THURSDAY, NOVEMBER 14, 1878

CLEOPATRA'S NEEDLE AND THE WIND PRESSURE

THE statements recently made in the *Times* respecting the stability of Cleopatra's needle and the maximum intensity of the pressure of the wind in this country have awakened much interest, if not anxiety, about the subject. The appearance of the lofty obelisk balanced on so small a base suggests to many the thought of an egg standing on its end, and presents every idea of instability. This idea is much amplified by a very erroneous estimation, we believe, by most persons of the real dimensions of the base; we have heard this estimated at various diameters down to two feet, but in reality it is in no direction less than five. The statement that the stability of the obelisk is sufficient to withstand a wind pressure of 80 or 90 lbs. per square foot having been made, the storm from Liverpool at once broke on it and upset people's minds, if not the monolith. Thus we learn, from the observations taken by Mr. Hartnup, the astronomer at the Liverpool Observatory, that on January 30, 1868, "it began to blow strongly about 9 A.M., and from that time gradually increased in violence until half-past 11 P.M. on the 31st, when there was one gust of wind which registered 51 lbs. on the square foot. From this time the gale rapidly increased till noon next day, blowing with a severity quite unprecedented in this country. The anemometer which has been erected at the Bidston Observatory is made to register up to 60 lbs. on the square foot, the idea being that no gale would reach that degree of violence. Between eleven o'clock and one o'clock, however, the registering pencil was driven far beyond this limit, and Mr. Hartnup calculated that at several periods the pressure could not have been less than from 70 lbs. to 80 lbs. on the square foot. The anemometer was erected in 1851, and the most severe gale registered up to this time was in December, 1863, when there were three gusts which registered 45 lbs. to the square foot." Further details respecting this remarkable hurricane will be found in the *Journal* of the Scottish Meteorological Society, from which we find that at Glasgow, from 1.15 P.M. to 1.30 P.M., twenty-one miles of wind passed the observatory, giving a velocity of eighty-four miles per hour, or corresponding to a pressure of 35½ lbs. to the square foot, while the strongest gusts registered 42 lbs. on the square foot. At Edinburgh the gale was more severe than at the latter place; cabs and horses are said to have been blown over, but there is no record of the pressure or velocity as there was unfortunately no anemometer in working order. Many authorities state that the maximum pressure of the wind does not exceed 55 lbs. to the square foot in this country, and as this is the figure commonly assumed by engineers in the design of large structures, it is of the greatest importance that the trustworthiness of the Bidston anemometers should be ascertained. Pressure anemometers are obviously liable to errors from the varying modulus of elasticity of their springs and the momentum of their moving parts and supports, while Robinson's anemometers may give a maximum velocity due to small eddies, which is much in excess of the true value. Mr. John Dixon in his letter to the *Times* on the subject gives a good illustration of a pressure of 80 lbs. to the square foot by comparing it to the weight on the floor of a densely-crowded room. It has been ascertained by experiment that the weight of a crowd of persons can attain 80 to 120 lbs. per square foot, the latter figure being reached only when the experiment was made with labourers of above the average stature packed as closely as possible, and the former being commonly taken as the maximum load to which the platform of a bridge can be subjected by a dense mixed crowd. Thus Mr. Dixon remarks, "the windows of a building certainly have to bear an equal strain with the walls, and I suppose it would be immaterial to the glass whether it was placed vertically or horizontally. A densely packed crowd hardly weighs 80 lbs. per square foot of the space it stands upon. Reduce therefore the theory to common sense; would any one dream of standing on a floor formed of glazed window sashes?" On the whole we rather think not, even if, to make the case analogous, means were taken to distribute the pressure uniformly, and we are forced to the conclusion that either the Bidston Observatory is a very strongly constructed building with window-sashes and glass of unusual strength, or that the anemometers are untrustworthy.

Leaving now the question of the maximum pressure of the wind to be decided by meteorologists, there remains to be ascertained what that pressure would have to reach on the banks of the Thames to endanger the existence of the obelisk. Mr. Dixon's assurance has probably set the fears of many at rest; he says: "As to its stability there need be no fear—130 lbs. of wind-pressure would not upset it. The columns of the *Times* are not the place to ventilate calculations and figures." We can assure Mr. Dixon that these calculations would be of sufficient interest to the readers of NATURE to find a place in its columns, but in their absence we are obliged to fall back on our own. The widths of the top and bottom of larger face of the obelisk are respectively 64 inches and 95 inches, the height being 60 feet 6 inches exclusive of the pyramidal point, which would be 7 feet high if intact; assuming, then, an additional foot of height for the lower rounded end, the moment about the base of the pressure on the area of the larger face will be 12,931 foot pounds for a wind pressure of 1 lb. on the square foot. The weight of the stone is estimated at 196 tons, whence, on the assumption of perfect rigidity, the ultimate stability would be 196 tons × radius of base (2·5), and the corresponding wind pressure $= \frac{196 \times 2{\cdot}5 \times 2240}{12{,}931} = 84{\cdot}88$ lbs. per square foot. But the material of the obelisk not being perfectly rigid, it will be seen that this ultimate stability could not be reached. The effect of the wind-pressure is to cause a deviation of the line of action of the resultant pressure on the base from its centre with a diminution of the stress on the windward, and an increase of that on the lee-side of the base; if the decrease exceeds the normal pressure due to the weight the joint will tend to open, while if the increase is carried too far it may reach the crushing strength of the material.

Both these effects have to be considered. Now in the design of masonry work of a substantial character it is

the usual engineering practice to so distribute the stresses that no joint tends to open under the most unfavourable conditions, though this condition is doubtless frequently neglected in flimsy structures. In order that this condition should be fulfilled, the resultant of the pressure on the base must not deviate from the centre of gravity of the base by a quantity greater than x' given in the equation $x' = \frac{I}{XS}$, where I is the moment of inertia of the base about the neutral axis or line through its centre of gravity perpendicular to the direction of the deviation of the resultant, S = the area of the base, and X = the greatest distance of a point in the base from the neutral axis on the side of the greatest pressure. In the case of a circular base $x' = \frac{\text{diameter of base}}{8} = .625$ feet in the present instance. The wind pressure corresponding to this deviation $= \frac{196 \times .625 \times 2240}{12{,}931} = 21.22$ lbs. per square foot. When the wind-pressure exceeds this amount there is still the tensile strength of the cement with which the stone is bedded to resist the tendency of the joint to open on the windward side. While the introduction of a layer of cement under the stone doubtless adds to its steadiness under a wind-pressure of 30 or 50 lbs. to the square foot, it would add a very serious element of danger should the pressure ever approach that recorded at the Bidston Observatory, as the cement on the lee side would probably then be subjected to a crushing stress in excess of its strength, and by giving way would cause the column to heel over to some extent; in fact, if there was any probability of that wind-pressure being reached, it would have been safer to have omitted the cement and trusted for the ultimate stability to the far greater resistance to crushing of the granite. It would be impossible, without making assumptions unfounded on experiment, to estimate with any accuracy the value of the additional stability given by the cement in the case of moderate wind-pressures. We have, however, calculated the conditions of equilibrium, neglecting the tensile strength of the cement, as well as the bending of the stone.

On this assumption we find that a wind pressure of 50 lbs. per square foot would cause the joint to open on the windward side as far into the base as the centre; the column would thus be standing only on the leeward half of its base, but the stability would not be endangered by this as the maximum pressure on the base at its outer edge would only amount to 40 tons per square foot, which is less than the crushing strength even of the cement. The line of the resultant pressure on the base would be at a distance of 1.472 feet from the centre, if the bending of the column is disregarded. To take into consideration the flexure of the column would involve too long calculations for our present purpose, even if the modulus of elasticity of granite had been determined with sufficient accuracy to make the results of any value, but this we believe has not yet been done. The conclusions we arrive at are as follows:—As long as the foundations remain secure, the obelisk may be frequently subjected to a wind pressure of 21 lbs. per square foot without the slightest tendency to accident; if subjected at long intervals to a pressure of 40 or 50 lbs. to the square foot, it would probably stand for an indefinitely long period until the fatigue of the cement under variations of stress or its natural decay, if that ever takes place, causes its rupture, but under a pressure of this intensity it must be borne in mind that considerable oscillation would take place, and that if the period of the gusts nearly agreed with the time of vibration of the stone it might be overturned; while if a pressure of 80 lbs. per square foot is reached it is very questionable if the survivors among the inhabitants of the neighbourhood will find it *in situ* when they have time to go and look for it.

DRAPER'S SCIENTIFIC MEMOIRS

Scientific Memoirs: being Experimental Contributions to a Knowledge of Radiant Energy. By John William Draper, M.D., LL.D. (London: Sampson, Low, and Co. New York: Harper Brothers, 1878.)

THE scientific world is to be congratulated on the accession to its literature of these memoirs constituting as they do a distinct historical sketch of the works of a physicist who is at once an ardent experimentalist and a careful theorist. As he remarks in his preface, many of his results of experimental investigation on scientific topics have been largely disseminated in European languages, and many of the conclusions they have presented have been admitted into the accepted body of scientific knowledge. The papers in which these results were published have, however, appeared from time to time in various American and English periodicals, but we now have them collected in a form in which they are accessible and convenient for reference.

The four opening memoirs seemingly occupy their position in the volume for the purpose of calling the attention of the reader to the fact that a large portion of the subject that Kirchhoff treated mathematically in a paper which appeared in *Poggendorff's Annalen* in 1860, and which at the time was considered the foundation of spectrum analysis, had already been experimentally proved and published by our author some thirteen years before. The theorist apparently ignored the work of the experimentalist, and the claim of the one to priority in regard to the enunciation of certain fundamental principles of spectrum analysis is now on the best of evidence disputed by the other. The titles of these first four memoirs and their dates of original publication will give an idea of the indictment framed against Kirchhoff which appears in a note appended to the last of them. They are—

I. Examination of the radiations of red-hot bodies. The production of light by heat, published in 1847.

II. Spectrum analysis of flames. Production of light by chemical action, published in 1848.

III. On invisible fixed lines in the sun's spectrum detected by photography, published in 1843.

IV. On the nature of flame, and on the condition of the sun's surface, published in 1858.

Controversy regarding priority of discovery is always distasteful, and the indictment against Kirchhoff is a heavy one, but the offence might have been charged also against those scientific writers who, careless of history, have been accomplices in doing Draper an injustice. But turning to the more agreeable side of the subject of these memoirs we find that Draper fixed the temperature at which solid

bodies emit light with heat to be 977°, and shows experimentally that as the temperature of an incandescent body rises it emits rays of an increasing refrangibility; also that the amplitude of any particular vibration increases with the temperature, and that to every particular wave-length there belongs a particular colour. But even more remarkable are the deductions he makes regarding light and heat, deductions which, though evident *now*, perhaps, in the present state of knowledge, had by no means *then* the appearance of undoubted truths. He boldly asserted that light and heat were effects of radiation and not forces existing in the radiations themselves.

It is, however, with photographic research that the name of Draper is most generally linked; and as his researches in this line commenced in 1837, two years before the announcement of Daguerre's and Fox Talbot's discoveries, his claim to be considered one of the pioneers in photography admits of no contravention. In his memoir on "Studies in the Diffraction Spectrum" we read: "Several years before the commencement of the discovery of photography by Daguerre and Talbot (1839), I had made use of the process for the purpose of ascertaining whether the so-called chemical rays exhibited interference, and in 1837 published the results in the *Journal* of the Franklin Institute, Philadelphia (July, 1837, p. 45). In this, as will be seen by consulting that publication, I was successful." In his memoir of 1843, he describes the mode in which he photographed the spectrum, from the blue to the ultra-violet, and from near C in the red region to a point some distance below the limit of visibility. The apparatus he employed would at the present time be considered, perhaps, somewhat rude, but, as is well known, the roughest appliances in the hands of a true philosopher are sufficient even for delicate experiment. Thus, in photographing his spectrum we find that he worked before the days of collimating lenses, and with a consequent feebleness of light which was a serious matter when the slow (as compared with that now extant) process of Daguerre was employed for registering the impressions of the radiations. Half an hour's exposure was not too long to give to obtain a developable image, whereas now as many seconds as he gave minutes, with the same size of spectrum and width of slit, would be more than ample. The method by which Draper registered the lines in the red and ultra-red regions is fully treated of in his fifth memoir. The plate received a preliminary exposure to white light, and was then exposed to spectrum; or feeble daylight was allowed access to the plate whilst being similarly exposed; the result, on development by mercury, being that the dark lines in these regions were registered as light lines on a dark background, instead of as dark lines on a white background. This action Draper, Claudet, and others ascribed to the antagonism of the blue and red rays which are found in white light, and heads his memoir "Interference of radiations" in consequence. Till last year this view of the antagonism of rays was accepted as existent, when it received a blow, and probably a final one, from the announcement of the experimental proof that this action was produced through the spectrum possessing the power of accelerating the oxidation of the compound of silver which had been altered by light, and which, when so changed became undevelopable. Whatever may be the explanation of this phenomenon, we have in Draper's photographs of the least refrangible region a gigantic feat, considering the date at which it was performed. Though recent methods may outstrip the more antiquated one as regards rapidity of execution, yet it is due to him to acknowledge that he has long priority in showing that chemical action was not confined to the least refrangible end of the spectrum. As regards the application of photography to portraiture, to our author seems to belong the honour of having taken the first portrait by the Daguerreotype process, and the arrangements adopted for the purpose read rather comically in these days of quasi-instantaneous pictures. In his memoir, "On Taking of Portraits by Photography," he says:—"On a bright day, and with a sensitive plate, portraits can be obtained in the course of five or seven minutes in the diffused daylight. . . . Difficult parts of the dress . . . require intervals (exposure) differing considerably, to be fairly copied, the white parts of a costume passing on to solarisation before the yellow or black parts have made any decisive representation. We have therefore to make use of temporary expedients. A person dressed in a black coat and open waistcoat of the same colour must put on a temporary front of a drab or flesh colour, or, by the time that his face and the dark shadows of woollen clothing are evolved, his shirt will be blue, or even black, with a white halo around it." We are sure that the author cannot have regretted the supercession of a process which entailed such "dodging" to render a portrait practicable, more particularly at the time when he sat for the photograph from which the admirable portrait forming the frontispiece was engraved.

To this same memoir we have also an append in which it is shown that Dr. Draper had priority in taking a photograph of the moon; and when it is considered that the exposure was twenty minutes, and the diameter of the image about one inch, it would not be surprising had it lacked in detail. By an extract from the minutes of the New York Lyceum of Natural History we learn that in this photograph we have "a distinct representation of the moon's surface."

To yet another discovery of Draper's we must refer, since, like some others of his, it has been re-discovered quite recently. He says, in his description of the Daguerreotype process, "On these principles" (he alludes to the different photographic effects produced by different rays of light) "it is plain that an achromatic object-glass is by no means essential for the production of fine photographs; for if the plate be withdrawn at a certain period when the rays that have a maximum energy have just completed their action, those that are more dispersed but of slower effect will not have had time to leave any stain. We work, in fact, with a temporary monochromatic light." With a cigar-box as camera and a spectacle-lens as an objective he tested his theory, and found that on this principle he could photograph an engraving, with all its finest details present. The similarity between Janssen's use of an uncorrected lens for solar work and this is apparent.

