offers the most striking analogy to the more recent and modern refuse heaps now being formed, and seems to point at a continuity of population since early quaternary times. The absence of human remains or split bones might even imply that the primitive inhabitants, like their present descendants, were at no period addicted to anthropophagy. In other respects the latter occupy an extremely low social position. They practise no arts beyond the manufacture of frail bark canoes, unchanged since the time of Drake's visit, shell knives, bows, darts, and harpoons. The wigwams are branches stuck in the ground and gathered to a point above, or else a mere guanaco skin (among the Onas) suspended from a tree to windward. Their food is mainly fish, crustaceans, wild berries, mushrooms, cetaceans, greedily devoured in a highly putrescent state. They believe in ghosts and demons, but have no idea of a god, or of any religious worship; are guided rather by instincts than by reason; lack even the maternal sentiment, at least after the period of weaning; show no feeling of real affection for friends or kindred, the only developed sentiment being that of pure selfishness. Their stupidity is such that they are unable to count beyond three, after which everything is *vuru*—much, many. Yet, in the face of all this the writer was assured by the English missionaries now evangelising these primitive or debased peoples, that the language of the Yahgans, into which they have translated the Gospel of St. Luke, contains no less than 30,000 words, "a wealth contrasting strangely with their present low state of culture, and naturally suggesting the hypothesis of an origin very different and far superior to the present." But, assuming a former higher state, the difficulty is to understand how such a rich linguistic inheritance could have been preserved for countless generations in their present degraded condition, and amid the adverse surroundings of their present habitat. On this subject clearly more light is demanded.

CHARACTERISTICS OF THE NORTH AMERICAN FLORA[1]

II.

THIS contrast is susceptible of explanation. I have ventured to regard the two antipodal floras thus compared as the favoured heirs of the ante-Glacial high northern flora, or rather as the heirs who have retained most of their inheritance. For, inasmuch as the present Arctic flora is essentially the same round the world, and the Tertiary fossil plants entombed in the strata beneath are also largely identical in all the longitudes, we may well infer that the ancestors of the present northern temperate plants were as widely distributed throughout their northern home. In their enforced migration southward, geographical configuration and climatic differences would begin to operate. Perhaps the way into Europe was less open than into the lower latitudes of America and Eastern Asia, although there is reason to think that Greenland was joined to Scandinavia. However that be, we know that Europe was fairly well furnished with many of the vegetable types that are now absent, possibly with most of them. Those that have been recognised are mainly trees and shrubs, which somehow take most readily to fossilisation, but the herbaceous vegetation probably accompanied the arboreal. At any rate, Europe then possessed Torreyas and Gingkos, Taxodium and Glyptostrobus, Libocedrus, Pines of our five-leaved type, as well as the analogues of other American forms, several species of Juglans answering to the American forms, and the now peculiarly American genus Carya, Oaks of the American types, Myricas of the two American types, one or two Planer-trees, species of Populus answering to our Cotton-woods and our Balsam-poplar, a Sassafras, and the analogues of our Persea and Benzoin, a Catalpa, Magnolias, and a Liriodendron, Maples answering to ours, and also a Negundo, and such peculiarly American Leguminous genera as the Locust, Honey Locust, and Gymnocladus. To understand how Europe came to lose these elements of her flora, and Atlantic North America to retain them, we must recall the poverty of Europe in native forest trees, to which I have already alluded. A few years ago, in an article on this subject, I drew up a sketch of the relative richness of Europe, Atlantic North America, Pacific North America, and the eastern side of temperate Asia in genera and species of forest trees (*Am. Journ. Sci.* iii. vi. 85). In that sketch, as I am now convinced, the European forest elements were somewhat under-rated. I allowed only 33 genera and 85 species, while to our Atlantic American forest were assigned 66 genera and 155 species. I find from Nyman's Conspectus that there are trees on the southern and eastern borders of Europe which I had omitted, that there are good species which I had reckoned as synonyms, and some that may rise to arboreal height which I had counted as shrubs. But on the other hand and for the present purpose it may be rejoined that the list contained several trees, of as many genera, which were probably carried from Asia into Europe by the hand of man. On Nyman's authority I may put into this category *Cercis Siliquastrum*, *Ceratonia Siliqua*, *Diospyros Lotus*, *Styrax officinalis*, the Olive, and even the Walnut, the Chestnut, and the Cypress. However this may be, it seems clear that the native forest flora of Europe is exceptionally poor, and that it has lost many species and types which once belonged to it. We must suppose that the herbaceous flora has suffered in the same way. I have endeavoured to show how this has naturally come about. I cannot state it more concisely than in the terms which I used six years ago.

"I conceive that three things have conspired to this loss of American, or as we might say, of normal types sustained by Europe. First, Europe, extending but little south of lat. 40°, is all within the limits of severe glacial action. Second, its mountains trend east and west, from the Pyrenees to the Carpathians and the Caucasus beyond; they had glaciers of their own, which must have begun their work and poured down the northward flanks while the plains were still covered with forest on the retreat from the great ice forces coming from the north. Attacked both on front and rear, much of the forest must have perished then and there.

"Third, across the line of retreat of whatever trees may have flanked the mountain ranges, or were stationed south of them, stretched the Mediterranean, an impassable barrier. . . . Escape by the east, and rehabilitation from that quarter until a very late period, was apparently prevented by the prolongation of the Mediterranean to the Caspian, and probably thence to the Siberian Ocean. If we accept the supposition of Nordenskjöld that, anterior to the Glacial period, Europe was 'bounded on the south by an ocean extending from the Atlantic over the present deserts of Sahara and Central Asia to the Pacific,' all chance of these American types having escaped from and re-entered Europe from the south and east seems excluded. Europe may thus be conceived to have been for a time somewhat in the condition in which Greenland is now. . . . Greenland may be referred to as a country which, having undergone extreme glaciation, bears the marks of it in the extreme poverty of its flora, and in the absence of the plants to which its southern portion, extending six degrees below the Arctic circle, might be entitled. It ought to have trees and it might support them. But since their destruction by glaciation no way has been open for their return. Europe fared much better, but has suffered in its degree in a similar way" (*American Journal of Science, l.c.*, p. 194).

Turning to this country for a contrast, we find the continent on the eastern side unbroken and open from the Arctic circle to the tropic, and the mountains running north and south. The vegetation when pressed on the north by on-coming refrigeration had only to move its southern border southward to enjoy its normal climate over a favourable region of great extent; and, upon the recession of glaciation to the present limit, or in the oscillations which intervened, there was no physical impediment to the adjustment. Then, too, the more southern latitude of this country gave great advantage over Europe. The line of terminal moraines, which marks the limit of glaciation, rarely passes the parallel of 40° or 39°. Nor have any violent changes occurred here, as they have on the Pacific side of the continent, within the period under question. So, while Europe was suffering hardship, the lines of our Atlantic American flora were cast in pleasant places, and the goodly heritage remains essentially unimpaired.

The transverse direction and the massiveness of the mountains of Europe, while they have in part determined the comparative poverty of its forest vegetation, have preserved there a rich and widely distributed Alpine flora. That of Atlantic North America

[1] An Address to the Botanists of the British Association for the Advancement of Science; read at Montreal to the Biological Section, August 29, 1884, by Prof. Asa Gray. Continued from p. 235.

is insignificant. It consists of a few Arctic plants left scattered upon narrow and scattered mountain-tops, or in cool ravines of moderate elevation; the maximum altitude is only about 6000 feet in lat. 44°, on the White Mountains of New Hampshire, where no winter snow outlasts midsummer. The best Alpine stations are within easy reach of Montreal. But as almost every species is common to Europe, and the mountains are not magnificent, they offer no great attraction to a European botanist.