Mixed up with photography is actinometry, and here we find that Draper not only invented the chlor-hydrogen photometer, which depends on the combination of chlo-

rine and hydrogen when acted upon by radiations, but that he also used it practically, though not with such nicety of method as subsequently employed by Bunsen and Roscoe. He also invented the ferric oxalate photometer, dependent on the reduction of this ferric compound to the ferrous state and the liberation of carbonic acid. In both of the foregoing we have a measure of the *quantity* of the radiations which these mixed gases, or solution, select. On this particular subject of selective absorption, when chemical action takes place, Draper experimented most fully. He showed, for instance, that the sensitiveness of the surface of a Daguerreotype plate is at its maximum when of a yellow tint, owing to the absorption of the blue rays, and conclusively shows that when it is of a blue tint that these same rays are largely reflected. In fact, he announced, with all the authority of a successful experimentalist, that for the production of chemical action in a compound by any particular ray, the absorption of that ray by the compound was an absolute necessity. In late years we have had several rediscoveries of this important truth, and probably it will be rediscovered again and again, notwithstanding the publication of these memoirs.

We have not space to do more than to mention the memoirs on the "Distribution of Heat in the Spectrum," on "The Chemical Force in the Spectrum" (both titles of which, by the by, are inexact, as Draper himself was the first to prove), and on "The Supposed Magnetic Effects Produced by the Violet Rays," all of which are important contributions to science, as are also those on "The Cause of the Flow of Sap in Plants, and the Circulation of the Blood in Animals," and "On the Decomposition of Carbonic Acid Gas by Plants in the Prismatic Spectrum." All these have been treated in a masterly manner, and the results lucidly and tritely recorded. Reading these memoirs leads us to the conclusion that we have in Draper a successful experimenter, who has been perhaps too little appreciated in the world owing to his too great modesty in neglecting to call attention to the facts he has observed, and to claim for himself honour where the honour was due. Like other men of mark in science, the ardent pursuit of it was undertaken through what might be termed an accident. He tells us in his preface that happening to see a glass containing some camphor, portions of which had been caused to condense in very beautiful crystals, he was induced to read everything he could obtain respecting the chemical and mechanical influence of light, adhesion, and capillary attraction; the experiments he made in connection with these subjects being contained in the volume before us. His thoughts being thus directed to physiological studies, he published papers on these topics in the *American Journal of Medical Sciences*, which created such a favourable impression that he was appointed, in 1836, Professor of Chemistry and Physiology in Hampden Sidney College, Virginia. He afterwards was appointed to a similar chair at New York University, which, we believe, he at present holds.

It would be travelling out of our province to do more than call attention to Dr. Draper as the author of "A Treatise on Human Physiology," "The History of the Intellectual Development of Europe," "The History of the American Civil War," and of "The History of the Conflict of Religion and Science," works which have met with well-merited success, and which show the varied bent of his mind.

The history of the Rumford medal fund held in trust by the Royal Society, and the awards made by this body are too well known to need repetition; but it is not equally well known that a similar medal fund was founded in the United States by Rumford, and is held in trust by the American Academy of Arts and Sciences. The medals were to be awarded for "the most important discovery or improvement relating to light and heat that had been made during the preceding two years in any part of America." The awards of the American Rumford medals have been made few and far between, and till 1876 may be said to have been given for inventions rather than discoveries. At this date the medal was awarded to Dr. Draper (as the medal itself records) "for researches on radiant energy." Had he been an European there can be little doubt but that he would have received one of our English medals years ago, and that his name would have been in the same list with those of Leslie, Fox Talbot, Fresnel, and Faraday. As it is he has the honour of being the first recipient of the American Rumford medal which has ever been awarded for pure scientific research.

A CATECHISM OF BOTANY

A First Catechism of Botany. By John Gibbs, of the Essex and Chelmsford Museum. (Chelmsford: Edmund Durrant and Co. London: Simpkin, Marshall, and Co.)

THIS little book is in its way quite a curiosity. It is a survival of a method of instruction which was very popular in its day, but which it is to be hoped—notwithstanding that Magnall's "Questions" is still said to be a good property—even in country towns like Chelmsford, is on the road to extinction. Catechisms originated in the necessity of giving some uniformity and precision to oral religious instruction. Their great merit is of course that they remove all responsibility from the teacher, and merely require that their formulæ should be taught with patience and perseverance. They render unnecessary, indeed even undesirable, any knowledge of the subject on the part of the teacher, and hence it is easy to see the reason of their popularity amongst persons engaged in education, and who, possessed of no scientific training, are yet anxious to get credit for teaching scientific subjects. Mr. Gibbs has evidently felt some uneasiness on this head, and points out accordingly in his preface that:—

"The answer to every question may be verified by examination of the plant itself in all its parts to which reference is made. Only in such a way can this catechism be made useful, and by such criticism its value will be ascertained."

But the insidious influence of the purely dogmatic method makes itself but too evident in the next sentence, which is surely the strangest ground of recommendation ever urged for a scientific book:—

"In its original form it was admitted to the International Exhibition of 1871, which contained nothing but what the Committee of Selection approved as excellent."

The approval of the Committee must have been easily given if it extended to the following curious inquiry :—

"83. *In the common horse-tail of our ditches every internode of the stem seems to consist of two hollow tubes, one inside the other. How do these differ from the wood and bark of plants more highly organised?*"

Another extract will show the catechetical method in its most aggravated form. Imagine the children in some small country school bitterly endeavouring to commit to heart the following :—

"261. *Can you describe the flower of the fuchsia?*

"It is that of a Calycifloral Exogen, with a coloured calyx valvate in æstivation, and consisting of four sepals. The corolla is twisted, and consists of four petals. The stamens are eight, in two rows, with long filaments. The pistil is syncarpous, with an inferior ovary, a long style, and a stigma of four lobes."

It is fair, however, to say that some of the information imparted by Mr. Gibbs is less indigestible. If the whole catechism were as sensible as the following, it might be actually useful :—

"221. *What name do botanists give the cabbage?*

"*Brassica oleracea.*

"222. *What do they call the cauliflower?*

"It is a variety of the same species.

"223. *Is not the difference between them enough to make them appear distinct species?*

"It would be if they were not known to be derived from a common origin.

"224. *Then how came they to differ so much?*

"They differ in consequence of cultivation having increased the luxuriance of their growth; some plants producing an abundance of large and succulent leaves, and others an extraordinary number of flower buds. Such plants have been selected by gardeners for many generations, till they have resulted in the production of distinct varieties.

"225. *How are these varieties perpetuated?*

"The varieties of *Brassica oleracea* are perpetuated by seed which is taken from plants kept carefully apart from other varieties of the same species, for if the pollen of one variety happen to fall on the stigma of another, the seed produced by that flower would give origin to plants intermediate or uncertain in their character. Sometimes new varieties appear in this way."

But the catechetical method in its unrelieved dryness is too much even for the author. He preserves his gravity with undeviating firmness till we come to the last question and its answer, which deserve reproduction in the pages of NATURE as something absolutely unique in botanical literature.

"322. *Describe a Daisy.*

"Of this little plant of the Composite order,
Bellis perennis is surely the name ;
A perennial herb in the garden's gay border,
To ornament which from the meadows it came.

"Its roots of a good many fibres are growing
From under the sides of a prostrate rhizome ;
Which branches above, but is never found going
At any great length from the centre to roam.

"Spathulate leaves in a rosulate cluster,
Every ramification surround ;
And in the middle about which they muster,
A simple peduncle is commonly found.

"Are these the green leaves of a bud? Let us waken
With knowledge and skill to examine the facts ;
And then shall not be for a calyx mistaken
A real involucre consisting of bracts.

"For each of the ligulate florets composing
The circular ray is a separate bloom ;
And each little cup in the centre reposing,
For every part of a flower has room.

"It seems that the cup of the calyx adhering
Unto an inferior ovary so,
Accounts for that innermost organ appearing
To be in the place where we find it below.

"The corolla above it of tubular figure,
Coherent epigynous petals compose ;
As whoso describes it with technical rigour
By five little teeth on the edge of it knows.

"The stamens are called syngenesious truly,
Because of the fact that their anthers cohere ;
The style passes through them, and on it will duly
A couple of stigmatic branches appear.

"When all this is done and the blooming is over ;
When fruits monospermous are ripen'd and gone ;
They leave the receptacle nothing to cover
Its form which we find in the shape of a cone.

"If now I have done my agreeable duty,
I venture to hope I shall have better luck
Than the flower itself, which, because of its beauty,
Some ruthless examiner haply may pluck."

T. D.

OUR BOOK SHELF

A Manual of Anthropometry. By Charles Roberts, F.R.C.S. (London : J. and A. Churchill, 1878.)

THE full title of this moderately-sized volume gives an accurate account of its contents. It is "a guide to the physical examination and measurement of the human body, containing a systematic table of measurements, an anthropometrical chart or register, and instructions for making measurements on a uniform plan."

The author's appetite for figures is marvellous, and would be commendable, were it not too indiscriminate, his tables having the air of being immense hotch-pot collections, both in their titles and headings and in the run of their results, which is more irregular than is natural to the statistics of generically similar facts. The author does not seem to recognise the importance of what is really the main question to the statist, namely, how to obtain trustworthy results with a minimum of effort. He seems to squander his efforts, the results he obtains being very disproportionate to the labour bestowed in getting them. Thus in a chart, of which the leading idea is very good, for recording measurements at frequent intervals of different parts of the body of the same growing person, he has places for the entry of the measurement of more than sixty parts, a number altogether too great to be dealt with satisfactorily in statistical combination with similar measurements of other persons. The theoretical part of the book is altogether loose and unsatisfactory ; it is a mixture of imperfectly understood Quetelet and water ; Quetelet himself being somewhat lax in theory and much too watery already. On the other hand, the volume has many merits, and it is a pleasant duty to notice them as much as it is a disagreeable one to point out the defects in a work that aspires to set a standard to which future statisticians should conform. Thus the arrangement of the sample statistical tables is very convenient in its main features, and to that extent well worthy of imitation, though not as good as might be in all its details. For instance it omits mention of any measure of variability, such as the Probable Error. The book includes a long and useful list of anthropometric works copied with important additions from the American work of Dr. J. H. Baxter. The author is evidently most zealous, and having himself measured and weighed people by the hundred, he writes with the aplomb due to

much experience. His zeal is contagious, and consequently much of what he has written will favourably attract the attention of the statist.

It is a pity that the custom does not exist of weighing and measuring all the members of a family at frequent intervals between childhood to manhood, seeing how critical a test of sanitary condition is afforded by the progress of growth. Each illness leaves its mark, therefore a chart of height and weight with accompanying remarks, would give in a compendious form a very valuable life-history of the individual.

A Text-book of Arithmetic for Use in Higher Class Schools. By Thomas Muir, M.A., F.R.S.E. (Daldy, Isbister and Co., 1878.)

"NUMBER," infers "Recorde," in his "Whetstone of Witte," "is the onelie thing (almost) that seperateth man from beastes. Hee therefore that shall contempne numbre, he declareth himselfe as brutishe as a beaste, and unworthy to be counted in the fellowshippe of men. But I truste there is no man so foule ouerseene, though manie right smallye do it regarde."—(De Morgan, "English Mathematical and Astronomical Writers.") We have done with the miserable mercantile compendiums founded on Cocker, which De Morgan condemned, and have had, since his own "Arithmetic" appeared, many works of high value. Mr. Muir's work is worthy of taking place with these. His aims are high—mathematical accuracy, rational treatment, the presentment of essentials, with the accessories in due subordination, the production of a work suited both for mental training and as a preparation for the practical business of life. There is perhaps matter given more suitable for the use of teachers than of pupils—that is, for a school book we think much might be more concisely put. Persons taking up the subject at a more advanced age may find this fulness of explanation very valuable. The exercises are good and varied, and there is a chapter containing notices of books for future reading.

In connection with these notices and Mr. Muir's chapter on the roots of numbers (a part of the work which appears to us to require excision and a new treatment), we may add the following title :—"Éléments de Calcul Approximatif." Par Charles Ruchonnet (de Lausanne). Seconde Édition. (Paris, 1874)—a work which we have already noticed in NATURE.

The work is a thoroughly reliable one, accurately and neatly printed.

The Elements of Dynamics (Mechanics), with numerous Examples and Examination Questions. By J. Blaikie, M.A. (Edinburgh: J. Thin, 1878.)

MR. BLAIKIE says "special pains have been taken to establish the necessary propositions by proofs involving no higher mathematics than the geometry of the first two books of Euclid, and algebra as far as simple equations. At the same time the nomenclature, definitions, and general treatment are in harmony with advanced modern works on the subject." The author starts with kinematics and kinetics and derives statics as a particular case. A chapter is devoted to machines and another to hydrostatics. The objects laid down in the above statement have been well kept before the writer's eye, and the result is a good introductory book for young students. A word of decided commendation is due to the selection of general examples; there are besides some six university examination papers, specimens from the old universities, and from Edinburgh, London and Glasgow. The list of errata we have made is a very slight one, and we say this after working out all the examples.

This accuracy and carefulness of selection may be attributed to the fact of the work having been examined by such men as Professors Tait and Balfour Stewart and Mr. N. M. Ferrers. That our favourable opinion of this work is not singular may be inferred from the fact that a second edition is already in preparation.

Handbook to Map of the Geographical Distribution of Animals. By Andrew Wilson, Ph.D., &c. (Edinburgh and London: W. and A. K. Johnston, 1878.)

THIS is a very brief statement of the extent and limits of the six zoological regions and sub-regions, as given in Mr. Wallace's "Geographical Distribution of Animals," with an enumeration of the chief groups of mammals and birds characteristic of each region. The only novelty is that of placing the Ethiopian region fourth in order, thus separating it from the Palæarctic and Oriental, to both of which it is closely allied, and making it follow the Australian, with which it has no affinity. It is difficult to see the reason of this innovation, which will certainly not be considered an improvement. The map is in two large sheets, with the regions and sub-regions copied from Mr. Wallace's map, and similarly distinguished by colours. It is, however, a mere outline, and entirely without names—a great deficiency in any case, and especially when intended for junior students, to whom alone such a meagre sketch of the subject would be acceptable.

LETTERS TO THE EDITOR

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

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

Gigantic Land Tortoises

MY attention has been called to the recent discussions in NATURE (vol. xviii. p. 220 *et seq.*) in reference to the geographical distribution of the gigantic land-tortoises of Malta, the Galapagos, and other oceanic islands (see also the annual address of the president of the Geological Society). On my return to America in 1864 from a four-years' residence in the guano key of Sombrero, West Indies, I put a small collection of fossil reptilian remains, found on that key, in the hands of the late Prof. Jeffries Wyman, of Boston, who had kindly consented to examine them. His report on the subject, received in August, 1865, was added as an appendix to a paper of mine on the geology of the key, but the latter was partially injured by a fire in the study of the late Prof. Joseph Henry, of the Smithsonian Institution, and its publication consequently postponed. I have since found time to restore and publish only a portion of my own paper,[1] but the report of Prof. Wyman has remained untouched among the charred MSS. of my observations on the guano-deposit of Sombrero. I inclose herewith a copy of Prof. Wyman's report, and also his subsequent autograph letter, in returning me the specimens. (In the former I have supplied, in italics, the probable words which are missing along the singed edges of some of the leaves.) I have thought these details worthy of statement in justice to this distinguished comparative anatomist—who recognised thirteen years ago the occurrence of this interesting fauna in a locality of the Atlantic, and one evidently unknown to the recent investigators—and in explanation of the long delay in the publication of his views. The specimens in question remain still in my possession, with the exception of one in the museum of this school.

I may further state that fossil specimens of these turtles, mostly fragmentary, have been found in many of the northern excavations upon Sombrero, since they were first worked, in 1856, and perhaps are still, as its exploitation has been continued by an English company for many years past. They occur altogether in the guano-veins which intersect the limestone beds to an unknown depth beneath the sea-level, and which are certainly but insertions from an ancient surface-bed of rock-guano, overlying but long since entirely denuded along with the crown of the key. In 1860–61, just before my arrival, enormous quantities of a guano-breccia were taken out from the largest of

[1] "Ann. Lyc. of Nat. Hist. of N.Y.," 1868, p. 251.

the northern quarries, which was largely made up of these fragments, probably to the amount of hundreds of tons! It will be seen from my paper (*loc. cit.*) that the Sombrero Key is merely the eroded remnant of an atoll, which presented, by its peculiar isolation, the most favourable refuge for this Chelonian family. Their existence in this region seems to furnish an important link in reference to the question of the ancient geographical connection between the Mascarene and the Galapagos Islands. Their occurrence has never been reported on the other guano keys of the Caribbean Sea—Navassa, Swan, Monk's, Redonda, &c; but I would suggest the propriety of an examination of the cargoes of guano from Navassa, &c., as well as from all other localities, which may still be brought to England. The conditions of the existence of this fauna will be discussed with more detail in the remainder of my Sombrero paper, when sufficiently restored and re-written for publication.

ALEXIS A. JULIEN

MY DEAR SIR,—The collection of fossils from the Sombrero Key, which you kindly placed in my hands for examination, comprises the remains of birds, turtles, and Saurian reptiles. Those of the first, and from the more superficial deposit, appear to belong to existing species of sea-birds now found along the coast, and have undergone no change. The following comprises a list of such specimens as are sufficiently well preserved to be identified. There are many other specimens, but they are so much broken that I have not been able to determine them. Specimens numbered from 1 to 17 inclusive are bones of turtles, and those from 1 to 11 inclusive are all from the same, viz., the middle, deposit.[1]

1. Left humerus of a large turtle; the ends are gone and the shaft alone is preserved; it is 6 inches in length, and at the smallest part has a diameter of 2·07 inches, from before backwards, and of 1·57 inches from side to side. Admitting that the usual proportions existed, the whole length would have been about 12 inches.

2. A fragment comprising a large part of a humerus; nearly the whole of the articular facet is preserved, its longest diameter measuring 2·38 inches, thus indicating a large species like that of 1.

3. Middle portion of a femur, 1·25 inch in diameter. This would indicate an entire bone of from 8 to 9 inches in length.

4. Lower third of a left humerus; the inner tuberosity is broken off, and does not therefore exhibit the emargination found in most turtles. This is somewhat smaller than the same part from a Galapagos turtle (*T. elephantopus*), the length of whose carapace was 27 inches.

5. A femur from which the upper portion is broken off. This is of the same size as the corresponding part in the Snapper (*E. serpentina*), the carapace of which was 15 inches long. The transverse diameter of the condyles was 1·35 inch.

6. Middle portion of the shaft of a humerus, 0·55 inch in diameter.

7. A similar fragment, 0·75 inch in diameter.

8. A fragment of one of the marginal bones, 1 inch in thickness. This could have only belonged to a turtle of the size of the Galapagos species.

9. A fragment of the right ilium, including the middle portion, the longest diameter of which last is 1·55 inch, and the two facets for the articulation of the ischium and pubes.

10. The shaft of a femur 0·75 inch in diameter.

11. Upper half of the ascending portion of the scapula; this has a diameter at the articular end of 0·90 inch.

All of the above specimens are from the same deposit in which the matrix is soft and crumbling.

12. Lower two-thirds of a humerus partly imbedded in a very dense matrix, which contrasts very strongly with that found in connection with the preceding specimen. The fragment is 3·50 inches long, 2·35 inches across condyles; a part of the inner one is broken off, but there are some signs of the lateral groove and notch at the end. The narrowest part of the shaft measures 0·92 inch in diameter.

13. Lower end of a radius from the left side.

14. Fragment of a carapace having a raised articular surface for the articulation of the pelvis, as in some of the land turtles.

15, 16, 17. Other fragments of a carapace.

17*a*. An irregular cast of a part of the interior of the carapace and plastron, the walls of the latter (?) being broken, but portions of them still adhering. Three of the median bony dermal plates, the largest 2·25 inches in diameter. These plates have neither ridge nor tuberosity on the median line, though there are slight projections over the head of the ribs resembling those of very old specimens of *E. serpentina*. The plastron is indistinctly seen, but enough remains to show that its union with the carapace was by a broad surface, and not by a narrow one, as in the marine and some of the fresh-water species.

18. A caudal vertebra of a saurian.

19. Anterior half of a lower jaw of a saurian which resembles in size and the arrangement of the teeth that of the *Iguana cornuta*, as figured by Cuvier in the *Ossemens fossiles*. The points of the teeth are compressed and show some signs of having been serrated, though now worn nearly smooth.

20. Fragment of a femur, which closely resembles in size and shape that of the *Iguana tuberculata*.

21. Another fragment of a femur closely resembling the last, but about one-fourth smaller.

The remains of turtles form by far *the largest part* of the collection of which the above is a list. From the fact which you communicated to me, that at *the present time* not a single species of turtle inhabits the *Sombrero Key*, the question at once arises whether these remains belong to species like those now inhabiting the sea, or to such as live either in fresh-water or on the land. After a careful comparison I do not find that any of them can be considered as of marine origin. All the long bones, consisting chiefly of arm and thigh bones, differ in a marked degree from corresponding ones of the sea-turtles in having the axis of the bones strongly curved instead of being nearly straight, in having the shaft at its middle nearly round instead of flattened, and in having the distal ends proportionally much broader. A comparison of the fossil fragments with the corresponding parts of fresh-water and land species is much more difficult, since these two kinds, in their anatomical features, so gradually shade into and so closely resemble each other that there is really no well-marked line of distinction.

It is certain, nevertheless, that the remains above noticed belong either to the fresh-water or land species, and the discovery of them where such no longer exist alive indicates a great revolution in the *previous history* of the island, and is therefore a *marked fact*. In addition we have the interesting remains of one of the species, which is certainly extinct and of gigantic size, equalling the largest specimens which are found living in any part of the world, and thus surpassing any now found in North or South America. The nearest instances of turtles of similar size are in the Galapagos Islands, where is found *I. elephantopus*. Specimens 7 and 10 indicate species as large as those now inhabiting the Americas.

Although among turtles it is almost impossible to establis species from fragments of bones, and these not the most characteristic ones, yet I have no doubt that the remains here described show the existence at least of three species, one, the longest of which represented by specimen 1, was undoubtedly an inhabitant of the land.

JEFFRIES WYMAN

Cambridge, August 14, 1865

[1] The Red Sandrock.—A. A. J.

The Figure of the Planet Mars

IN the report of the proceedings of the Academy of Sciences at Paris for October 22 (NATURE, vol. xviii. p. 712), with reference to a communication from me relative to the flattening of the planet Mars, it is stated that I confirm M. Amigues' conclusions from independent calculations. Allow me to say that the communication referred to, has clearly established by reference to dates of publication, that the calculations I had been the first to make were confirmed by the subsequent results of M. Amigues. A formula presented by me in February, 1870, in which the mean density, surface density, and velocity of rotation of Mars are expressed in connection with its ellipticity, was reproduced by apparently identical methods by M. Amigues, in the *Comptes Rendus* for June, 1874. The conclusions drawn from this formula by M. Amigues were, that in order to account for the high amount of ellipticity assigned to Mars by many astronomers its mean density must be less than its surface density. My conclusion was, on the contrary, that the high ellipticity alluded to was improbable and that the values given by Bessel, Oudemanns, Johnson, and other astronomers, whereby Mars would have an ellipticity nearly the same as that of the earth, should be adopted until the subject was cleared up by fresh observations.

H. HENNESSY

Royal College of Science for Ireland, November 2

The Colour-Sense

WITH reference to Dr. Pole's valuable papers on Homer's colour-blindness, it may interest your readers to learn that I have now nearly completed a work on "The Origin and Development of the Colour-Sense," which will be shortly published by Messrs. Trübner and Co. In it I have endeavoured to show (*inter alia*) that the use of colour-terms in the Homeric poems is strictly analogous to that of other races, existing or extinct, at the corresponding stage of culture; and that both depend, not upon dichromic vision, but upon a defect of language closely connected with the small number of dyes or artificial pigments known to the various tribes. To establish this result I have sent a number of circular letters to missionaries, Government officials, and other persons having relations with native uncivilised races in all parts of the world; and their answers to my queries, framed so as to distinguish carefully between perception and language, in every case bear out the theory which I had formed. As my results will so soon be published elsewhere, I shall not burden your columns with them at present, but may add that my researches lead me to place the origin of the colour-sense far lower down in the animal scale, as evidenced both by the distinctive hues of flowers and fruits, and by the varied integuments of insects, birds, &c., so far as these are the result of sexual selection, or of mimicry and other protective devices.

GRANT ALLEN

Magnus's "Hydrostatics" and the "London Science Series"

I KNOW it is unusual for an author to offer any reply to the favourable or unfavourable criticism of his reviewer; but I shall be glad if, by way of exception to this wise rule, you will allow me to make a few remarks on the notice of my little book which appeared in NATURE, vol. xviii. p. 693, as they refer to a subject of wider interest than the contents of the work itself. It unfortunately often happens that an author is able to detect that the reviewer has taken no further trouble than to make a few quotations from the preface of the book under review. For my own part I have no complaint on this ground. On the contrary, if the reviewer had even glanced at the preface he would have seen that the book has not been written for the use of very young boys, but that it "is intended for the use of those pupils in the upper Forms of schools who have already acquired some elementary knowledge of the principles of mechanics"—for those, in fact, to whom, after some adverse criticism, he is good enough to say "the book will undoubtedly prove useful."

My object in writing, however, is less to disprove anything that may have been said with regard to my own book than to take away the point of the criticism which has been directed against other volumes of the "London Science Series." As one of the Editors of this Series, I am anxious to correct an erroneous but somewhat prevalent impression that these books are intended to be "science primers." Nothing could be farther from the intentions of the Editors of this Series than the attempt to rival the excellent and original science primers published by Messrs. Macmillan. Judged by such a standard they must necessarily appear difficult and elaborate. But the standard is incorrect. The books of the present series are, as they purpose to be, essentially class-books, and many of them have been expressly written to meet the wants of the pupils of the higher forms of schools.

Although my reviewer "cannot imagine" that I "can be acquainted with science teaching in schools or its requirements," I may lay claim to so much experience as a teacher and school-examiner as shows me that a class-book should be rather above than below the average attainments of the form, and should be so written as to encourage the more advanced pupils to pursue their studies to a higher point.

If Science is to take the place of Classics in any of our schools it should be so taught as to afford an equivalent amount of mental discipline. If this is not the case the modern school will always rank below the grammar school, and there will be some ground for the alleged inferiority of the modern, with respect to the classical side of a public school. To teach science properly several hours a week ought certainly to be given to it, and I should be disposed to criticise somewhat severely the time-table of any school in which the boys "probably have one hour, or at most two, to devote to the subject in a week." Indications of showy and superficial knowledge on the part of boys who take up Science instead of Classics are not wanting, and this showiness may be partly due to the want of thoroughness of some of the text-books commonly in use.

PHILIP MAGNUS

Savile Club, London, November 3

[We have sent Mr. Magnus' letter to our Reviewer, who replies as follows.—ED.]

MR. MAGNUS complains that if his reviewer "had even glanced at the preface he would have seen that the book has not been written for very young boys, but that it is intended for the use of those pupils in the upper Forms of schools who have already acquired some elementary knowledge of the principles of mechanics." To this I may reply, firstly, that I did much more than glance at the preface; secondly, that I nowhere assert that the book is intended for "very young boys;" and thirdly, that I assert my belief that "for advanced boys in Upper Fifth and Sixth Forms the book will undoubtedly prove useful." By "young boys" I meant boys in the Upper Fourths, Removes, and Lower Fifths, whose average ages range between fourteen and sixteen. It is in these Forms that the principal science teaching in a Public school takes place.

I nowhere have asserted that the book is intended to be a "science primer," and my remark that it is intended for "school purposes" is taken from the commencement of the Editor's preface.

I am the more constrained to repeat my belief that the author cannot "be acquainted with science teaching in schools or its requirements" when I read his remarks on the character of a school class-book, and when I notice that he speaks of "science taking the place of classics."

I believe I am right in stating that in no school in England does science take the place of classics. I should sincerely deplore such a result. Any attempt to enforce it could only result in utter failure from an educational point of view. Science can never "afford an equivalent amount of mental discipline" to classics. Mr. Magnus may not be aware of the fact that science is taking the place of Latin verses in our public schools, and that no proposition has ever, as far as I know, been made to the effect that classics should be abandoned.

Finally, Mr. Magnus tells us that he "should be disposed to criticise somewhat severely the time-table of any school in which the boys probably have one hour, or at most two, to devote to the subject in a week." Possibly he would; but the fact is no less true that in almost all our principal schools two hours a week is the maximum time which is given, in the ordinary course of school work, to any one subject of science, and class books must be framed in accordance with such usage.

THE REVIEWER

The Discovery of a Crannog in Ayrshire

IN his letter reporting this interesting discovery (NATURE, p. 695), Dr. Munro remarks that amongst the constituents of the crannog was "brushwood, amongst which beech, birch, and hazel were readily recognised."

Now as *beech* is certainly not at present a *native* of Scotland, and as, to the best of my knowledge, it never has been claimed as an indigenous tree at any period, the finding of beech branches in the Tarbolton crannog is not the least interesting part of the discovery, and I venture to hope that Dr. Munro will be able to give us proofs that the brushwood he mentions is, beyond any doubt, beech.

Of course the other trees—oak, birch, and hazel—are truly indigenous. The *absence* of Scots-fir is also not without interest.

F. BUCHANAN WHITE

The Power of Stupefying Spiders Possessed by Wasps

MR. CECIL'S letters on "The Power of Stupefying Spiders possessed by Wasps" give details of a fact perfectly well known to entomologists, certainly to all those who have studied the Aculeata; but it is well known to the latter that no true wasp, according to the popular understanding of that name, ever supplies its larvæ with insects stupefied in the manner described. The insects alluded to in Mr. Cecil's letters probably belong to the section of aculeate insects usually known as sand-wasps by naturalists, a very misleading name, since a large number are wood-borers. It would render the subject of stupefying much more understandable to the general reader if this was more clearly elucidated; the general term wasp gives no clue in this instance to the insect observed. We have in this country fossorial insects belonging to the genera Pompilus, Priocnemus,

Agenia, Aporus, Miscophus, Ammophila, Crabro, Cerceris, Philanthus, and some others, all of which stupefy the caterpillars, spiders, or bees, which they store up for the nourishment of their brood, and it would be desirable to have it pointed out to what genera the insects really belong. The species seen by Mr. Cecil, in a collection at Athens, which is described as "a thin-bodied variety," is, I think, a species of the genus Ammophila, or of Pompilus; that observed by Mr. Armit, of Queensland, is probably a species of Pelopæus. Some further definition of the insects I consider highly desirable, as the general term wasp must, I believe, lead to a very false conclusion.