Farther south, the Appalachian Mountains are higher, between lat. 36° and 34° rising considerably above 6000 feet; they have botanical attractions of their own, but they have no Alpine plants. A few sub-Alpine species linger on the cool shores of Lake Superior at a comparatively low level. Perhaps as many are found nearly at the level of the sea on Anticosti, in the Gulf of St. Lawrence, abnormally cooled by the Labrador current.

The chain of great fresh-water lakes, which are discharged by the brimming St. Lawrence, seems to have little effect upon our botany, beyond the bringing down of a few north-western species. But you may note with interest that they harbour sundry maritime species, mementos of the former saltness of these interior seas. *Cakile Americana*, much like the European Sea Rocket, *Hudsonia tomentosa* (a peculiar Cistaceous genus imitating a Heath), *Lathyrus maritimus*, and *Ammophila arenaria* are the principal. Salicornia, Glaux, *Scirpus maritimus*, *Ranunculus Cymbalaria*, and some others may be associated with them. But these are widely diffused over the saline soil which characterises the plains beyond our wooded region.

I have thought that some general considerations like these might have more interest for thei Biological Section at large than any particular indications of our most interesting plants, and of how and where the botanist might find them. Those who in these busy days can find time to herborise will be in the excellent hands of the Canadian botanists. At Philadelphia their brethren of "the States" will be assembled to meet their visitors, and the Philadelphians will escort them to their classic ground, the Pine Barrens of New Jersey. To have an idea of this peculiar phytogeographical district, you may suppose a long wedge of the Carolina coast to be thrust up northward quite to New York harbour, bringing into a comparatively cool climate many of the interesting low-country plants of the south, which at this season you would not care to seek in their sultry proper home. Years ago, when Pursh and Leconte and Torrey used to visit it, and in my own younger days, it was wholly primitive and unspoiled. Now, when the shore is lined with huge summer hotels, the Pitch Pines carried off for firewood, the bogs converted into cranberry-grounds, and much of the light sandy or gravelly soil planted with vineyards or converted into melon and sweet-potato patches, I fear it may have lost some of its botanical attractions. But large tracts are still nearly in a state of nature. *Drosera filiformis*, so unlike any European species, and the beautiful Sabbatias, the yellow Fringed Orchises, Lachnanthes and Lophiola, the larger Xyrises and Eriocaulons, the curious grass Amphicarpum with cleistogamous flowers at the root, the showy species of Chrysopsis, and many others, must still abound. And every botanist will wish to collect *Schizæa pusilla*, rarest, most local, and among the smallest of ferns.

If only the season would allow it, there is a more southern station of special interest,—Wilmington, on the coast of North Carolina. Carnivorous plants have, of late years, excited the greatest interest, both popular and scientific, and here, of all places, carnivorous plants seem to have their most varied development. For this is the only and the very local home of Dionæa; here grow almost all the North American species of Drosera; here or near by are most of the species of Sarracenia, of the bladder-bearing Utricularias—one of which the President of our Section has detected in fish-catching—and also the largest species of Pinguicula.

But at this season a more enjoyable excursion may be made to the southern portion of the Alleghany or Appalachian Mountains, which separate the waters of the Atlantic side from those of the Mississippi. These mountains are now easily reached from Philadelphia. In Pennsylvania, where they consist of parallel ridges without peaks or crests, and are of no great height, they are less interesting botanically than in Virginia; but it is in North Carolina and the adjacent borders of Tennessee that they rise to their highest altitude, and take on more picturesque forms. On their sides the Atlantic forest, especially its deciduous-leaved portion, is still to be seen to greatest advantage, nearly in pristine condition, and composed of a greater variety of genera and species than in any other temperate region, excepting Japan. And in their shade are the greatest variety and abundance of shrubs, and a good share of the most peculiar herbaceous genera. This is the special home of our Rhododendrons, Azaleas, and Kalmias; at least, here they flourish in greatest number and in most luxuriant growth. *Rhododendron maximum* (which is found in a scattered way even as far north as the vicinity of Montreal) and *Kalmia latifolia* (both called Laurels) even become forest trees in some places; more commonly they are shrubs, forming dense thickets on steep mountain-sides, through which the traveller can make his way only by following old bear-paths, or by keeping strictly on the dividing crests of the leading ridges.

Only on the summits do we find *Rhododendron Catawbiense*, parent of so many handsome forms in English grounds, and on the higher wooded slopes the yellow and the flame-coloured *Azalea calendulacea*; on the lower the pink *A. nudiflora* and more showy *A. arborescens*, along with the common and wide-spread *A. viscosa*. The latter part of June is the proper time to explore this region, and, if only one portion can be visited, Roan Mountain should be preferred.

On these mountain-tops we meet with a curious anomaly in geographical distribution. With rarest exceptions, plants which are common to this country and to Europe extend well northward. But on these summits from Southern Virginia to Carolina, yet nowhere else, we find—undoubtedly indigenous and undoubtedly identical with the European species—the Lily-of-the-Valley!

I have given so much of my time to the botany of the Atlantic border that I can barely touch upon that of the western regions.

Between the wooded country of the Atlantic side of the continent and that of the Pacific side lies a vast extent of plains which are essentially woodless, except where they are traversed by mountain-chains. The prairies of the Atlantic States bordering the Mississippi and of the Winnipeg country shade off into the drier and gradually more saline plains, which, with an even and gradual rise, attain an elevation of 5000 feet or more where they abut against the Rocky Mountains. Until these are reached (over a space from the Alleghanies westward of about twenty degrees of longitude) the plains are unbroken. To a moderate distance beyond the Mississippi the country must have been in the main naturally wooded. There is rainfall enough for forest on these actual prairies. Trees grow fairly well when planted; they are coming up spontaneously under present opportunities; and there is reason for thinking that all the prairies east of the Mississippi, and of the Missouri up to Minnesota, have been either greatly extended or were even made treeless under Indian occupation and annual burnings. These prairies are flowery with a good number of characteristic plants, many of them evidently derived from the plains farther west. At this season the predominant vegetation is of Compositæ, especially of Asters and Solidagoes, and of Sunflowers, Silphiums, and other Helianthoid Compositæ.

The drier and barer plains beyond, clothed with the short Buffalo-Grasses, probably never bore trees in their present state, except as now some Cotton-woods (*i.e.* Poplars) on the margins of the long rivers which traverse them in their course from the Rocky Mountains to the Mississippi. Westward the plains grow more and more saline; and Wormwoods and Chenopodiaceæ of various sorts form the dominant vegetation, some of them *sui generis*, or at least peculiar to the country, others identical or congeneric with those of the steppes of Northern Asia. Along with this common campestrine vegetation there is a large infusion of peculiar American types, which I suppose came from the southward, and to which I will again refer.

Then come the Rocky Mountains, traversing the whole continent from north to south; their flanks wooded, but not richly so,—chiefly with Pines and Firs of very few species, and with a single ubiquitous Poplar, their higher crests bearing a well-developed Alpine flora. This is the Arctic flora prolonged southward upon the mountains of sufficient elevation, with a certain admixture in the lower latitudes of types pertaining to the lower vicinity.

There are almost 200 Alpine Phænogamous species now known on the Rocky Mountains, fully three-quarters of which are Arctic, including Alaskan and Greenlandian; and about half of them are known in Europe. Several others are North Asian, but not European. Even in that northern portion of the Rocky Mountains which the Association is invited to visit, several Alpine species novel to European botany may be met with; and farther south the peculiar forms increase. On the other hand, it is interesting to note how many Old World species extend their range southward even to lat. 36° or 35°.

I have not seen the Rocky Mountains in the Dominion; but I apprehend that the aspect and character of the forest is Canadian, is mainly coniferous, and composed of very few species. Oaks and other cupuliferous trees, which give character to the Atlantic forest, are entirely wanting, until the southern confines of the region are reached in Colorado and New Mexico, and there they are few and small. In these southern parts there is a lesser amount of forest, but a much greater diversity of genera and species, of which the most notable are the Pines of the Mexican plateau type.

The Rocky Mountains and the Coast Ranges on the Pacific side so nearly approach in British America that their forests merge, and the eastern types are gradually replaced by the more peculiar western. But in the United States a broad, arid, and treeless, and even truly desert region is interposed. This has its greatest breadth and is best known where it is traversed by the Central Pacific Railroad. It is an immense plain between the Rocky Mountains and the Sierra Nevada, largely a basin with no outlet to the sea, covered with Sage-brush (*i.e.* peculiar species of Artemisia) and other subsaline vegetation, all of grayish hue; traversed, mostly north and south, by chains of mountains, which seem to be more bare than the plains, but which hold in their recesses a considerable amount of forest and of other vegetation, mostly of Rocky Mountain types.

Desolate and desert as this region appears, it is far from uninteresting to the botanist; but I must not stop to show how. Yet even the ardent botanist feels a sense of relief and exultation when, as he reaches the Sierra Nevada, he passes abruptly into perhaps the noblest coniferous forest in the world—a forest which stretches along this range and its northern continuation, and along the less elevated ranges which border the Pacific coast, from the southern part of California to Alaska.

So much has been said about this forest, about the two gigantic trees which have made it famous, and its Pines and Firs which are hardly less wonderful, and which in Oregon and British Columbia, descending into the plains, yield far more timber to the acre than can be found anywhere else, and I have myself discoursed upon the subject so largely on former occasions, that I may cut short all discourse upon the Pacific coast flora and the questions it brings up.

I note only these points. Although this flora is richer than that of the Atlantic in Coniferæ (having almost twice as many species), richer indeed than any other except that of Eastern Asia, it is very meagre in deciduous trees. It has a fair number of Oaks, indeed, and it has a Flowering Dogwood, even more showy than that which brightens our eastern woodlands in spring. But altogether it possesses only one-quarter of the number of species of deciduous trees that the Atlantic forest has; it is even much poorer than Europe in this respect. It is destitute not only of the characteristic trees of the Atlantic side, such as Liriodendron, Magnolia, Asimina, Nyssa, Catalpa, Sassafras, Carya, and the arboreous Leguminosæ (Cercis excepted), but it also wants most of the genera which are common throughout all the other northern temperate floras, having no Lindens, Elms, Mulberries, Celtis, Beech, Chestnut, Hornbeam, and few and small Ashes and Maples. The shrubbery and herbaceous vegetation, although rich and varied, is largely peculiar, especially at the south. At the north we find a fair number of species identical with the eastern; but it is interesting to remark that this region, interposed between the North-East Asiatic and the North-East American and with coast approximate to the former, has few of those peculiar genera which, as I have insisted, witness to a most remarkable connection between two floras so widely sundered geographically. Some of these types, indeed, occur in the intermediate region, rendering the general absence the more noteworthy. And certain peculiar types are represented in single identical species on the coasts of Oregon and Japan, &c. (such as Lysichiton, Fatsia, Glehnia); yet there is less community between these floras than might be expected from their geographical proximity at the north. Of course the high northern flora is not here in view.

Now if, as I have maintained, the eastern side of North America and the eastern side of Northern Asia are the favoured heirs of the old boreal flora, and if I have plausibly explained how Europe lost so much of its portion of a common inheritance, it only remains to consider how the western side of North America lost so much more. For that the missing types once existed there, as well as in Europe, has already been indicated in the few fossil explorations that have been made. They have brought to light Magnolias, Elms, Beeches, Chestnut, a Liquidambar, &c. And living witnesses remain in the two Sequoias of California, whose ancestors, along with Taxodium, which is similarly preserved on the Atlantic side, appear to have formed no small part of the Miocene flora of the Arctic regions.

Several causes may have conspired in the destruction;—climatic differences between the two sides of the continent, such as must early have been established (and we know that a difference no greater than the present would be effective); geographical configuration, probably confining the migration to and fro to a long and narrow tract, little wider, perhaps, than that to which it is now restricted; the tremendous outpouring of lava and volcanic ashes just anterior to the Glacial period, by which a large part of the region was thickly covered; and, at length, competition from the Mexican plateau vegetation,—a vegetation beyond the reach of general glacial movement from the north, and climatically well adapted to the south-western portion of the United States.

It is now becoming obvious that the Mexican plateau vegetation is the proximate source of most of the peculiar elements of the Californian flora, as also of the southern Rocky Mountain region and of the Great Basin between; and that these plants from the south have competed with those from the north on the eastward plains and prairies. It is from this source that are derived not only our Cacteæ but our Mimoseæ, our Daleas and Petalostemons, our numerous and varied Onagraceæ, our Loasaceæ, a large part of our Compositæ, especially the Eupatoriaceæ, Helianthoideæ, Helenioideæ, and Mutisiaceæ, which are so characteristic of the country, the Asclepiadeæ, the very numerous Polemoniaceæ, Hydrophyllaceæ, Eriogoneæ, and the like.

I had formerly recognised this element in our North American flora, but I have only recently come to apprehend its full significance. With increasing knowledge we may in a good measure discriminate between the descendants of the ancient northern flora and those which come from the highlands of the south-west.

BRYN MAWR COLLEGE

THIS College is an Institution for Women, founded by the late Dr. Joseph W. Taylor; the following account of its foundation and objects, from the *Philadelphia Ledger*, has been kindly forwarded to us by Prof. Sylvester.

The work on the buildings and other preparations for the opening of the College are being pushed forward as expeditiously as possible, so that everything will be ready by June next. This new educational institution, it will be remembered, was founded by the late Joseph W. Taylor, M.D., a prominent member of the Society of Friends, of Burlington, N.J., who bought the land—about thirty-two acres—and began the erection of the college buildings in 1879. He died in January, 1880, leaving an endowment of 800,000 dols. for the continuance of the work he had begun—the erection and starting of a college for women.

By the terms of the will of the founder, the Trustees are members of the Society of Friends, but the students may be of any denomination, and their religious belief is to be respected. It was part of the purpose of Dr. Taylor to give to women of intelligence and refinement the best opportunities for culture, combined with Christian influences and social amenities. Scholars under sixteen years will be ineligible for admission. The Board of Trustees consists of: President—Francis T. King, of Baltimore, Md.; Charles S. Taylor, Burlington, N.J.; James C. Thomas, Baltimore, Md.; James E. Rhoades, Philadelphia; James Whitall, Philadelphia; John B. Garrett, Bryn Mawr, Penn.; Charles Harteshorne, Philadelphia; David Scull, Jr., Philadelphia; William R. Thurston, New York City; Albert K. Smiley, Lake Mohonk, N.Y.; Francis R. Cope, Philadelphia; Philip C. Garrett, Philadelphia, and Edward Bittle, Philadelphia.

As Dr. Taylor did not wish the college named after him, the Trustees have given the title of Taylor Hall to the main building, in commemoration of his munificent bequest. This building, according to the plans, will contain rooms for chemical, biological, and botanical laboratories, a library and reading room, a handsome assembly room, and recitation rooms. It will be 130 feet long, three stories in height, and constructed of Port Deposit granite stone. Work on it was begun in August, 1879.