British Museum, November 2 FREDK. SMITH

The Expected Meteor Shower

THE meteor shower of Biela's comet, referred to in your "Astronomical Notes" as likely to occur on the 27th inst., should also be looked for on several evenings preceding that date. Last year there were more of these slow-moving *Andromedes* on the 25th than on the 27th of November. On the former night, from 5h. 30m. to 7h., I saw sixteen shooting stars, seven of which belonged to this stream, for they showed a good radiant at R.A. 24° Dec. 45° N. Yet on the 27th only two others were noted out of a total of 10 recorded during a watch from 9h. to 10h. 30m. An occasional look out is therefore advisable on several nights about the 27th, when, if meteors are seen in more than ordinary profusion, it will be important to record their numbers and paths. W. F. DENNING

Ashleydown, Bristol, November 7

Geological Climate and Geological Time

IN considering the climatic changes which have evidently taken place on various parts of the earth's surface, it seems to me that what may have been a very important factor has been rather strangely left out of calculation by physicists, never having been noticed hitherto, as far as I am aware. It is that of the heat which must at one period or other have been transmitted from the moon. There can be scarcely a doubt that this must at one time have influenced the earth's climate to a very powerful degree, producing the effects of a second or additional sun. In the absence of any perceptible marks of atmospheric or aqueous erosive action on the moon it is at present impossible to arrive at any idea of its relative age or at what period its heat may have been most abundantly radiated; but if the much hotter climate which once prevailed in northern latitudes could be referred to this cause it might give us some clue to the difficulty. Something also might be done in comparing the various changes of climate which have taken place in certain parts of the earth's surface, as indicated by geological evidence, with the actual course of the moon. The subject is at least worth entertaining, and may be recommended to the consideration of physicists. WILLIAM DAVIES

10, Guildford Street, Russell Square, November 4

A "New Galvanometer"

THE galvanometer (with its coil moving about a horizontal axis) described by Dr. Obach in NATURE, vol. xviii. p. 707, is not new. Prof. Pickering has fully described it, under the name of *Cosine* galvanometer, in his "Elements of Physical Manipulation," Part 2 (1876), p. 260. When this instrument was first used I do not know. R. E. BAYNES

Christchurch, Oxford, November 9

COMMERCIAL CRISES AND SUN-SPOTS[1]

"Thou Sun, of this great world both eye and soul."

IT is curious to notice the variety of the explanations offered by commercial writers concerning the cause of the present state of trade. Foreign competition, beer-drinking, over-production, trades-unionism, war, peace, want of gold, superabundance of silver, Lord Beaconsfield, Sir Stafford Northcote, their extravagant expenditure, the Government policy, the wretched Glasgow Bank directors, Mr. Edison and the electric light, are a few of the happy and consistent suggestions continually made to explain the present disastrous collapse of industry and credit.

It occurs to but few people to remember that what is happening now is but a mild repetition of what has previously happened time after time. October, 1878, is comparable with May, 1866, with November, 1857, with October, 1847, and, going yet further back, with a somewhat similar condition of things, in 1837, in 1825-26, and even in 1815-16. The incidental circumstances of these commercial collapses have indeed been infinitely diversified. At one time the cause seemed to be the misconduct of the great firm of Overends; in 1857 there was the mutiny in India, the peace with Russia, and a commercial collapse in the United States; in 1847 occurred the Irish famine and a failure of European harvests generally, following upon the great railway mania; the crisis of 1837 succeeded an immense expansion of home trade, the establishment of joint stock banks, and the building of multitudes of factories and other permanent works; 1825 was preceded by extravagant foreign speculations and foreign loans; 1815 was the year of the general peace. All kinds of distinct reasons can thus be given why trade should be now inflated and again depressed and collapsed. But, so long as these causes are various and disconnected, nothing emerges to explain the remarkable appearance of regularity and periodicity which characterises these events.

The periodicity of the earlier portion of the series is so remarkable that, even without the corroboration since received, it convinced scientific inquirers that there was some deep cause in action. Dr. Hyde Clarke, for instance, wrote, more than thirty years ago, a paper entitled "Physical Economy—a preliminary inquiry into the physical laws governing the periods of famines and panics." This paper was published in the *Railway Register* for 1847, and is well worth reading. In the commencement he remarks: "We have just gone through a time of busy industry, and are come upon sorrow and ill-fortune; but the same things have befallen us often within the knowledge of those now living. Of 1837, of 1827, of 1817, of 1806, of 1796, there are men among us who can remember the same things as we now see in 1847. A period of bustle, or of gambling, cut short in a trice and turned into a period of suffering and loss, is a phenomenon so often recorded, that what is most to be noticed is that it should excite any wonder." Dr. Hyde Clarke then proceeds to argue in a highly scientific spirit that events so regularly recurring cannot be attributed to accidental causes; there must, he thinks, be some physical groundwork, and he proposed to search this out by means of a science to be called Physical Economy. In the third page of his paper he tells us that he had previously written a paper on the laws of periodical or cyclical action, printed in Herapath's *Railway Magazine* for 1838. "At this time," he says, "it was my impression that the period of speculation was a period of ten years, but I was led also to look for a period of thirteen or fourteen years. . . . In the course of these inquiries I looked at the astronomical periods and the meteorological theories without finding anything at all available for my purposes." A little below Dr. Hyde Clarke continues:—"Still thinking that the interval was an interval of about ten years, I was, during the present famine, led to look for a larger period, which would contain the smaller periods, and as the present famine and distress seemed particularly severe, my attention was directed to the famine so strongly felt during the French Revolution. This gave a period of about fifty-four years, with five intervals of about ten or eleven years each, which I took thus:—

"1793 1804 1815 1826 1837 1847."

Dr. Hyde Clarke was by no means the only statist who

[1] This article, although treating the same subject, and partially containing the same facts as a paper by the same writer, read at the recent meeting of the British Association, is a distinct composition. The paper in question will probably be published elsewhere.

adopted a theory of periodicity thirty or forty years ago. In February, 1848, Mr. J. T. Danson read a paper to the Statistical Society of London, attempting to trace a connection between periodic changes in the condition of the people and the variations occurring in the same period in the prices of the most necessary articles of food. Mr. James Wilson had published, in 1840, a separate work or large pamphlet upon "Fluctuations of Currency, Commerce, and Manufactures," in which he speaks of the frequent recurrence of periods of excitement and depression. In later years Mr. Wm. Langton, the esteemed banker of Manchester, independently remarked the existence of the decennial cycle, saying: "These disturbances are the accompaniment of another wave, which appears to have a decennial period, and in the generation of which moral causes have no doubt an important share." The paper in which this remark occurs is contained in the *Transactions* of the Manchester Statistical Society for 1857, and is one of the most luminous inquiries concerning commercial fluctuations anywhere to be found.[1] In still later years Mr. John Mills of the Manchester Statistical Society has almost made this subject his own, insisting, however, mainly upon the mental origin of what he has aptly called the Credit Cycle.

The peculiar interest of Dr. Hyde Clarke's speculations consists in the fact that he not only remarked the cycle of ten or eleven years, but sought to explain it as due to physical causes, although he had not succeeded in discovering any similar astronomical or meteorological variation with which to connect it. Writing as he did in 1838 and 1847, this failure is not to be wondered at. His supposed period of fifty-four years is perhaps deserving of further investigation, but it is with his period of ten or eleven years that we are now concerned.

My own inquiries into this interesting subject naturally fall much posterior to those of Dr. Clarke; but, about the year 1862, I prepared two elaborate statistical diagrams, one of which exhibited in a single sheet all the accounts of the Bank of England since 1844, while the other embraced all the monthly statements I could procure of the price of corn, state of the funds, rate of discount, and number of bankruptcies in England from the year 1731 onwards. Subsequent study of these diagrams produced upon my mind a deep conviction that the events of 1815, 1825, 1836-39, 1847, and 1857, exhibited a true but mysterious periodicity. There was no appearance, indeed, of like periodicity in the earlier parts of my second diagram. In the first fifteen years of this century statistical numbers were thrown into confusion by the great wars, the suspension of specie payments, and the frequent extremely high prices of corn. It must be allowed, moreover, that the statistical diagram, so far as concerns the eighteenth century, presents no appreciable trace of decennial periodicity. The recent continual discussions concerning the solar or sun-spot period much increased the interest of this matter, and in 1875 I made a laborious reduction of the data contained in Prof. Thorold Rogers' admirable "History of Agriculture and Prices in England from the Year 1259." I then believed that I had discovered the solar period in the prices of corn and various agricultural commodities, and I accordingly read a paper to that effect at the British Association at Bristol. Subsequent inquiry, however, seemed to show that periods of three, five, seven, nine, or even thirteen years would agree with Prof. Rogers' data just as well as a period of eleven years; in disgust at this result I withdrew the paper from further publication. I should like, however, to be now allowed to quote the following passage from the MS. of the paper in question:—

"Before concluding I will throw out a surmise, which, though it is a mere surmise, seems worth making. It is now pretty generally allowed that the fluctuations of the money market, though often apparently due to exceptional and accidental events, such as wars, great commercial failures, unfounded panics, and so forth, yet do exhibit a remarkable tendency to recur at intervals approximating to ten or eleven years. Thus the principal commmercial crises have happened in the years 1825, 1836-9, 1847, 1857, 1866, and I was almost adding 1879, so convinced do I feel that there will, within the next few years, be another great crisis. Now if there should be in or about the year 1879, a great collapse comparable with those of the years mentioned, there will have been five such occurrences in fifty-four years, giving almost exactly eleven years (10·8) as the average interval, which sufficiently approximates to 11·1, the supposed exact length of the sun-spot period, to warrant speculations as to their possible connection."

I was led to assign the then coming (that is, the now present) crisis to the year 1879, because 11·1 years added twice over to 1857, the date of the last perfectly normal crisis, or to 1847, the date of the previous one, brings the calculator to 1879. If I could have employed instead Mr. J. A. Broun's since published estimate of the sun-spot period, to be presently mentioned, namely, 10·45 years, I should have come exactly to the present year 1878. My mistake of one year was due to the meteorologists' mistake of eight months, which, as crises usually happen in October and November, was sufficient to throw the estimate of the event into the next twelvemonths.

While writing my 1875 paper for the British Association, I was much embarrassed by the fact that the commercial fluctuations could with difficulty be reconciled with a period of 11·1 years. If, indeed, we start from 1825, and add 11·1 years time after time, we get 1836·1, 1847·2, 1858·3, 1869·4, 1880·5, which show a gradually increasing discrepancy from 1837, 1847, 1857, 1866 (and now 1878), the true dates of the crises. To explain this discrepancy I went so far as to form the rather fanciful hypothesis that the commercial world might be a body so mentally constituted, as Mr. John Mills must hold, as to be capable of vibrating in a period of ten years, so that it would every now and then be thrown into oscillation by physical causes having a period of eleven years. The subsequent publication, however, of Mr. J. A. Broun's inquiries, tending to show that the solar period is 10·45 years, not 11·1,[1] placed the matter in a very different light, and removed the difficulties. Thus, if we take Mr. John Mills' "Synopsis of Commercial Panics in the Present Century," and, rejecting 1866 as an instance of a premature panic, count from 1815 to 1857, we find that four credit cycles occupy forty-two years, giving an average duration of 10·5 years, which is a remarkably close approximation to Mr. Broun's solar period. Thus encouraged, it at last occurred to me to look back into the previous century, where facts of a strongly confirmatory character at once presented themselves. Not only was there a great panic in 1793, as Dr. Hyde Clarke remarked, but there were very distinct events of a similar nature in the years 1783, 1772–3, and 1763. About these dates there can be no question, for they may all be found clearly stated on pp. 627 and 628 of the first volume of Mr. Macleod's unfinished "Dictionary of Political Economy." Mr. Macleod gives a concise, but, I believe, correct account of these events, and as he seems to entertain no theory of periodicity, his evidence is perfectly unbiased. Yet, in the space of a few lines, he unconsciously states this periodicity, saying:—"Ten years after the preceding crisis of 1763 another of a very severe nature took place in 1772 and the beginning of 1773. It extended over all the trading nations of Europe." A few lines below he goes on to state that in May, 1783, a rapid drain of bullion to the Continent set in, which greatly alarmed the Bank directors and embarrassed the merchants. The

[1] It is reprinted in the *Transactions* of the same Society for 1875-76.

[1] NATURE, vol. xvi. p. 63.

paragraph in which this occurs is headed "The Crisis of 1783," and on turning the page we at once come on another paragraph headed "The Crisis of 1793." Here then we have, in a few lines of a good authority concerning the history of finance, a statement of four crises occurring at almost exactly decennial intervals. It is wonderful that no writer has, so far as I know, previously pointed out the strictly periodic nature of these events; and I may add that I have several times lectured to my college classes about these crises without remarking their periodicity. It is true that we cannot, by any management of the figures, bring them into co-ordination with later crises so long as we adhere to the former estimate of the solar period. If, starting from 1857, we count back nine intervals of 11·1 years each, we get to 1757 instead of 1763; we are landed in the middle of a cycle instead of in the beginning or end; and there can be no possible doubt about the crises of 1763 and 1857. But, if we are once allowed to substitute the new estimate of Broun, which is the same as the old one of Lamont, the difficulty disappears; for the average interval is 10·44 . . . years!

This beautiful coincidence led me to look still further backwards, and to form the apparently wild notion that the great crisis generally known as that of the South Sea Bubble might not be an isolated and casual event, but only an early and remarkable manifestation of the commercial cycle. The South Sea Bubble is generally set down to the year 1720, and the speculations in the shares of that company did attain their climax and commence their collapse in that year. But it is perfectly well known to the historians of commerce that the general collapse of trade which profoundly affected all the more advanced European nations, especially the Dutch, French, and English, occurred in 1721. Now, if we assume that there have been since 1721, up to 1857, thirteen commercial cycles, the average interval comes out 10·46 years; or if we consider that we are in this very month (November, 1878) passing through a normal crisis, then the interval of 157 years from 1721 to 1878 gives an average cycle of 10·466 years.

It would be impossible, however, to enlist the South-Sea Bubble in our series unless there were some links to connect it with subsequent events. I have, therefore, spent much labour during the past summer in a most tedious and discouraging search among the pamphlets, magazines, and newspapers of the period, with a view to discover other decennial crises. I am free to confess that in this search I have been thoroughly biased in favour of a theory, and that the evidence which I have so far found would have no weight if standing by itself. It is impossible in this place to state properly the facts which I possess; I can only briefly mention what I hope to establish by future more thorough inquiry.

It is remarkable to notice that the South Sea Company, which came to grief in 1720-21, was founded in 1711, just ten years before, and that on the very page (312) of Mr. Fox Bourne's "Romance of Trade,"[1] which mentions this fact, the year 1701 also occurs in connection with speculation and *stock-jobbing*, as the promotion of companies was then called. The occurrence of a crisis in the years 1710-11-12, is indeed almost established by the lists of bubble insurance companies formed in those years, as collected by Mr. Cornelius Walford, and obligingly shown to me by him.[2]

Again, it is quite plain that about ten years after stock-jobbing had been crushed by the crisis of 1721, it reared its head again. A significant passage in the *Gentleman's Magazine* of 1732 (vol. ii. p. 561) remarks that "Stock-jobbing is grown almost epidemical. Fraud, corruption, and iniquity in great companies as much require speedy and effectual remedies now as in 1720. The scarcity of money and stagnation of trade in all the distant parts of England, is a proof that too much of our current coin is got into the hands of a few persons." This "getting the current coins into the hands of a few people" was the favourite theory at that time to explain any slackness of trade, just as now over-production is the theme of every short-sighted politician. But the legislature of that day thought they could remedy these things in a drastic manner, so they passed in 1734 "An Act to prevent the infamous practice of stock-jobbing." Mr. Walford, who has inquired into the commercial history of this time far more minutely than any other writer, remarks[1] that "gambling in stocks and funds had broken out with considerable fervour again during the few years preceding 1734. It was the first symptom of recovery from the events of 1720."

I may add that there was in 1732 a great collapse of a society called the "Charitable Corporation for Relief of the Industrious Poor." A great many people were ruined by the unexpected deficit discovered in the funds of this kind of bank, and Parliament and the public were asked to assist the sufferers, just as they might now be asked to aid the shareholders of the City of Glasgow Bank. Thus does history repeat itself!