The second building, Merion Hall, contains the dormitories. It is built of Fairmount stone, three stories high, and will be 160 feet long, affording accommodation for fifty students and caretakers. The study rooms are to be so arranged that two of the pupils will use one in common, each pupil having a bedroom on either side of the study room. The latter apartments will each have an open fireplace, but the building will be warmed by air heated by steam, and carried through the house under slight pressure from a fan. All rooms occupied by the students are to be ventilated by a main shaft which acts as a chimney for the boiler house, so that a constant current of warm air reaches the rooms, while at the same time the vitiated air is withdrawn. All the bathing and plumbing arrangements have been placed in one wing, constructed with great care, and are ventilated by force ventilation. The dining-room entrance, hall and parlour, are to be appropriately fitted up.

For the gymnasium the plans provide a brick building, 80 by 74 feet. It will contain a main hall, supplied with the most perfect appliances in use by Dr. Sargent at Harvard College, offices, dressing-room, baths, and an examination room, in which a record of the exercises will be kept. A track, raised nine feet from the floor, and extending around the building on the inside, will also be provided, in order to permit the students to run or walk when inclement weather prevents out-door exercise. The gymnasium will be under the charge of a lady trained by Dr. Sargent, who will be the instructress in light gymnastics. Under her direction all exercises will be carefully regulated to the strength of the students, to insure normal development and avoid all danger of over-exertion.

The laundry will contain the boilers which will furnish heat and hot water to the other buildings, in addition to the necessary appliances of a laundry. A house is being built on the adjoining lot for the President, and three cottages which are already on the premises are to be used for the Faculty or to accommodate any overflow of students from Merion Hall until other permanent structures like it are built. The plan adopted contemplates four such structures, to hold 160 students. The total cost of the buildings, including construction and furnishing of laboratories, providing for heating and water supply, the purchase, grading, and ornamenting the grounds, a complete system of drainage on the Waring system, and furniture, will probably exceed 200,000 dols.

It is understood that a large number of applications have already been received by the trustees, and many students whose names have not yet been recorded are known to be preparing. The college will be one of strictly high grade, and will have no preparatory department. The "group system" of arranging studies in the college course, which is adopted, to some extent, in England, but most perfectly represented in the Johns Hopkins University at Baltimore, is to be used. It secures to the students, it is claimed, a thorough training in the two chief ancient and the modern languages, in mathematics, and in some branches of science, besides instruction in metaphysics, drawing, hygiene, and art.

Each department will be under the instruction of specialists, and all students will be required to pursue certain prescribed studies. There will be five fellowships to college graduates who have already distinguished themselves in particular branches of study, namely: Greek, English, mathematics, history, and biology. A scholarship of 500 dols. will be offered yearly to a graduate of Bryn Mawr College to enable her to pursue studies in some European university.

The Trustees, knowing the large expense necessary to procure the best professors, a good library, and a supply of all laboratory appliances required for a college of the best class, have husbanded the funds placed in their hands for the future use of the institution, and it is said but little of the endowment will have been encroached upon before the college opens. Although some of the Trustees are also managers of Haverford College, "Bryn Mawr" will be an independent institution, and practically a Philadelphia one.

The Faculty has not yet been perfected, but the Trustees have made the following selections:—Dean of the Faculty and Professor of English, M. Carey Thomas, Ph.D., University of Zürich; Associate in Botany, Emily L. Gregory, L.B., late in charge of the laboratory work of Harvard Annex, and Teacher of Botany in Smith College; Associate Professor of Biology, Edmund B. Wilson, Ph.D., Fellow in Biology of Johns Hopkins University, and late Lecturer on Biology in Williams College, and Associate Professor of Mathematics; Charlotte Angus Scott, A.B., Sc.B., University of London, and late Lecturer on Mathematics in Girton and Newnham Colleges. It is expected that all the chief appointments will have been made before the appearance of the college catalogue.

Dr. James E. Rhoades, the President of the college, in speaking of women's colleges a few days since, said: "New England has from an early date given great attention to collegiate education, and has at the present time three colleges for women, beside the Harvard Annex. The States south of New England and west of Pennsylvania need a college to give the desired facilities for higher education to the graduates of girls' schools and high schools. A large part of the teaching in the United States is done by women, who, not having the advantages of men, are obliged to take lower and less remunerative positions."

SCIENTIFIC SERIALS

The American Journal of Science, December 1884.—The distribution and origin of Drumlins, by W. M. Davis. The term drumlin is here taken in a generic sense to include any kind of more or less smoothly-rounded hills formed by local accumulatian of glacial drift on a foundation of different geological formation. The subject is treated under five heads:—(1) the place of drumlins in a geographical classification; (2) terminology: (3) general description; (4) distribution; (5) origin.—The geological relations and genesis of the specular iron ores occurring in the Sierra Maestra (Coast Range) of the district of Santiago de Cuba, by James P. Kimball.—A new tantalite locality, by Charles A. Schaeffer. The author describes a mineral from the Etta tin mine, Dakotah, hitherto supposed to be casiterite, but which is shown to be tantalite. The analysis gave the following results:—

Tantalic oxide	79·01
Stannic oxide	0·39
Ferrous oxide	8·33
Manganous oxide	12·13
	99·86

—Note on Palæozoic rocks of Central Texas, by Charles D. Walcott. The results are given of a recent survey of a portion of the Palæozoic area in this region, undertaken chiefly for the purpose of studying the Cambrian section and collecting fossils from the Texas Potsdam horizon. Besides procuring fresh data on the Potsdam and Silurian sections and faunas, the author determined the true relations of an area hitherto known as Archæan, but which is now referred to the Cambrian. The age of the granite of Barnet County was also determined.—On the sufficiency of terrestrial rotation for the defection of streams, by A. C. Baines.—Chemical affinity; part iii., the existing problem, by John W. Langley.—Peculiar modes of occurrence of gold in Brazil, by Orville A. Derby. A specimen in the National Museum, Rio de Janeiro, from Ponte Grande, Minas Geraes, shows films of gold on limonite, which the author thinks can scarcely be accounted for except on the hypothesis of natural deposition from solution. The districts of Campanha and S. Gonçalo in the same province afford examples of large auriferous deposits in decomposed gneiss with an almost complete absence of veins and of the other usual concomitants of gold.—On colemanite, a new borate of lime, by A. Wendell Jackson. This substance has recently been determined by J. T. Evans, whose analysis gives the formula:

$$2CaO . 3B_2O_2 . 5 \text{ aq.}$$

It differs from pandermite in containing five instead of three molecules of water, but its chief interest lies in its morphological relations.—On the decay of quartzite and the formation of sand, kaolin, and crystallised quartz, by James D. Dana.

Revue d'Anthropologie, tome viii. fasc. 4, 1884. Paris.—A continuation of M. Mathias Duval's lectures on "Transformism," dealing chiefly with the questions of natural selection and survival of the fittest.—Notes on the anatomy of two negroes, by Dr. T. Chudzinski, head of the anatomical department of the Faculty of Medicine at Paris.—On the "Beni-M'Zab," by Dr. Amat. The writer here gives the results of personal observations made during his tenure in 1883 of a medical official post in the country of these tribes, who live under the French protectorate, and occupy an immense territory of Barbara, lying between 32° and 33° 20′ N. lat. and 0° 40′ and 1° 50′ E. long. After giving a summary of the principal historical events connected with this people, who lay claim to being the sole representatives of the pure Berbers in Algiers, Dr. Amat enters at great length into the consideration of the results obtained by his careful anthropometric examination of fifty natives of Ghardaïa. From the means of these determinations it would appear that the M'Zabites are of generally lower stature, and have less delicately proportioned limbs and features than the Arabs, but that, like the latter, they are often perfectly white in infancy, while light-coloured hair and beards are occasionally met with among the adults. The people are under the government of a religious or teaching body, composed of a powerful caste of learned clerks, or *tolbas*. The practice of interring food and domestic utensils with the dead points to usages of more ancient date than those of the form of Islamism which they follow. Unlike the genuine Arabs, they migrate in large numbers to the cities, where they conduct prosperous mercantile businesses, while they are the great corn purveyors of the Sahara. They employ among themselves a special form of language, which is a Berber dialect with certain affinities to the Kabyle, and is not a written tongue. The form of Islamism followed is that known as Owahbite Ibadite.—The concluding part of M. Denicker's notes on the Kalmuks. The author here treats of the special form of Buddhist Lamaism followed by the Kalmuk tribes, their hierarchy, mythology, rituals, religious festivals, objects of worship, and the special forms under which Cakya, Mowni, and others of their most highly-venerated so-called *bourkans*, are worshipped. Owing to the comparatively late adoption of Buddhism, the Kalmuks have retained in their epic poems, aphorisms, and folk-lore, of which examples are given, more of the primitive Mongolian character than some of their kindred; but the Russian Kalmuks, like their brethren in China, are rapidly losing the warlike and aggressive spirit of their ancestors under the levelling systems of government to which they are subjected in both empires.—On the horizontal plane of the cranium, by E. Goldstein, with tables giving the variations and differences determined among persons of different races. These tables, which are remarkable for their voluminous and detailed character, will be found of great use in studying the causes of the angular variations observable in various ethic groups, and in the anthropoids, and in determining how far such deviations from a fixed horizontal line are dependent on race, age, or disease.

Bulletins de la Société d'Anthropologie de Paris, tome vii., fasc. 3, 1884.—M. de Ujfalvy's report of the results obtained by Dr. Lenhossek and others from an examination of the ancient Magyar tumuli, laid bare on the reconstruction of the town of Szegedin after the inundations of 1879.—On the age and character of the covered *allées* of dolmens on the plain of Ellez, near Tunis, by M. Girard de Rialle. The report is based on the communications of M. Poinssot.—On the presence of *Elephas primigenius* in the alluvial Chelles-beds, by M. Chouquet, who does not consider the juxtaposition of fossil remains as a proof of contemporaneity, but rather as the result of distinct depositions, which frequently belong to different geological periods.—Communication by M. D'Acy on the mammoth of the Cromer forest beds.—On the caves of Saumoussay, near Saumur, by M. Bonnemère, whose opinion that they are of pre-Roman date is opposed by M. Drouawlt and others.—On the exploration of the caves of Muikow in Cracovia, by M. Zaborowski. The authenticity of the supposed "finds" of Muikow is forcibly called in question by MM. Mortillet, Szambatty, and other local authorities.—Notes on the anthropological characters of California, by M. Ten Kate, who has here given the results of the cephalometric and other measurements made by him in his explorations, in 1883, of the districts of California south of 24° 40′ N. lat. The crania examined were of a well-marked Melanesian character, dolichocephalous, with moderate prognathism.—On a supplementary part of the great pectoral muscle, by M. Chudzinski.—On the influence of climate and race on the normal temperature of the human body, by Dr. Maurel. The results deduced from carefully tested determinations seem to be that the temperature of Europeans in intertropical and equatorial regions is raised only about 0° 30′ above its normal range in Europe, but that the mean temperature of certain races, as the Hindoos, is about 0° 50′ higher than that of Europeans.—On a gorilla fœtus, by M. Denicker. The subject was a female resembling in its pose and its thoracic development a human fœtus of five or six months. The lower members presented the true gorilla character.—On the antiquity of the Dingo in Australia, by M. Zabrowski.—On the case of a living double monstrosity, by M. Fourdrignier.—On cephalometric determinations of certain murderers who had been executed, as compared with measurements yielded by an equal number of persons distinguished for excellence of character or attainments, by Dr. Bajenoff.—On the first rudiments of infantine speech, by Dr. Allaire. The author considers that six distinct periods are observable in the development of the powers of speech, which are dependent on the successive processes of suction, digestion, dentition, &c., labial sounds being first emitted, while the dentals are acquired after the gutturals and nasals.—On recent German views regarding the cradle of the Aryan races, by M. Ujfalvy.—On the depopulation of the Marquisas, by M. Clavel, who considers that the general change of habits, and the cessation of intertribal wars, with its attendant decrease of activity, which have resulted from their contact with Europeans, must, rather than alcoholism of which he has seen no genuine cases, be accepted as the real factors in the rapid diminution of population that is going on in the Polynesian archipelago.—Note on the chariots of war employed by the Gauls, by M. Pétriment.—On the significance of the annual festival of the Indian Arikaris of Dokata, by Dr. Hoffman.—On the pathological characteristics of the Mandinguis of the Ouolof country, by Dr. Tautain.—On the "*Couvade*," by Dr. Maurel. The writer, on the authority of Dr. Lenoël of Amiens, asserts that this usage exists at the present day among the Indians of Guyana, near the Amazon.

Reale Istituto Lombardo, November 13, 1884.—The paintings of the Italian masters in the public museums of Europe, by Prof. G. Mongeri.—On the projected Penal Code for Italy, by Prof. A. Buccellati.—On the secular variation of the elements of terrestrial magnetism at Milan, by Ciro Chistoni.—On the total eclipse of the moon, October 4, 1884, by Prof. G. Celoria.—Meteorological observations made at the Brera Observatory, Milan, during the months of August and September, 1884.

November 27.—Experimental studies on the antiseptics of tubercular virus, by Prof. G. Sormani and Dr. E. Brugnatelli.—Successful treatment of a large tumour of twenty-two years' standing in the left side of a patient forty years of age, by Dr. G. Fiorani.—On the geometrical movement of the invariable systems, by Prof. C. Formenti.—The paintings of the Italian masters in the public museums of Europe (continued), by Prof. G. Mongeri.—Meteorological observations made at the Brera Observatory during the month of October 1884.

Jahrbücher für wissenschaftliche Botanik, herausgegeben von Dr. N. Pringsheim, Band xiii., Viertes Heft.—"Beiträge zür Morphologie und Physiologie der Meeresalgen," by G. Berthold, contains detailed investigations of the heliotropism of marine Algæ; also of the influence of other factors upon their structure and mode of growth, together with a description of certain means by which marine Algæ protect themselves from too great intensity of light, *e.g.* (1) by hair-like organs, of which the author distinguishes three types; (2) by peculiar formations in the protoplasm of individual cells: the most highly developed structures of this order are found in the genus *Chylocladia*, where one is to be seen in each of the peripheral cells of the thallus, and appears as a highly refractive, plate-like mass in close apposition with the outer wall. Reactions show that these structures consist chiefly of a substance of a proteid nature.—"Ueber die Wasservertheilung in heliotropisch gekrummten Pflanzentheilen," by A. Thate. The author tests Kraus's view that in organs with positively heliotropic curvature the shaded side contains more water than the illuminated side; he concludes that such a difference in amount of water cannot be proved, though on the other hand it cannot be asserted that it does not exist, analytical methods being as yet too imperfect: at best only approximate results can be obtained by Kraus's method.