Whether it was that the act of 1734 really did diminish the infamous practice of stock-jobbing, or, whether the sun-spots manifested less variation than usual, it is clear that between 1732 and 1763 it is very difficult to discover anything approaching a mania or crisis. My learned and obliging correspondents at Amsterdam and Leiden, Drs. S. and W. Vissering, disclaim any knowledge of such events in the trade of Holland at that time, and my own diagram, showing the monthly bankruptcies throughout the interval, displays a flatness of a thoroughly discouraging character. Nevertheless, inquiry leads me to believe that although there really was nothing to call a crisis, mania, or panic, yet there were remarkable variations in the activity of trade and the prices of some staple commodities, such as wool and tin, sufficient to connect the earlier with the later periods. It is a matter of much regret that I have hitherto been quite unable to discover a connected series of price-lists of commodities of the early part of last century. The accounts of prices of goods at Greenwich Hospital, to be found in several statistical works, are not only incomplete, but probably misleading. Any reader of this article who can point out to me series of prices of metals or other commodities, not merely agricultural, before 1782, will confer a very great obligation upon me by doing so.

Deferring, however, for the present, any minuter inquiry, I permit myself to assume that there were about the years 1742 and 1752 fluctuations of trade which connect the undoubted decennial series of 1711, 1721, and 1732, with that commencing again in the most unquestionable manner in 1763. Thus the whole series of decennial crises may be stated as follows: (1701?), 1711, 1721, 1731-32, (1742? 1752?), 1763, 1772-73, 1783, 1793, (1804-5?), 1815, 1825, 1836-39 (1837 in the United States), 1847, 1857, 1866, 1878. A series of this sort is not, like a chain, as weak as its weakest part; on the contrary, the strong parts add strength to the weak parts. In spite, therefore, of the doubtful existence of some of the crises, as marked in the list, I can entertain no doubt whatever that the principal commercial crises do fall into a series having the average period of about 10·466 years. Moreover, the almost perfect coincidence of this period with Broun's estimate of the sun-spot period (10·45) is by itself strong evidence that the phenomena are causally connected. The exact nature of the connection cannot at present be established. As we have seen, Hyde Clarke, Wilson, and Danson all argued, some thirty or forty years ago, that commercial fluctuations must be

[1] This book contains an interesting account of some of these early manias and panics.

[2] These lists are partly published in Mr. Walford's "Insurance Cyclopædia," article Gambling.

[1] "Insurance Cyclopædia," art. Gambling.

governed by physical causes. But here we are embarrassed by the fact that no inquirer has been able to discover a clear periodic variation in the price of corn. This is what Sir William Herschel attempted to do, at the beginning of this century, in his truly prophetic inquiry about the economic effects of the sun-spots; but his facts are evidently too few to justify any sure inference. Carrington also compared the sun-spot curve with that of the price of corn, without detecting any coincidence; and my own repeated inquiries have been equally without result as to this point. The fact is, I believe, that cereal crops, as grown and gathered in Europe, depend for their success upon very complicated conditions, so that the solar influence is disguised. But it does not follow that other crops in other latitudes may not manifest the decennial period. Dr. Schuster[1] has pointed out a coincidence between good vintages and minima of sun-spots which can hardly be due to accident, and the whole controversy about the connection of Indian famines with the sun-spot period is of course familiar to all readers of NATURE. Now if we may assume Dr. Hunter's famine theory to be true there is little difficulty in explaining the remarkable series of periodic crises which I have pointed out.

The trade of Western Europe has always been strongly affected by communication with the Indies. Several of the crises are distinctly traceable to this cause, especially those at the beginning of the eighteenth century. That was a time of wild enterprise in the tropical regions, as the very names of the South Sea Company, the Mississippi scheme, the Darien project, &c., show. The Dutch, English, and French East India Companies were then potent bodies, the constant subject of legislation and controversy. Thus it is my present belief that to trade with India, China, and probably other parts of the tropical and semi-tropical regions, we must attribute the principal fluctuations in European commerce. Surely there is nothing absurd in such a theory when we remember that the present crisis is at least partly due to the involvement of the City of Glasgow Bank in the India trade, through the medium of some of their chief debtors. Thus the crisis of 1878 is clearly connected with the recent famines in India and China, and these famines are confidently attributed to solar disturbance.

To establish this view of the matter in a satisfactory manner, it would be desirable to show that there has been a decennial variation of trade with India during the 170 years under review. The complications and disturbances produced in the statistics of such a trade by various events are so considerable that I have not yet attempted to disentangle them properly. Yet the accounts of the merchandise (not including bullion) exported by the English East India Company between the years 1708–9 and 1733–34 display such a wonderful tendency to decennial variation, that I cannot refrain from quoting them. As stated by Milburn in vol. i. p. xlviii. of his "Oriental Commerce," they are as given in the following table, except that I have struck off three places of figures useless for our purposes:—

Values of Merchandise Exported to India

Years.	£1000	Years.	£1000
1708–9 ...	162	1721–22 ...	148
1709–10 ...	161	1722–23 ...	135
1710–11 ...	201	1723–24 ...	118
1711–12 ...	162	1724–25 ...	97
1712–13 ...	109	1725–26 ...	80
1713–14 ...	85	1726–27 ...	77
1714–15 ...	79	1727–28 ...	101
1715–16 ...	61	1728–29 ...	102
1716–17 ...	69	1729–30 ...	135
1717–18 ...	88	1730–31 ...	137
1718–19 ...	107	1731–32 ...	150
1719–20 ...	134	1732–33 ...	105
1720–21 ...	122	1733–34 ...	140

[1] NATURE, vol. xvi., p. 45.

In the above table there are three well-marked maxima in 1710–11, 1721–22, and 1731–32 at intervals closely approximating to that of the sun-spot curve. I believe that there are some traces of the same decennial variation in subsequent portions of the same tables. The fact that this variation is difficult to trace may possibly explain the absence of any serious crises in 1742 and 1752.

Probably, however, we ought not to attribute the decennial fluctuation wholly to Indian trade. It is quite possible that tropical Africa, America, the West Indies, and even the Levant are affected by the same meteorological influences which occasion the famines in India. Thus it is the nations which trade most largely to those parts of the world, *and which give long credits to their customers*, which suffer most from these crises. Holland was most easily affected a century ago; England is most deeply affected now; France usually participates, together with some of the German trading towns. But I am not aware that these decennial crises extend in equal severity to such countries as Austria, Hungary, Switzerland, Italy, and Russia, which have comparatively little foreign trade. Even when they are affected, it may be indirectly through sympathy with the great commercial nations.

There is nothing in this theory inconsistent with the fact that crises and panics arise from other than meteorological causes. There was a great political crisis in 1798, a great commercial collapse in 1810-11 (which will not fall into the decennial series); there was a Stock Exchange panic in 1859; and the great American collapse of 1873-75. There have also been several minor disturbances in the money market, such as those of February, 1861, May and September, 1864, August, 1870, November, 1873; but they are probably due to exceptional and disconnected reasons. Moreover, they have seldom, if ever, the intensity, profundity, and wide extension of the true decennial crises.

If it were permitted to draw any immediate conclusion from these speculations, I should point to the necessity of at once undertaking direct observations upon the varying power and character of the sun's rays. There are hundreds of meteorological observatories registering, at every hour of the day and night, the most minute facts about the atmosphere; but that very influence, upon which all atmospheric changes ultimately depend, *the solar radiation*, is not, I believe, measured in any one of them, at least in the proper manner.[1] Pouillet showed long ago (1838) how the absolute heating power of the sun's rays might be accurately determined by his Pyrheliometer. This instrument, and the results which he drew from its use, are fully described in his "Éléments de Physique Expérimentale et de Météorologie" (livre 8me, chap. i., section 285). But I have never heard that his experiments have been repeated, except so far as this may have been done by Sir John Herschel, with his so-called Actinometer, as described by him in the Admiralty Manual of Scientific Inquiry. I fancy that physicists still depend upon Pouillet's observations in 1837 and 1838 for one of the most important constants of the solar system, if constant it can be called. While astronomers agitate themselves and spend infinite labour about the two-hundredth planetoid, or some imperceptible satellite, the very fountain of heat and light and life is left unmeasured. Pouillet indeed assumed that the heating power of the sun's rays is a constant quantity, which accounts for his not continuing the solar observations. But, if there is any truth in all these sun-spot speculations, there must be a periodic variation in the sun's rays, of which the sun-spots are a mere sign, and perhaps an unsatisfactory one. It is possible that the real variations are more regular than the sun-spot indications, and thus perhaps may be explained the curious fact that the decennial crises recur more regu-

[1] Of course there have been abundance of black-bulb thermometer observations made in various parts of the world, but I doubt whether they are of much value.

larly on the whole than the maxima and minima of sun-spots.

But why do we beat about the bush when all that is needed is half-a-dozen of Pouillet's pyrheliometers with skilled observers, who will seize every clear day to determine directly the heating power of the sun? Why do we not go direct to the Great Luminary himself, and ask him plainly whether he varies or not? If he answers No! then some of us must reconsider our theories, and perhaps endure a little ridicule. But if, as is much more probable, he should answer Yes! then the time will come when the most important news in the *Times* will be the usual cablegram of the solar power. Solar observatories ought to be established on the table-lands of Quito or Cuzco, in Cashmere, in Piazzi Smyth's observatory on the Peak of Teneriffe, in Central Australia, or wherever else the sun can be observed most free from atmospheric opacity. An empire on which the sun never sets, and whose commerce pervades every port and creek of the sunny south, cannot wisely neglect to keep a watch on the great fountain of energy. From that sun, which is truly "of this great world both eye and soul," we derive our strength and our weakness, our success and our failure, our elation in commercial mania, and our despondency and ruin in commercial collapse.

W. STANLEY JEVONS

THE WERDERMANN ELECTRIC LIGHT

WE are able this week to give some further details concerning Mr. Werdermann's method of dividing the electric light.

The real difficulty was found in devising a form of *light* which *could* be divided into several, and still give enough illuminating power for practical use; and it is in this particular that Mr. Werdermann has apparently succeeded. It may be interesting here to state Mr. Werdermann's reasons for adopting this particular form of lighting.

When in an electric lamp, electrodes having the same sectional area are used, the changes at the points between which the voltaic arc passes, take place in a manner which is well known, viz., a crater or hollow is formed in the positive electrode which emits the light, the crater itself being heated by the current to white heat, and the surrounding part to redness. The negative electrode which assumes the form of a cone, is only heated to redness, and emits scarcely any light.

It was found that an increase in the sectional area of the positive electrode diminishes the light emitted by that electrode, and if the increase is continued gradually, the light on that electrode finally disappears entirely, whereas the heating effect upon the negative electrode in connection therewith increases, until finally light is emitted by the same. Again, by increasing the sectional area of the negative electrode, the heating effect upon the same decreases proportionally to the increase of its area, until the area having been sufficiently increased the heat almost entirely disappears, and consequently the consumption or wearing away of that electrode is scarcely appreciable.

The light given out by the positive electrode in connection therewith, on the contrary, increases in proportion to the difference existing between the sectional area of the two electrodes, and instead of a crater being formed in the positive carbon, the latter assumes the form of a cone as formerly was the case with the negative carbon. The greater the difference between the areas of the two carbons the shorter is the length of the voltaic arc which can be obtained between them, and when the area of the positive is gradually diminished and that of the negative increased, the light is produced by the carbons apparently in contact, and a small deposit of graphite is seen on the negative electrode. The section of this deposit is about $\frac{1}{4}$ that of the positive carbon itself, and it is about $\frac{1}{8}$ of an inch high.

Mr. Werdermann was led to make these experiments by the idea that perhaps by altering the sectional area of the carbons a similar effect might be produced to that which is obtained in electrolysis when a plate is used as one electrode and a small wire at the other, and from the

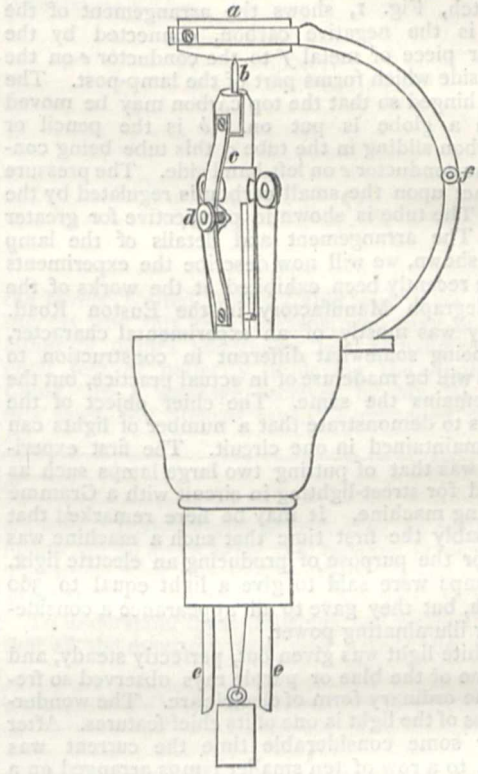

FIG. 1.

results obtained he devised his present system of electric lighting.

His lamp is constructed in the following manner:—

He places the negative carbon which is in the form of a disc 2 inches in diameter, and about 1 inch thick, uppermost. This carbon is clasped all round by a copper band which is prolonged to the terminal to which one of the leading cables is attached. The lower or positive electrode is a small pencil of carbon 3 millimetres in

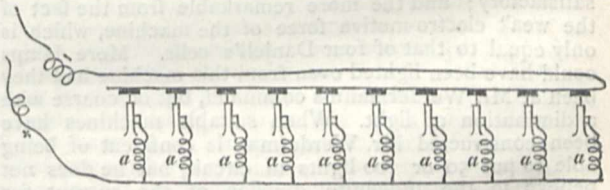

FIG. 2.

diameter, and can be made of any suitable length. This slides up vertically in a tube placed directly underneath the disc. This tube guides the pencil and also forms a contact for it, the top of the tube being solid copper in two pieces, one being rigid and the other pressing against the carbon by means of a regulating spring. The carbon pencil protrudes above the tube about $\frac{3}{4}$ of an inch, and touches the negative disc, and this length when the current passes is made incandescent.

The small carbon is pointed at its upper extremity and retains this point while burning. A small electric arc is formed round the points of junction, and to this is due the greater part of the light and not to incandescence alone. The carbons are kept in contact by chains attached to the lower end of the pencil passing over pulleys and down again to a weight of about 1½ lbs., which is sufficient to keep the pencil pressing gently against the disc.

The sketch, Fig. 1, shows the arrangement of the lamp; *a* is the negative carbon, connected by the semicircular piece of metal *f* to the conductor *e* on the right-hand side which forms part of the lamp-post. The metal *f* is hinged so that the top carbon may be moved back when a globe is put on. *b* is the pencil or positive carbon sliding in the tube *c*, this tube being connected to the conductor *e* on left-hand side. The pressure of the contact upon the small carbon is regulated by the spring *d*. The tube is shown in perspective for greater clearness. The arrangement and details of the lamp being thus shown, we will now describe the experiments which have recently been exhibited at the works of the British Telegraph Manufactory in the Euston Road. The display was mostly of an experimental character, the lamps being somewhat different in construction to those which will be made use of in actual practice, but the principle remains the same. The chief object of the inventor was to demonstrate that a number of lights can be steadily maintained in one circuit. The first experiment tried was that of putting two large lamps such as will be used for street-lighting in circuit with a Gramme electro-plating machine. It may be here remarked that this is probably the first time that such a machine was ever used for the purpose of producing an electric light. The two lamps were said to give a light equal to 360 candles each, but they gave to all appearance a considerably higher illuminating power.