Band xiv., Erstes Heft.—"Beiträge zur Entwickelungsgeschichte einiger Inflorescenzen," by K. Göbel. This article is chiefly devoted to the study of the development of the inflorescence in the *Gramineæ*. The author finds that, as regards their symmetry, the different varieties of inflorescence in this order cannot be referred to one type, but to two, the dorsiventral and the radial.—"Ueber Bau und Funktion des pflanzlichen Hautgewebesystems," by M. Westermaier, suggests as an important function of the epidermis that it shares with the vascular system in the supply of water to the internal tissues, forming a complete peripheral mantle of aqueous tissue.—" Ueber Poren in den Aussenwänden von Epidermiszellen," by H. Ambronn. An attempt to show that the origin of pits in the outer walls of epidermal cells is referable to undulations in the young walls, and that these pits are not to be regarded as the functional equivalents of those in the walls of internal tissues.—" Nachträgliche Bemerkungen zu den Befruchtungsact von Achlya," by N. Pringsheim. A further contribution to the controversy as to the sexuality of the Saprolegniæ.

Zweites Heft.—" Ueber das Vorkommen von Gypskrystallen bei den Desmidieen," by Alfred Fischer. An investigation of the crystals of Calcium sulphate already known to exist in *Closterium;* similar bodies are also found in other genera of Desmids. In *Staurastrum*, *Desmidium*, and *Hyalotheca* they are not found. The author concludes that they are to be regarded as an excretory product; when the quantity produced is small, it may remain dissolved in the cell-sap; when larger it appears as crystals.—" Ueber farbige körnige Stoffe des Zellinhalts," by P. Fritsch. This article deals with the "anatomical structure" of colouring granules, exclusive of chlorophyll, and without reference to their development. In the light of recent discoveries the chief interest of such bodies centres in their development, and their relation to the chlorophyll granules.—" Die Zellhaut, und das Gesetz der Zelltheilungsfolge von Melosira (Orthosira Thwaites) Arenaria Moore," by Otto Müller. A careful investigation of the succession of divisions as seen in this filamentous Diatom, which will throw light upon the process of multiplication of cells in other members of the group.

Drittes Heft.—" Untersuchungen über die Homologien der generativen Produkte der Fruchtblätter bei den Phanerogamen und Gefässkryptogamen," by L. Celakovsky. The author brings evidence from teratological specimens to bear upon the question of the homology of the integuments of the ovule with the indusium of the Fern-Sorus, with the object of establishing that homology.—" Untersuchungen über die Morphologie und Anatomie der Monokotylen-ähnlichen Eryngien," by M. Möbius. The main results of this investigation are that the similarity of the parallel-nerved species of Eryngium to the Monocotyledons lies only in the leaves and rhizomes; that it extends, however, beyond mere external characters, and may be recognised in the anatomical structure.

Bulletin de la Société des Naturalistes de Moscow, 1884, No. 1.—On the calculation of the average figures of relative wetness, by K. Weihrauch (in German). The author shows that the averages calculated by a mere addition of the observed values of $\frac{s}{k}$ do not give correct figures, and advocates a calculation consisting of an addition of all numerators (s) and of all denominators (k) separately, before making the division. He illustrates his method by several examples taken from the series of observations in the Caucasus. The paper will be continued.—What becomes of bile in the digestive tube? by Dr. A. Weiss (in French). The author confirms to some extent the well-known opinion of Prof. Schiff.—Materials for the flora of the Government of Tamboff, district of Tamboff, by Th. Ignatieff. The steppe flora is characteri ed, as usual, by the *Stipa pennata*, but the following plants, showing a passage towards a more southern flora, are met with:—*Adonis vernalis*, *Verbascum Phœniceum*, *Echium rubrum*, *Muscari leucophœum*, *Iris furcata*, *Fritillaria ruthenica*, and *Salvia nutans*. All these, which do not extend much north—they are not met with in the Moscow flora—are remarkable for the most vivid coloration of their flowers. The author gives a list of 464 plants found at Exthal.—Review of the generative organs of the males of Bombus, by General Radoszkowski (in French), with four plates.—Short description of a journey to Central Asia, lecture by N. Sorokine (in French). The author adds to his paper a very interesting chromolithographed picture representing a *saksaoul* forest (*Akabasis ammodendron*, Ledebour) of the Kyzyl-kounis deserts. It is for the first time that we find in print so good a representation of this plant as it covers the *bar-khans*, or sandy downs, of the Steppe.—Researches into the histology of the hair, the bristle, the prickle, and the pen, by W. Lwoff (in German), with four plates.—Notice on the hypotheses as to the origin of Lake Baikal, by W. Dybowsky (in German). The recent discovery in Lake Baikal of the very same sponge (*Lubomirskia baicalensis*) which is met with in the Bering Sea leads to the conclusion that it has immigrated into Lake Baikal from this sea. On the other side, several explorers of Siberia, and recently again M. Cherski, have shown that there are no traces of a marine communication of Lake Baikal with the sea during and since the post-Pliocene period; but there are very numerous traces of large lakes connected formerly by broad rivers, and it would seem probable that the sponge might have immigrated by this way. Dr. Dybowsky leaves the question open.

Bulletin de l'Académie Royale de Belgique, November 8, 1884.—On certain phenomena of reduction produced in grains when germinating, and on the formation of diastase, by M. A. Jorissen.—On the quadrilinear form and surfaces of the third order, by Prof. C. Le Paige.—Verbal communication on the phenomenon of stellar scintillation, by Ch. Montigny.—On the advanced vegetation observed in the spring of 1884 at Longchamps-sur-Geer, by Baron de Selys Longchamps.—On the chemical composition of krokydolite, and on the fibrous quartz of South Africa, by A. Renard.—On the Chinese philosopher, Lao-tse, a predecessor of Schelling in the seventh century, B.C., by M. C. de Harlez.—An ambassador of the Duke of Alençon at the court of Queen Elizabeth, by Baron Kervyn de Lettenhove.—On a portrait of Van Dyck's grandmother in the Este Gallery, Modena, by Henry Hymans.

Atti della R. Accademia dei Lincei, July 1884.—On the co-existence of different empirical formulas, and in particular on those containing the capillary constant of fluids or the cohesion of solids, by Adolfo Bartoli.—Report of the committee appointed to rearrange the Corsini Library recently acquired by the Academy. This valuable library was found to comprise altogether 39,082 works, including 5903 Elzevirians, Aldines, and other old and rare editions, 2511 MSS. and 191 volumes of music, besides 116 portfolios of engravings and 17,733 prints and drawings.—Meteorological observations made at the Royal Observatory of the Capitol during the month of June 1884.

Rivista Scientifico Industriale, October 31, 1884.—Variations in the electric resistance of solid and pure metallic wires under variations of temperature, by Prof. Angelo Emo.—Boulier's pyrometer, described and figured by M. Lauth.—The gigantic fossil turtle of Verona, described by S. Capellini.

November 15-30, 1884.—Variations in the electric resistance of solid and pure metallic wires under variations of temperature (continued); part 2, original determinations of the electric resistance of the chief metallic wires under different temperatures, by Prof. Angelo Emo.—On the oxidation of sulphur by ozone, by S. Zinno.—The Ammonites of the province of Venice, described and figured by T. A. Catullo.