A pure white light was given out, perfectly steady, and showing none of the blue or purple rays observed so frequently in the ordinary form of electric arc. The wonderful steadiness of the light is one of its chief features. After burning for some considerable time the current was switched on to a row of ten smaller lamps arranged on a shelf. The light from each lamp was apparently of the same strength and the effect was very brilliant, but the total illuminating power was not nearly so great as in the case of the two larger ones. But it seemed to show that a form of light had been devised that could be split up into a considerable number of smaller ones, each of which could be made use of in a practical way. The ten lamps were estimated to have a lighting power of forty candles each, but this is probably somewhat above the mark. But the results obtained, both as regards the wonderful regularity of the lamps and the practical demonstration of dividing the light, seem to have been satisfactory; and the more remarkable from the fact of the weak electro-motive force of the machine, which is only equal to that of four Daniell's cells. More lamps could have been lighted even from this machine had they been at Mr. Werdermann's command, but of course with a diminution of light. When suitable machines have been constructed Mr. Werderman is confident of being able to put 50 or 100 lights in circuit, but he does not believe in the indefinite division of the current for lighting purposes.

The lights were all connected parallel, as shown in diagram, Fig. 2. The thick wires + and − connect the lamps with the machine, the first lamp on the + cable being last on the − wire. The spirals *a* are extra resistances put in the circuit of each lamp, the object being to render the divided current less sensitive to any slight variation in the resistance of the lamps themselves, due to unequal pressure of contact, &c. The resistance of each lamp, including the wire *a*, is about 0·39 ohms. The resistance of the ten in parallel circuit about 0·037 ohms. The carbon pencil consumes at the rate of from 1½ to 2 inches per hour in the small lamps; the large ones taking 4½ millimetre carbons, consume about 2½ or 3 inches in the same time. The pencils are made in Paris, costing about 1 franc per yard, which length will last for twelve hours. The discs are of ordinary carbon.

However many lights may be in use, one, two, three, or any number can be put out without affecting the others, the regulation of the current being provided for by a switch attached to each lamp. But if necessary, the current which originally went through those that are extinguished can be added to those kept alight, of course increasing their illuminating power. The lamps are set in action simultaneously, can be as easily put out, and again re-lighted.

Returning again to the intensity of the light, it was stated that the large lamps were equal to 360 candles. Now the effect of this light upon the eyes is apparently not injurious, and it is Mr. Werdermann's intention to use only globes of ordinary glass, as in the present form of gas-lamps; by this means the loss of light will be very slight indeed as compared with other systems, where the loss is from 20 to 30 per cent., incurred by using opal or ground glass globes.

Owing to the very small electromotive force of the machine the insulation of the cables can easily be provided for, and Mr. Werdermann hopes, with sufficiently powerful machines, to be able to carry the current to a considerable distance without any appreciable loss.

In conclusion, it may be worth while giving a few details in regard to the Gramme machine used. It is an electro-plating machine of the old pattern, having four upright electro-magnets and two bobbins, one for feeding the electro-magnets, the other for taking off the light-producing current. The bobbins are wound with thick copper bands. The electromotive force, as before stated, is only equal to four Daniell's cells, and the resistance of the taking-off bobbin is about 0·008 ohms. The quantity of current produced is of course large.

It may be mentioned that the large lamps were connected parallel, but having no extra resistances, as in the case of the 10; their resistance is also a trifle less. The resistances given are when the lamps are not alight; when burning it would be somewhat less. The power required to drive the machine described is about two horse-power.

A curious fact about the light is that the top carbon is not consumed, or at any rate so slowly, that it is not noticeable; therefore, to all intent and purpose, the lower carbon only is wasted.

T. E. GATEHOUSE

DUPLEXING THE ATLANTIC CABLE

THE simultaneous transmission of two telegraphic messages in opposite directions upon one wire, now known by the name of duplex telegraphy, dates back from the year 1853. In that year Dr. Gintl, the director of state telegraphs in Austria, described a method by which this feat could be accomplished, and in July of the same year the method suggested by Gintl was tried between Prague and Vienna. An improvement on this method was suggested by a German electrician, Frischen, by Messrs. Siemens and Halske, of Berlin, and other workers at this subject. Nevertheless, owing to practical difficulties, the experiments were little more than interesting additions to our knowledge. So little hope, indeed, was there of the practical realisation of this important matter that, in a standard work on telegraphy, published in 1867, after describing the early methods of duplex telegraphy, the author remarks:—"Systems of telegraphing in opposite directions and of telegraphing in the same

direction more than one message at a time must be looked upon as little more than feats in 'intellectual gymnastics,' very beautiful in their way, but quite useless in a practical point of view." Such assertions should teach all scientific writers the lesson of "hoping all things not impossible, believing all things not improbable," an attitude of mind which, Sir John Herschel remarks, should always characterise the natural philosopher, and which, in the present day, is certainly the safest one. Within six years of the publication of the foregoing statement duplex telegraphy was not only largely employed in actual telegraphy, but its use on certain busy lines became absolutely indispensable. The change from theoretical to practical success is due to an American, Mr. J. B. Stearns, who in 1872 succeeded in overcoming the main obstacle in duplex telegraphy, namely, what is known as the static discharge from the line. This Stearns accomplished by using a "condenser"; and further he developed a system of "duplexing" the line similar to the principle of the Wheatstone bridge.

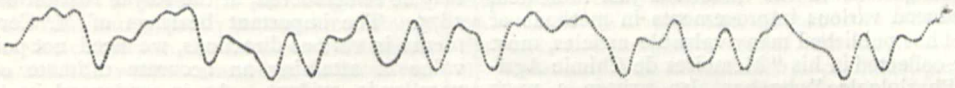

FIG. 1.

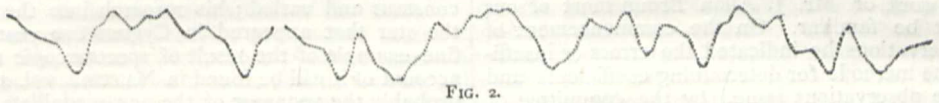

FIG. 2.

More or less successful attempts were afterwards made to duplex submarine cables, and in the early part of 1877 Mr. J. Muirhead succeeded in duplexing the cables of the Eastern Telegraph Company by his artificial condensers. But we believe that his success was only partial. Subsequently Mr. Muirhead has been at work duplexing the Direct United States Cable with some prospect of success, and this week Stearns, who may be called the father of duplex telegraphy, has actually achieved the great feat of perfectly duplexing the Anglo-American Cable. In a message received by Mr. W. H. Preece this week, Mr. Stearns says, "I managed to get some

FIG. 3.

specimens for you this morning, though we had no time to make the balance *especially* perfect for the purpose. No. 1 shows signals received single; No. 2, ditto, duplex. No one can tell the difference. No. 3 is our balance while keying, but not receiving. No. 4 shows the balance perfect at first, but destroyed and restored again by the adjuster. It shows with what facility the ordinary adjustments can be made after the balance is once obtained. The whole time occupied by slip No. 4 was about twenty seconds."

To understand these drawings our readers must know that all the messages now sent across the Atlantic are

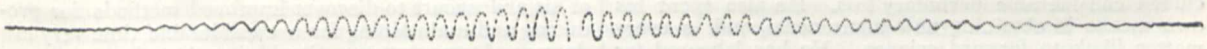

FIG. 4.

automatically registered by means of Sir W. Thomson's delicate and beautiful siphon recorder, which spirts out little jets of ink in a fine stream on a moving ribbon of paper. When no current passes the ink-marks form a straight line, but a current causes this line to deviate to the right or left, according to the direction of current. Hence the ordinary right and left strokes of a needle instrument or the long and short dashes of a Morse are here indicated by marks above and below the middle line. Thus the balance is shown by the almost perfectly straight line in Fig. 3 and the messages in Figs. 1 and 2.

The essence of duplex telegraphy is to obtain an electrical balance round on the line such that the sending instrument is not affected by currents circulating round it coming from the sending end, but only by currents received from the opposite end, and *vice versâ*. Hence, if the balance be once obtained, double transmission is possible. This balance Stearns has succeeded in obtaining by the use of his system as applied to land lines, and without the aid of the additional arrangements of artificial condensers used by Dr. Muirhead.

THE ROYAL SOCIETY MEDALLISTS

THE following are the awards of medals by the Council of the Royal Society for the present year. The medals will be given away at the Society's anniversary meeting on the 30th inst.:—The Copley Medal to M. Jean Baptiste Boussingault for his long-continued and important researches and discoveries in agricultural chemistry; a Royal Medal to Mr. John Allan Broun, F.R.S., for his investigations during thirty-five years in magnetism and meteorology, and for his improvements in methods of observation; a Royal Medal to Dr. Albert Günther, F.R.S., for his numerous and valuable contributions to the zoology and anatomy of fishes and reptiles; the Rumford Medal to M. Alfred Cornu, for his various optical researches, and especially for his recent re-determination of the velocity of propagation of light; the Davy Medal to MM. Louis Paul Cailletet and Raoul Pictet, for their researches, conducted independently but contemporaneously, on the condensation of the so-called permanent gases.

Jean Baptiste Boussingault was born in Paris in 1802. He was educated at the Mining School of St. Étienne, after leaving which he became connected with an English company formed to recover and work some mines in South America. This project, however, turning out unsatisfactory, after a considerable time spent in scientific travel in that continent, he returned to France and commenced those researches with which his name is more closely allied, the most important of which lie in the domain of agricultural chemistry. Probably his investigations of greatest value are those in which he has determined the quantities of carbon, nitrogen, and hydrogen found in plants, and his comparison of these with the amounts of the same constituents supplied to the plant by manures, &c. During these investigations he has shown, by a series of most conclusive experiments, the inaccuracy of the theory "that plants in their growth

derive nitrogen from the air," but, on the contrary, has pointed out that all the nitrogen assimilated by them may be accounted for in the different compounds of that body which are supplied to the plant in other ways. Boussingault's experiments also on the nutritive properties of the nourishment supplied to herbivorous animals are of great interest. In these he has traced the distribution of the various constituents of the food by the vital process, and has determined the different quantities of the various constituents which undergo assimilation. Besides investigations in the directions just indicated, he has introduced various improvements in methods of analysis, and has published many valuable articles, most of which are collected in his "Mémoires de Chimie Agricole et de Physiologie;" he has also written a work entitled "Traité d'Economie Rural."

With the work of Mr. J. Allan Broun most of our readers must be familiar. On the commencement of magnetic observations he indicated the errors or insufficiencies of the methods for determining coefficients and correcting the observations issued by the committee of the Royal Society for the instruction and direction of superintendents of observatories; he devised new methods for these ends which have made the observations in all the magnetic observatories available for strict scientific conclusions. He has made investigations in magnetism and meteorology during thirty-five years; among the new results obtained many of them are of the highest value, and have taken their place as standard scientific data. He established an observatory twice on a mountain-peak 6,000 feet above the sea, with the complement of instruments employed in first-class observatories (on the second occasion with a double series of magnetical instruments)—this, in a wild country, done amidst great difficulties in erecting instruments and obtaining trained observers, requiring continued and persevering action. This and many other duties were done at his own expense, and though, in general, ultimately repaid, they yet included considerable pecuniary loss. He also spent his own means in obtaining new instruments, and in every matter likely to forward science. He has laboured for years without remuneration in scientific work of a peculiarly tedious kind.

Albert C. L. G. Günther is the Keeper of the Zoological Department of the British Museum, a position to which he succeeded on the death of Dr. J. E. Gray. Very early in his life he devoted himself to the study of the natural sciences, and, if we are not mistaken, his earliest essay as an author was a very complete memoir of the fishes of the Neckar. About 1854 he accepted an appointment in the British Museum under Dr. J. E. Gray, who soon learned to value and appreciate the services of his assistant. Dr. Günther commenced the investigation and arrangement of the batrachian reptiles in the National Collection, with a zeal and energy that knew no limits, and which soon rendered this portion of the Zoological Department without a rival among the Museums of Europe. Not wearied by such a task he set about a far greater one, the arrangement and description of the immense class of the fishes, and no zoologist has ever raised a greater or more enduring monument to his memory than Dr. Günther has done in his great and truly scientific catalogue of all the known fish. The care of a large and daily-increasing collection, with all the worry incident on the want of room to properly store it—the toil and labour involved in the publication of the extensive work just alluded to, might well have excused Dr. Günther from attempting other work, but still we find him apparently never weary, and memoirs of a value like those on Hatteria, on Ceratodus, and on the Giant Tortoises, not to mention a long list of others, were being constantly published by him. He is also the author of an important work published at the expense of the Ray Society, "On the Reptiles of British India," and joint author with Col. Playfair of a work on the "Fishes of Zanzibar." All will agree that his name is a very worthy one to be added to the grand roll call of the Royal Society's medallists.

The name of M. Alfred Cornu must be familiar to the readers of NATURE in connection with his remarkably ingenious and successful method of determining the velocity of light. A detailed account of M. Cornu's method will be found in vol. xi. p. 274, and succeeding volumes of NATURE. It was also expounded by him, it may be remembered, at the Royal Institution, on May 7, 1875. The important bearings of M. Cornu's experiments in various directions, we need not point out; its value in attaining an accurate estimate of the sun's parallax is evident. As is evidenced by the *Comptes Rendus*, M. Cornu's work in his own department is constant and varied; his research into the spectrum of the star that appeared in Cygnus two years ago was a fine example of the result of spectroscopic research; an account of it will be found in NATURE, vol. xv. Although probably the youngest of the new medallists, M. Cornu's long and incessant work makes him almost a veteran in scientific research.

MM. L. Cailletet and Raoul Pictet have lately been so closely engaged in the same kind of experimental work, namely, the liquefaction of gaseous bodies, that their names have naturally become associated in connection with the important results which have followed their independent researches. The methods, however, employed by the two chemists in obtaining those results which have lately added so much to their reputation are to a certain extent different. Cailletet's experiments, which were conducted on the gases air, hydrogen, marsh gas, nitric oxide, and carbonic oxide, depend for the cold necessary to produce the liquefaction of the gas, on the expansion of the gas when suddenly compressed only at moderate degrees of cold.

Pictet's experiments, on the other hand, are the result of his endeavours to discover improved methods for producing and maintaining for a considerable time very low degrees of temperature. Combining these improvements with the production of the bodies to be liquefied under great pressure, he has succeeded in liquefying oxygen and hydrogen and in solidifying the latter. He has also determined the specific gravities of the gases when in that condition, assigning to them the weights ·9883 and ·9787. Besides his most recent researches on the condensation of gases, M. Pictet has carried out other investigations on those phenomena, the consideration of which lies between the provinces of physics and chemistry. Among such investigations may be mentioned his observations on the application of the mechanical theory of heat to the study of volatile liquids and to some simple relations between the latent heats, atomic weights, and tensions of vapours. M. Pictet has also been successful in applying his scientific investigations to practical use, in the perfecting of apparatus for the rapid production of large quantities of ice.

We are glad to know that the health of M. Pictet is not so seriously impaired by overwork as was rumoured a few days ago. On the best authority it is stated that his recovery is by no means beyond hope, and that he is not suffering from incipient softening of the brain. There is no contradiction, however, to the sad statement that the sight of one of M. Pictet's eyes is gone, and that he will probably lose the power of the other.

AFGHANISTAN

WHATEVER opinions our readers may hold as to the present action of the Government with respect to Afghanistan, it may not be considered inappropriate to summarise briefly what we know about a country, which at no remote date may become a part of the British

Empire. A good deal has been written on the country, and some valuable records of the observations of travellers who have been permitted to penetrate it have been published. One of the best sketches of Afghanistan in its various aspects will be found in the magnificent "Noveau Dict. de Géog. Universelle," by Vivien de St. Martin, now being issued by Hachette and Co. On this the present article is mainly based. For further details we would refer our readers to this work, and the long bibliography appended to the article, as well as to a paper in the *Geographical Magazine* for October, and a pretty exhaustive account of the botany of the country in the *Gardener's Chronicle* of November 2, and the works referred to in these two journals.

As a whole, Afghanistan may be regarded as a mountainous table-land. It is the eastern half of the table-land of Iran, of which Persia occupies the western half. On the eastern side, towards Sind, the table-land sinks into what may be considered as parallel chains, forming so many staged terraces; one of these chains, more elevated than the others, and from which shoot several remarkable peaks, is known by the name of the Sulieman Mountains—*Soleimân-Kôh*. The mean height of this transverse chain is about 9,000 or 10,000 feet. The Sulieman Mountains are about sixty miles distant from the Sind border, though the crest of the plateau is not reached for about another 150 miles. On the south side the plateau descends by similar, but perhaps less pronounced gradations, towards the sea; up to the present time the southern slope has been but incompletely explored. To the west the Afghan plateau undergoes a very considerable depression, at the bottom of which lies the marshy lake, Hamoun, into which the Helmand river finds its way; but it again rises in the vast plains which lead towards Farsistan. On the north the plateau falls rapidly towards the plains through which flows the Oxus, and in the north-east it is connected with the highlands of Central Asia and the Himalayas by the enormous mass of the Hindu-Koosh. The highest summits of the latter chain, which conceals the deep basin of the Cabul river, are lost in the regions of eternal snow; many of its peaks exceed 20,000 feet in height. The Khavak Pass, one of the principal passes of the Hindu-Koosh, is at a height of more than 12,000 feet. On the south the basin of the Cabul river is shut in by the Sefid-Kôh chain, which runs, like the Hindu-Koosh, from west to east, and the highest summits of which, to the south-south-east of Jellalabad, reach a height of more than 13,000 feet. The source of the Cabul river is about 8,000 feet above the sea, and of the Helmand, more than 9,000 feet. All this extreme zone of Afghanistan is only a mass of mountains cut by a multitude of rugged valleys; this is the coldest part of the country. A mass which dominates it, above the sources of the Cabul and the Helmand, the Kôh-i-Baba or "Father of Mountains," rising to a height of 15,000 feet, may be regarded as the knot which connects the Hindu-Koosh with the Mountains of Ghour. It is in this cold region, which commences at the Mountains of Ghour and is continued eastward by the long valley of the Cabul river, that the primitive race of the Afghan people have been formed, a race uncultured, rude, and vigorous like their native valleys.

With the exception of the two basins of the Cabul and the Helmand, Afghanistan is characterised by a scarcity of running water. Elphinstone had noticed this prevailing feature, and all subsequent observations have confirmed it. Only four or five rivers of any consequence flow down the long eastern slope of the plateau, and some of these are lost in the sands. The Helmand, fed by many affluents, after a course of about 600 miles, discharges into a large shallow lake, nearly all covered with reeds. This lake, known variously as Hamoun, Meshileh-Seistan, or Meshileh-Rustem, is black and nauseous, changes greatly in its configuration, sometimes even dividing up into two distinct basins.

Four-fifths of the surface of Afghanistan is, on the whole, a country of rocks and mountains, interspersed here and there with picturesque valleys, fertile and well watered, but presenting in several directions only elevated plains, cold, arid, and covered with meagre pasturage, which, however, supports numerous flocks. Situated under the parallels of Egypt and Syria, but with a surface not less varied than that of Switzerland, and mountains much more elevated than the Alps, Afghanistan combines in its climate and its products the extremes of the torrid and temperate zones. As the meagreness of its water-supply is characteristic of many parts of the country, dryness is the dominant feature of its climate, as also extremes of temperature, according to the season.

Of the geology of Afghanistan scarcely anything is known by direct observation. Its mineral products, however, appear to be abundant enough. The sands of the Cabul river are known to furnish gold. The Hindu-Koosh mountains contain silver, copper, cinnabar, lead, antimony, zinc, sulphur, &c. Iron especially abounds there, and copper is found in many other parts of the country; coal also has been proved to exist in several localities. Rock salt has given its name to an entire chain of mountains which stretch into the north of the Punjâb. In the north of Damân, in the neighbourhood of Kohat, are mines of sulphur and wells of naphtha.

The character of the vegetation in all the higher parts of Afghanistan is essentially European; all kinds of fruits abound, and many of them are found in a wild state. From the article on the botany of Afghanistan in the *Gardeners' Chronicle* of November 2, we find the following statement as to the general characteristics of the vegetation of the country:—

"Afghanistan abounds in spiny plants; herbs are to a great extent replaced by dwarf prickly shrubs having a relatively small amount of leaf-surface; and bulbous plants are also numerous. Fragrant flowers prevail, and resiniferous and oleiferous plants are numerous. Stocks, who travelled in Beloochistan and the southern borders of Afghanistan, says the upper region especially is remarkable for the fragrance of its plants, as Artemisia, Perowskia, Salvia, Teucrium, and other Labiatæ, from which cause the flesh of the sheep and goats acquires a fine and almost aromatic flavour. There is no nakedness of the soil, for hill and plain are alike covered with depressed shrubs, although their scorched aspect, after the sun acquires power in June, is anything but agreeable to the eye. The prevailing tint of the indigenous vegetation and of the landscape of the uncultivated plains is olive-green, though the well-cultivated valleys, as Quettah, are charmingly green in the spring time. The aspect of the vegetation of the lower region is far different, the plants being few and scattered over the bare brown and stony soil. Even in spring no annuals appear to diversify the scenery, and the under-shrubs are remarkably similar in external appearance. Woody, stunted, thorny, not above 1 foot high, with round cushion-like outlines, bleached stems, and a few leaves—they look like skeletons of plants, the grey ghosts of a vegetation which has perished of thirst. The glaucous aspect of all, and the universality of spines, are noteworthy features."

Wild animals are not over-abundant. The high valleys of the Hindu-Koosh shelter lions and leopards, which have neither the size nor ferocity of those of India. Wolves are met with, and in the eastern jungles tigers and hyænas. There are two species of bear, a black and a brown, but elephants are not found in the wild state. Jackals and foxes are numerous, monkeys in the north-east, and wild sheep and goats in the mountains of the north. The Angora cat is said to have originally come from Cabul.

There is probably no country of equal extent which

presents so great a mixture of races, though the two main divisions are Afghans proper and Tajiks. The former name is applied to all those tribes that speak Pushtu or Pukhtu, the other to those of the people whose native language is Persian. To the latter are also given the names Parsivân and Deggän or Dekkân. The Afghans are mostly pastoral, while the Tajiks are sedentary and cultivate the soil. To these two great classes must be added the Hindkis, of Hindu origin, and speaking Hindustani, very numerous in the eastern districts; also the Hezareh, a people with Mongol features but speaking Persian, found mainly between Ghazna and Herat. The Kisil-bash or "Red Heads," although not very numerous, are an important factor in the population. They are not Persian by origin, as is commonly stated, but belong to one of the Turcoman tribes of Persia. There has been much discussion as to the origin of the Afghans, no doubt the true aborigines of the country. Some have sought to find in them the descendants of the captive ten tribes of Israel; but this is a mere fanciful Mussulman tradition. Their language, at least, proves that they belong to the great Indo-European family, and that in this family they are specially allied to the Iranian group, but with a linguistic development peculiar to themselves, showing also the influence of Sanscrit. Moreover, it can be conclusively established, both by historical and ethnological evidence, that from the most ancient times the Afghans have inhabited the basin of the Cabul river, which is still the principal seat of the race. The true national name of the Afghan people, the name recognised by themselves, is that of Pashtoûn, Pakhtoûn, or Poukhtanêh. In physical type the Afghans, like all the other peoples of Western Asia, approach the European conformation; the difference being in physiognomy, not in type. Like most other primitive peoples, the social organisation of the Afghans is based on the tribe or clan, and in many respects, it has been said, resembles the old clan system of the Scottish Highlands.

OUR ASTRONOMICAL COLUMN

THE SOLAR ECLIPSE OF 1879, JULY 19.—Though the second of the solar eclipses of next year will not be actually total at any point upon the earth's surface, the difference between the geocentric diameters of sun and moon is sufficiently small to allow of the effect of the augmentation upon the latter, bringing up the phase to one nearly approaching totality in those parts which have the sun close upon the meridian. In the longitude of Aden, or rather, upon the opposite coast of Africa, about Zeyla, the moon's augmented semi-diameter will be only four seconds less than that of the sun, and though the eclipse thus remains annular, it will be seen that the annulus is very narrow in this part of its path—including its passage across Abyssinia. At Aden, there will be a very large eclipse, beginning at 10h. 23m. A.M., local mean time, and ending at 2h. 1m. P.M.; at greatest phase about 0h. 12m., the magnitude will be 0·97 of the sun's diameter. The difference between the illumination of the sky while any portion, no matter how small, of the direct light of the sun remains, and the instant it is entirely extinguished in a total eclipse, is so great as we know from our experience of total eclipses, that there may probably be a doubt as to the possibility of utilising the eclipse in question, in a further endeavour to observe the intra-mercurial planet or planets discovered by Prof. Watson. The next total eclipse of the sun will take place on January 11, 1880, and although, notwithstanding the long track of the shadow across the Pacific Ocean, it may be possible to secure observations, the interval available for so doing cannot be more than half that at the command of observers during the eclipse which traversed the United States last July.

COMETS OF SHORT PERIOD.—An ephemeris of Brorsen's comet, which, according to the calculations of Prof. Schulze, will arrive at perihelion on March 30, 1879, will be found in *Astron. Nach.*, No. 2,220; as already stated in this column, it is likely that the comet will be first observed at the southern observatories. About six weeks later Tempel's comet, 1867 II, which was re-observed in 1873, after undergoing great perturbation from the planet Jupiter, will be due at perihelion; the elements deduced from the observations of 1873 alone, by Dr. Sandberg, would assign, without taking account of perturbation, April 26 for the perihelion passage, but according to an orbit just published by M. Raoul Gautier, of Geneva which he says may be considered the most probable one till the observations to be expected next year, afford additional means of determining the mean motion, the comet would not be in perihelion till May 8, in which case its apparent track in the heavens will differ little from that which it pursued in 1873, when it arrived at its least distance from the sun on May 9. It is pretty sure to be always a faint object except for the larger telescopes, and considering the uncertainty which still appears to exist regarding the mean motion at its last appearance, a close search may be necessary for its rediscovery. M. Gautier is calculating the effect of Jupiter's attraction during the actual revolution, with the intention of publishing an ephemeris in due time; this effect, however, must be small, as the comet has not been nearer to the planet than about 1·5 during the interval. The ensuing return of Faye's comet in the latter part of the year 1880 will take place under much more favourable circumstances for observation than has been the case at any of its appearances since 1843, when it was first detected by the French astronomer; indeed, in 1851, 1858, 1865–66, and 1873 it was always a faint object, but the admirable calculations of Dr. Axel Möller have enabled us to follow its course with extreme precision, with a precision perhaps greater than has yet attended similar investigation in the case of any other comet during so long a period. Though the date of perihelion passage is not yet exactly ascertained, the comet will probably approach almost as near to the earth as in the autumn of 1843, and will be observable for many months.

THE SATURNIAN SATELLITE MIMAS.—According to elements which represent approximately the Washington observations, 1874-77, the following will be times of greatest eastern elongation of Mimas:—

	h.		h.
November 15 at	12·3	November 18 at	8·1
,, 16 ,,	10·9	,, 19 ,,	6·7
,, 17 ,,	9·5		

At these times, on the assumption of circular motion, the distance of the satellite from the end of the ring would be about 8′.

THE MINOR PLANET ISMENE.—According to a calculation of the elements of the small planet *Ismene*, No. 190, by Herr Leman, from observations between September 30 and October 31, it very closely approaches *Hilda*, in its exceptionally great distance from the sun, and consequent length of the period of revolution. We have for comparison:—

	Ismene.	*Hilda.*
Mean distance	3·893 ...	3·950
Aphelion distance	4·466 ...	4·595
Sidereal period in days ...	2·805 ...	2·855
,, ,, years ...	7·68 ...	7·85

Another group is formed by *Cybele*, *Freia*, *Sylvia*, *Camilla*, and *Hermione*, wherein the periods vary from 2297 days to 2377, the mean distance for the group, 3·451. Eventually the planets which approach so near to the orbit of Jupiter, as *Ismene* and *Hilda*, will furnish independent determinations of his mass, though the narrow limits of probable error, within which its value

has been determined by Bessel, Krueger, and Axel Möller, may detract from the importance of further investigation in this direction. Thus the sun's mass exceeds the mass of the planet,

1047·88 times according to Bessel, from elongations of fourth satellite.

1047·54 times according to Krueger, from perturbations of *Themis*.

1047·79 times according to Möller, from perturbations of *Faye's Comet*.

GEOGRAPHICAL NOTES

THE following form the series of scientific lectures to be delivered before the Royal Geographical Society during the present session, in pursuance of the scheme organised by the council two years ago:—"Geographical Evolution," by Prof. Geikie; "The Flora of the European Alps and its Connection with that of other Regions of the Earth," by Mr. John Ball, F.R.S.; and "The Modifications of the External Aspects of Organic Nature produced by Man's Interference," by Prof. Rolleston. The first two will be delivered some time before Easter, next year, and the last probably on the second Monday in May.

IN the absence of Lord Dufferin, the session of the Geographical Society was opened on Monday night by an address from Sir Rutherford Alcock, who reviewed recent exploring work.

AT the opening meeting of the Royal Geographical Society a paper by Signor L. M. d'Albertis, the well-known Italian naturalist, was read, descriptive of his three journeys up the Fly River, and his explorations of other parts of New Guinea. Perhaps the most interesting part of this very interesting paper was that which related to his earlier work when in company with Dr. O. Beccari in 1872. On that occasion they landed first on Sorong Island, between Salwatti and the mainland of New Guinea, in about S. lat. 0° 25′, and after making collections of plants and animals there, they moved on to Andai, near Dorei. During their stay there Signor d'Albertis explored the country to the foot of the high chain of mountains named Lapi Arfak. No one hitherto had been able to penetrate to the Arfak highlands, the home of the bird of paradise, and it is doubtful if the attempt had ever been made, owing to the fear entertained by the coast natives of the mountain tribes. Signor d'Albertis, however, succeeded in accomplishing this feat, for he lived for a month in a Papuan house at a height of 3,600 feet above the sea, and in the course of his daily shooting expeditions reached an altitude of 5,000 feet; so that with pardonable pride he claims to have been the pioneer of the Arfak mountains. Judging by the altitude he attained, he considers that the estimated height of the range—9,000 feet—is no exaggeration. From the point which he reached, 5,000 feet above the sea, the range runs uninterruptedly in a southerly direction, and joins that which constitutes the chief part of the backbone of New Guinea. As far as he could judge, separate streams issue from these ranges, giving origin to many small rivers which disembogue in the two bays known by the name of Geelwink. The mountains, even at the highest point he attained, are clothed with magnificent arboreal vegetation, but he was much astonished to find amongst the trees a species of oak and a conifer, the latter of which was afterwards recognised by Dr. Beccari as an *Araucaria*. Another point is worthy of notice; within a few minutes of the equator, in 134° E. long., all the climates of the world, except the Arctic, are represented, the tropical at the base and the temperate on the upper slopes and summits, both of which offer a rich variety of trees and plants. The same description applies to the neighbouring mountains where exist the most beautiful species of birds of paradise known to the world. In his second expedition Signor D'Albertis spent some time at Yule Island, on the southern coast, near Port Moresby, and he expresses a very decided opinion that this place will be of great importance as a centre of trade in the future.