SOCIETIES AND ACADEMIES

London

Geologists' Association, January 2.—On some recent views concerning the geology of the North-West Highlands, by Henry Hicks, M.D., F.G.S., President of the Association. The author stated that as the *Proceedings* of the Association contained several papers dealing with the controversy concerning the rocks of the North-West Highlands of Scotland, he thought it advisable to call the attention of the members to views contained in an important article published in NATURE (p. 29) by the Director-General of the Geological Survey, and in a "Report on the Geology of the North-West of Sutherland," by Messrs. Peach and Horne, in the same number, which cannot fail either to change entirely the future character of the controversy, or bring it rapidly to a satisfactory issue. Because of the positions held by the chief disputants on the one side, the controversy had assumed, to a great extent, the appearance of being one between official surveyors and some amateurs, who had been led to study the questions involved in it. The well-known and widely-accepted views first put forward by Sir R. Murchison, that there were clear evidences in the North-West of Scotland of a "regular conformable passage from fossiliferous Silurian quartzites, shales, and limestones upwards into crystalline schists, which were supposed to be metamorphosed Silurian sediments," were fully adopted by the official surveyors, including Sir A. C. Ramsay and Prof. Geikie, also by the late Prof. Harkness and others, who had examined the areas. Prof. Nicol, of Aberdeen, however, for many years stoutly contested Sir R. Murchison's views, and maintained that they were based on erroneous observations. Unfortunately, at that time his views did not meet with much approval. In the year 1878 the author re-opened the controversy by calling attention to some sections examined by him in Ross-shire, which he maintained did not bear out the views of Sir R. Murchison. He also suggested a modified interpretation of the views of Prof. Nicol. Since then many areas in Ross and Sutherland have been examined by Mr. Hudleston, Prof. Bonney, Dr. Callaway, Prof. Lapworth, and Prof. Blake, and their conclusions showed that though differences of opinion prevailed on some points, yet all were agreed as to there being no evidence in the areas examined by them to support the Murchisonian view of a conformable upward succession. Many other facts of great importance were brought out in these inquiries. The author expressed gratification at the candid manner in which the whole question had been dealt with by the Director-General and the Surveyors in their recent report, and at their readiness in acknowledging, after due examination in the course of surveying and mapping parts of the areas referred to, that they had found the "evidence altogether overwhelming against the upward succession which Murchison believed to exist."

EDINBURGH

Mathematical Society, January 9.—Mr. A. J. G. Barclay, President, in the chair.—Prof. Chrystal read a paper on the problem to construct the minimum circle enclosing *n* given points on a plane; Dr. Thomas Muir discussed the equation connecting the mutual distances of four points on a plane; and Mr. J. S. Mackay gave two notes on a theorem and a problem in geometry which had previously been brought before the Society.

PARIS

Academy of Sciences, January 5.—M. Bouley, President, in the chair.—Obituary notice of M. Victor Dessaignes, who died at Vendôme on January 5, by M. Berthelot.—Chemical studies on the skeleton of plants, part iii., by MM. E. Fremy and Urbain.—Note on the earthquakes in the south of Spain, by M. Hébert. These disturbances, the most serious that have been recorded throughout the historic period in Spain, are attributed exclusively to local causes, and especially to the structure of the soil, which is here formed of secondary strata, folded, overlapped, broken by numerous faults, and often traversed by old and recent eruptive rocks.—On a hydrate of chloroform, by MM. G. Chancel and F. Permentier.—Studies in the reproduction of phylloxera; distribution of the sulphuret of carbon amongst the vines by means of machinery, by M. P. Boiteau.—Equatorial observations of Barnard's and Wolf's comets made at the Observatory of Algiers (0.50 inch telescope), by MM. Trépied and Rambaud.—Observations of Encke's comet made at the same observatory, by M. Trépied.—On the internal constitution of the globe, by M. O. Callandreau.—On a generalisation of the theory of Abel, by M. H. Poincaré.—On a method of treating universal periodical transformations, by M. S. Kantor.—Note on the theory of electro-dynamic induction, of which the integral law is given by Neumann's theorem, by M. P. Duham.—A new theorem on the dynamics of fluids, by M. E. F. Fournier.—On the laws of chemical dissolution, by M. H. Le Chatelier.—Determination of the atomic weights of carbon, phosphorus, tin, and zinc, by M. J. D. Van der Plaats.—On the saturation of phosphoric acid by the bases, by M. A. J. Joly.—On the preparation of pure and highly concentrated oxigenated water, by M. Hanriot.—On fusibility in the oxalic series, by M. L. Henry.—Heat of combustion of acetal, crotonic aldehyde, isobutyric acid, and of some other substances of the fatty series, by M. W. Louguinine.—On the germination of plants in soils abounding in organic substances, but free from microbes, by M. E. Duclaux.—Observations on the previous paper, by M. Pasteur.—Fresh researches on the doundaké plant (*Cephalina esculenta*, Schum.), and on its active principle doundakine, by MM. E. Heckel and F. Schlagdenhauffen. The doundaké is described as an astringent and a febrifuge capable of replacing quinine, as well as a dye yielding a beautiful yellow colour worthy of the attention of dyers. It flourishes in Senegambia, Sierra Leone, and other parts of West Africa, and in many respects closely resembles the Morinda of the South Sea Islands.—On the presence of the genus Equisetum in the lower coal-measures of Beaulieu, Maine-et-Loire, by M. Ed. Bureau.—Influence of altitude on vegetation and the migration of birds of passage, by M. Alf. Angot.

BERLIN

Physiological Society, December 12, 1884.—Prof. Eulenburg spoke on investigations into the sense of temperature, which he had instituted specially for diagnostic purposes. As a test of the cutaneous perceptions in this respect, the only method available in practice was that of ascertaining the least differences perceived, and for this purpose the speaker had constructed special instruments which could be used to examine the sense of pressure as well as of temperature on the part of the skin. These instruments he laid before the Society. The apparatus for testing the sense of temperature consisted of two mercurial thermometers fastened on a transverse piece, with flat discoid tubes, one of which was fixed, the other movable. The fixed tube was surrounded at its lower part with metallic wires, by means of which, and an electric current, it could be warmed at pleasure. Both were placed beside or after one another on the spot to be examined, and the least difference of temperature which could be perceived was ascertained. When the temperature of the skin was below 27° C., its sensitiveness both to heat and cold was too obtuse for available results to be attained. In order to determine a normal scale above this limit, Prof. Eulenburg carried out a large number of measurements, which resulted in showing a great diversity in sense of temperature at different parts of the body. The sensitiveness to warmth was highest at the forehead and at the dorsal side of the last phalanges. At both these places differences of 0·2° C. were distinctly perceived. The least sensitiveness to warmth, on the other hand, was shown at the higher end of the anterior side of the upper part of the thigh, at the epigastrium, and in the median line of the back. At these places, only differences as large as from 0·9° C. to 1·1° C. were perceived. Sensitiveness to cold was likewise greatest at the forehead, and least at the epigastrium and back, but the degree of sensitiveness to cold did not always coincide with that of thermal sensitiveness at particular parts of the body, certain spots showing more sensitiveness to differences of heat, others to differences of cold. From the circumstance that the sense of temperature was more developed in the hands and face, which were exposed, than in those parts usually covered, and so far protected from variations, the speaker thought he was justified in inferring that the more delicate sense of temperature was an acquired sense. It was a striking fact that the tip of the tongue, so keen to mark variations of taste, was very dull in distinguishing variations of temperature. While engaged in these investigations Prof. Eulenburg became acquainted with the labours of Dr. Goldscheider, who, in the same manner as Herr Blix had done somewhat earlier, but, independently of this gentleman, came to the conclusion, as the result of a series of experiments, that the perceptions of temperature on the part of the skin had their seat in a large number of distinct cold and warmth points distributed over the whole body in definite complicated arrangement, the former of which (the cold points), under chemical as well as under electrical and mechanical stimulus, generated only the feeling of cold, the latter, under the same stimuli, only the feeling of warmth; that at all parts of the body there were a number of cold points which were easy to identify, and which were called cold points of the first class; and that, in addition, there were a larger number of cold points, more difficult to identify—cold points of the second class. Prof. Eulenburg repeated Dr. Goldscheider's experiments, and found them generally confirmed. He had further studied the distribution of the warm and cold points, both in himself and other persons, in such a manner that he marked with a fine pencil on the skin each warm or cold point found during examination, and then had an impression of the points so found made on wax paper, which he had laid over them. As a result of this operation it appeared that the forehead and the dorsal side of the phalanges had the most, the epigastrium the fewest, cold points. If the same spot of skin were examined on different days, the cold points of the first class always remained the same, while those of the second class varied, being found in larger number on one day than another. This diversity on different days appeared to coincide with the changes of temperature in the skin. The same relations held good in regard to the warmth points, which were separated locally from the cold points by tracts thermally insensible. The distribution of cold and warm points was not the same on all parts of the body. In some places the number of cold points predominated, in others the number of warm points. In the back of the hand, near to the wrist, for example, the number of warm points was in a majority, while towards the fingers the number of cold points preponderated. On comparing symmetrical parts of the body, it appeared that neither in number nor in the way in which they were distributed did the cold points on one side resemble those on the other. Prof. Eulenburg further confirmed Dr. Goldscheider's conclusions that in particular parts of the skin, between the cold and warm points, lay the points of pressure which were sensitive to touch but not to differences of temperature. The existence, on the other hand, of special points for perceiving pain due to temperature the speaker had been unable to verify. Under the stimuli inadequate to temperature feeling, as the electrical and mechanical, he had tried the electric current with positive results. A moderate stream, producing in the skin the well-known prickly feeling, having by means of a pointed electrode been introduced into a cold point, generated a decided feeling of cold. Mechanical stimuli, which should produce the same effect, failed, however, in Prof. Eulenburg's experiments to do so.

Physical Society, December 19, 1884.—Prof. Lampe gave some interesting historical notes on the calculations respecting solids of attraction, the results of which he had communicated at the sitting of November 21. In these problems he had started with a solid of greatest attraction, in regard to which Gauss had laid down the law that its attraction was related to that exercised by the same mass in globular form on a point of its surface, as $3 : \sqrt[3]{25}$. This law was found briefly adduced in a note in Gauss's treatise on capillarity, without any proof either there or anywhere else. Although Prof. Schellbach, who in 1845 calculated the form of the body of greatest attraction, ascribed the adduced law to Gauss, yet Prof. Lampe, in consideration that Gauss did not prove the law referred to and introduced it with the word "constat," was of opinion that it must have been already proved before the time when it was cited by Gauss. He had now, then, in point of fact, succeeded in tracing the author of the law. It originated, namely, with John Playfair, who, in 1809, in a treatise "On the Solid of Greatest Attraction," had calculated the form of such a body, and with reference to the magnitude of its attraction had arrived at the result already stated. In the same treatise John Playfair had dealt with a part of the problems brought before the Society by Prof. Lampe, and in respect of the cone and cylinder had come to the same results as himself. In calculating, however, the attraction of an ellipsoid flattened at the poles, he had, as was shown more at large by the speaker, committed an error, in consequence of which he had arrived at the conclusion that in the case of any eccentricity of the meridians the attraction was less than in the case of eccentricity 0, that is, than in the case of a globe. The fact, on the other hand, was that with oblateness the attraction at first increased and approached to that of the solid of greatest attraction, though yet without ever quite reaching it. It then diminished, till finally it sank to 0, when the pole coincided with the middle point. Let the attraction of a homogeneous mass in globular form be equal to 1, then the greatest attraction which this mass was in any case able to exercise was equal to 1·025986, while the maximum of attraction in an oblate rotatory ellipsoid was equal to 1·02213. Whether John Playfair's error had been already elsewhere observed or corrected was not known to the speaker. Altogether John Playfair's treatise appeared to have lapsed into oblivion, seeing that in the manuals of mechanics the law of maximum attraction being to the attraction of a ball as $3 : \sqrt[3]{25}$ was universally imputed to Gauss, and the calculations of the solid of greatest attraction, which John Playfair had already worked out, to Schellbach.—Following up this address Dr. Kœnig communicated the plan of an investigation which he contemplated carrying out in conjunction with Dr. Richarz. The investigation had for its object to determine with greater precision than had hitherto been done the mean density of the earth. The most exact measurements hitherto taken on this question came, as was known, from Herr von Jolly, in Munich, who, in a high tower, experimented on a balance, on one scale of which hung a wire, 21 m. long, bearing another scale at the bottom. After balancing a body in the upper scale and then transferring it to the scale 21 m. lower, the body was found to be somewhat heavier in the latter case in consequence of the more powerful attraction there exercised on it by the earth. On next placing under the lower scale a lead ball weighing 110 centner, and repeating the experiment, he found a greater increase on the upper scale weight than in the first instance. From the relation of these augmentations of weight and the volume and specific weight of the lead ball, Herr von Jolly calculated the mean density of the earth. Such a mode of measurement, however, laboured under this unavoidable source of error, that there was no means of safe-guarding the long wire from differences of temperature. Dr. Kœnig and Dr. Richarz had now, independently of each other, devised another method of utilising the balance for the purpose of determining the mean density of the earth. Instead of placing the lead ball 21 m. under the upper scale, they brought the heavy body directly under the upper scale, whence a line, passing through a perforation of the heavy mass, bore the lower scale immediately underneath it. When, now, a body was weighed in the upper scale, the mass of lead acted in a sense similar to that of the force of gravity, and its attraction was added to gravitation. When, on the other other hand, a body was weighed in the lower scale, the mass of lead operated in an opposite direction, and its attraction was subtracted from gravitation. By this experiment, therefore, a double effect was obtained from the mass of lead instead of the single effect in Herr von Jolly's experiment. Again, by bringing a second equally large mass of lead under the scale of the other side, disposing it in the same manner as the first mass, the effect of the mass of lead might be multiplied fourfold. An equilibration might be made by placing the weight on one side in the upper, on the other side in the lower, scale. Then the weights might be transposed. Independently of the advantage of a fourfold comparative estimate of the attraction of the mass of lead, all disturbances due to differences of temperature were by this method entirely obviated. The precision of the measurement would be still further enhanced by using a mass of lead of 2000 centner. The total mass of lead would compose a block, the most suitable form for which had yet to be theoretically determined. In the centre, above this block, would stand the balance, and the wires of both scales would pass through two equal perforations, at the ends of which, under the block, would depend the two lower scales. The construction of such a block of lead would be rendered possible by making it consist of 1300 separate pieces capable of being joined together into the form desired, and after a series of experiments they might be fitted up anew, so as to secure compensation for any errors due to unequal interior structure of the blocks. Of these masses of lead a parellelopiped would have a side of 2·5 m. and a height of 1·5 m. As was self-evident, the precision of the balance was a matter of extreme moment for these measurements. The mechanist who had undertaken their construction had engaged to produce a sensitiveness of one-hundred millionth for the weight of 1 kg. used in such measurements. He had further engaged, by an adequate modification of the construction, to obviate the error arising from the circumstance that the edges never corresponded mathematically with that term, but had always more or less diameter, so that with the inclination of the beams the plane of support changed. Dr. Kœnig hoped to be able in the course of a year to announce the numerical results of the experiment.

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