A LETTER from Mr. Andrew Goldie is published in the *Sydney Morning Herald*, in which he gives some account of a cruise along the south-east coast of New Guinea. Mr. Goldie found the currents and calms a great source of danger. On the way down the coast Mr. Goldie discovered a group of islands (Redlich Group) not marked on the chart, and two splendid harbours, the finest by far that he has seen in New Guinea. He names them Glasgow and Millport harbours, and he has taken soundings and drawn plans, which he intends to forward to the proper quarter. The party visited Cloudy Bay and ascended the Robinson River, taking soundings there and all through the bay, and correcting many errors on the Admiralty chart. They discovered a new river on the west side of Cloudy Bay, which has been named the Blunden. During this trip Mr. Goldie has evidently not overlooked one of the main objects of his being sent to New Guinea, for he has collected 100 fresh skins of birds, different from those in the neighbourhood of Port Moresby, and he has also obtained a large and very valuable collection of curiosities.

THE late Admiral Sir George Back, who was for some time one of the vice-presidents of the Royal Geographical Society, has bequeathed to that body the sum of 600*l.* to be invested in Consolidated Bank Annuities, the conditions attached to the bequest being that the interest shall be paid or applied annually "to or for the benefit of such scientific geographers or discoverers, or person or persons who may then be engaged in discovery or exploration, and in such manner and form as the president and council shall determine." It is further provided that if in any year no person shall be deemed of sufficient merit to receive the prize, the interest shall accumulate and in some succeeding year be awarded to one or more persons who may be considered most deserving, in such proportions as the president and ,council of the Society may determine. Sir George has also bequeathed to the Royal Geographical Society a very characteristic portrait of himself painted many years ago by Brockeden.

MR. KEITH JOHNSTON, the commander of the expedition despatched by the Committee of the African Exploration Fund to explore the country between the road now being constructed from Dar-es-Salaam, on the east coast of Africa, and the north end of Lake Nyassa, leaves for Zanzibar to-day, in company with Mr. Joseph Thomson, as geologist and naturalist, and great hopes are entertained that, in addition to achieving good geographical results, they will be able to furnish much information respecting the hydrology and geology of the unknown region they are about to explore. Should the financial position of the fund admit of it, Mr. Johnston will extend his explorations northward to Lake Tanganyika, and return to the coast by a different route.

THE arrival at Provincetown, Massachusetts, on October 26, of the Arctic exploration schooner *Florence*, Capt. George Tyson, relieved the anxiety felt for her safety, after her reported departure on September 26, from St. John, New Brunswick. The *Florence* has met with hard usage throughout her whole voyage, and officers and men have suffered considerably. According to the log, the coldest weather experienced was 53° below zero.

M. LIAIS, director of the Rio de Janeiro Observatory, has written to the Paris Geographical Society, intimating that, owing to the liberality of the Emperor of Brazil, he had been enabled to begin the great work of determining by electric telegraph the longitude of Rio in comparison with Greenwich. When the operation shall have been

completed, the geographical position of every city in Southern America will be known with exactitude.

THE Annual Meeting of the Dutch Geographical Society took place at Delft on October 27, when interesting communications were made by the president regarding the exploring expedition sent to Sumatra by the Society. The explorers report having passed through a number of districts which had never been visited before by Europeans, but through the resistance offered by one of the native chieftains, the expedition has now unfortunately been discontinued, and most of its members are on their way back to Holland.

IT is stated that the Russian Minister of Communications will shortly send a special expedition to the Amu Darya district, to describe the new waterway formed by the overflow of that river.

THE *New York Herald* publishes a complete list of positions on the Amazon and Madeira rivers which have been determined by the United States Survey Expedition in the corvette *Enterprise*, Commander Selfridge. They are ninety-two in number. The survey has demonstrated that it is possible for vessels drawing sixteen feet of water to pass during nine months of the year, and by careful navigation during the whole year, up to St. Antonio, on the Madeira. The river is always practicable for vessels drawing only eight feet. The Upper Madeira is not safely navigable except between December and July. Every evening the officers specially charged with the duty landed and ascertained the latitude and longitude of the halting-place, with reference also to its bearings with respect to certain conspicuous stars north and south, east and west. Six careful sets of observations, at intervals, were made to determine the rate of the chronometer. The charts compiled are to be reduced and published at Washington.

NOTES

WE take the following from the *Times*:—At the meeting of the Council of the Royal Society on Thursday last, the following were nominated as council and officers for the year ensuing to be proposed for election at the anniversary meeting of the Society, which will be held on St. Andrew's Day, the 30th instant:—President, William Spottiswoode, M.A., LL.D.; Treasurer, John Evans, F.G.S., V.P.S.A.; Secretaries, Prof. George Gabriel Stokes, M.A., D.C.L., LL.D., and Prof. Thomas Henry Huxley, LL.D.; Foreign Secretary, Prof. Alexander William Williamson, Ph.D. Other Members of the Council—Frederick A. Abel, C.B., V.P.C.S., William Bowman, F.R.C.S., William Carruthers, F.L.S., Major-Gen. Henry Clerk, R.A., William Crookes, V.P.C.S., Sir William Robert Grove, M.A., Augustus G. Vernon Harcourt, F.C.S., Sir Joseph Dalton Hooker, C.B., K.C.S.I., D.C.L., Vice-Admiral Sir Astley Cooper Key, K.C.B., Lieut.-Gen. Sir Henry Lefroy, C.B., Lord Lindsay, P.R.A.S., Sir John Lubbock, V.P.L.S, Lord Rayleigh, M.A., Charles William Siemens, D.C.L., John Simon, C.B., D.C.L., Prof. Allen Thomson, M.D., F.R.S.E. It will be remarked that Sir Joseph Hooker has carried out his intention of retiring from the presidency.

PROF. WÜRTZ delivered his Faraday Lecture on Tuesday evening at the Royal Institution, and was entertained at dinner last night at Willis's Rooms. We hope next week to give a full account of the proceedings on both occasions.

PROF. GYLDÉN, Director of the Stockholm Observatory, has received the Cöthenius Medal of the German Leopold-Caroline Society of Science, for his important researches in astronomy.

WE understand that, at a meeting of the Professors of Queen's College, Cork, it was resolved to erect a memorial to the late Prof. Harkness, in the form of a stained glass window, in the Examination Hall of the College. It is understood that the friends of the late professor in that city and elsewhere will be invited to co-operate in raising the funds necessary for this purpose.

DR. O. FINSCH, the well-known Bremen naturalist, is about to start on a scientific tour to the Polynesian Seas; the expenses of the tour will be defrayed by the Berlin Humboldt Institution, and Dr. Finsch travels at the special request of the Berlin Academy of Sciences.

OUR Paris correspondent writes that the Werdermann electric light has attracted much attention there, and will very shortly be tried at the office of the *Temps*. The Jablochkoff light is still in operation at the Avenue de l'Opéra, but will be stopped at the end of this month, unless a new arrangement as to cost can be come to. Indeed, our correspondent informs us, unless the present price of this light is considerably modified, it is not likely to keep its place.

AMONG the latest news about the progress of electric lighting is an account of an interview with Mr. Edison, given in the *New York Sun*. His Electric Light Company proposes to light the public buildings and private residences of New York with electric lights. The electricity would be made by twenty or more engines, stationed in different parts of the city. Each station would have an engine and several electric generating agencies. He thinks that the engines will be powerful enough to furnish light to all houses within a circle of half a mile. He passes the wires right through the gas-pipes, and brings them into the houses. "All that will be necessary will be to remove the gas burners, and substitute electric burners. The light can be regulated by a screw the same as gas. He does not pretend that it will give a much better light than gas, but it will be whiter and steadier than any known light; nor does he know now that it will be cheaper than gas. To the question as to whether he could measure the amount of electricity used, Mr. Edison said he had made no attempt to discover a meter. "I know that it can be measured, but it may take some to find out how. I propose that a man pay so much for so many burners whether he uses them or not. If I find that this works an injustice why I shall try to get up a meter, but I fear it will be very hard to do it." Mr. Edison says, according to the *Sun*, that "electric generating machines could be placed upon steamboats and locomotives, and the boats and cars lighted by the action of the engines, but the instant that the machinery stopped the lights would go out." Country towns, with the use of the electric generating machines, could be lighted by water power. Any power could be used provided it was strong enough to turn the shaft of the machine with the necessary rapidity. In an article on the subject of Electric Lighting in yesterday's *Times* an account is given of an exhibition of a new electric light by the Electro-Dynamic Light Company of New York on the 29th ult. It is described as a very simple affair, consisting of a small pencil of carbon a little larger than an ordinary pin, connected by wires with an electric machine, and inclosed in a hermetically sealed glass globe, which is filled with pure nitrogen gas. The pencil of carbon is heated by the electric current to a temperature of from 30,000° to 50,000° Fahrenheit. In an atmosphere with which it cannot chemically combine the carbon is practically indestructible, and the light is therefore produced without any consumption of material. In the experiments made five lights were placed in different parts of the darkened room, and all were connected by wires with a small electric machine. In an adjoining room a simple key was placed in one of the three ordinary keyholes in one of the walls and turned a little. Two of the burners attached to a hanging chandelier in the centre of the room immediately glowed faintly, and as the key was turned still further around the glow increased until a brilliant and perfectly steady white light was obtained,

equal to the light of twelve ordinary gas jets. The key was then turned to another of the keyholes, and another of the lamps was lighted up. In the same way the fourth and fifth burners were ignited, and there resulted an exceedingly brilliant white light, yet so soft and steady that it did not pain the eyes. The lights were easily turned to any desired degree of brilliancy —from that of a mere spark to a light of six times the intensity of the common gas jet, that being the *maximum* power of the lights in use. The company asserts its ability to easily fit up lights equal to thirty gas-burners. By a very simple "switch" in the wall the current of electricity is divided and subdivided to supply any number of burners desired, the electricity reaching the switch from the generator through a single wire. The light is turned on or off or regulated to any degree merely by turning a key which operates upon the switch. The plan is similar to that proposed by Edison. The difficulty of a meter has been overcome by the invention of a meter which will record the number of burners used in any given house and the number of hours each burner is lighted.

THE Institution of Civil Engineers have, as usual, issued a circular inviting communications on a number of subjects connected with their department; for such as meet with their approval they award several valuable prizes. The circular may be obtained by applying to 25, Great George Street, Westminster.

PROF. S. P. THOMPSON lectured to an audience of 2,600 persons in the Colston Hall, Bristol, on November 8, on the Electric Light. The Jablochkoff candle and Wallace lamp were amongst the systems shown in operation. The lecture is to be repeated on the 13th inst. to the working-men of Bristol.

WE are glad to notice a little work which is being done at Winchester, and which deserves commendation as a step in the right direction by a corporation. Mr. P. S. Abraham, M.A., B.Sc., who has for two months been engaged in naming, arranging, and cataloguing the different objects in the Winchester City Museum, has sent in a report to the Committee, from which we glean the following :—The zoological portion of the museum contains some 1,700 objects, which have been labelled and placed in their proper scientific positions by Mr. Abraham. This number is made up of 70 mammalian animals, 430 birds, 50 reptiles and frogs, 80 fishes, 50 specimens of corals, sponges, &c., and about 1,000 molluscs. There are, in addition, a few specimens of articulated animals, and a small cabinet of insects. There is also a valuable collection of lichens—many from Hampshire—and comprising 227 varieties. In the mineralogical room Mr. Abraham has classified, labelled, and arranged two large cases of minerals, which now contain above 1,200 specimens, one case of rocks, with 300 specimens, and two cases of fossils containing nearly 1,300 specimens. There are, besides, large and valuable collections in various other departments, though Mr. Abraham states they are very insecurely cased. We hope the Corporation will adopt his recommendations. He observes that the museum contains an excellent nucleus of specimens. The collection could be easily improved and enlarged by a judicious curator, by the exchange of duplicate specimens, of which there are many, and by filling up gaps by purchase of the wanting representative forms. In this manner, and without very great expense, the museum might be made well worthy of the city of Winchester. The Committee conveyed to Mr. Abraham their "unanimous expression of approval at the able manner in which he has arranged, labelled, and catalogued the collection in the City Museum."

VIOLENT volcanic eruptions are reported from several of the Aleutian Isles in the North Pacific. The news was brought to Honolulu by whalers returning from the Arctic Seas through Behring's Straits. The high volcanoes upon Amukta and Tshegula sent forth gigantic columns of smoke and copious streams of lava, and the same was the case with the mountain upon Umnak, which reaches a height of 2,800 metres. On the island of Unalashka an earthquake accompanied by a tidal wave totally destroyed the village of Makushin on August 29.

A LARGE sea- and fresh-water aquarium is now in course of construction at Leipzig. It will consist of about twenty tanks, of which nine are to contain marine animals. The capacity of the tanks will vary from 350 to 800 litres.

REMARKABLE discoveries of Roman structures have recently been made at Bonn, on the Rhine. It has been found that the Castrum the Romans had established there by far exceeded in extent and importance the celebrated Saalburg near Homburg. Unfortunately the directors of the Provincial Museum of Bonn, by whose orders the excavations were begun, were not able to acquire the ground upon which the discovery was made, so that archæologists must remain satisfied with the mere fact of the discovery and the measurements taken.

NEAR the Norwegian town of Hamar, at a farm called Storhammer, some 170 silver coins have been found in the ground, none of which are dated later than the year 1530. They are all of Danish, Swedish, or Norwegian origin. At the same time two silver spoons, a gold ring, and several small silver hooks, were found. All the objects have been purchased by the Christiania Museum.

IN 1880 there will be an international exhibition of sea and river fishing-tackle at Berlin. The programme of the exhibition, which will contain no less than nine subdivisions, will shortly be sent to all interested in fisheries, both in Germany and abroad.

FROM the twenty-second annual report of the Sheffield Free Libraries and Museum we are glad to see that in the reference department a large increase has taken place in the demand for books in the class of arts and science. Considerable additions have been made to the museum.

THE *Natural History Journal*, "conducted by the Societies in Friends' Schools," for October 15 contains several interesting papers on various scientific subjects. A new feature is the illustrations, which have been made by an ingenious, simple, and inexpensive process, described in the first paper. One of these, "Societies in Friends' Schools," is the Lisburn School Association, which sends us a very favourable "Fourth Annual Report." We have also received a creditable Annual Report (the eleventh) from the Metropolitan Scientific Association, which meets at the Ward Schools, Aldersgate Street, on the fourth Tuesday in each month.

WE have received a well-arranged list of lectures to be given in connection with the Hull Literary and Philosophical Society, in which scientific subjects are given a large place.

THE *Gardener's Chronicle* publishes the following abstract from a letter recently received from Dr. Beccari, from Sumatra :—"I have very little time to spare, only to tell you of a botanical discovery which I think is of some interest. It is a gigantic Aroid, which can only be compared with the Godwinia discovered by Seemann in Nicaragua. I have no books with me, and I am not able to ascertain the genus to which it belongs, especially as I have seen it only in fruit. I believe it to be a Conophallus, and if so, I propose to name it *Conophallus titanum*. The tuber of a plant that I dug up is 1·40 m. in circumference. Two men could hardly carry it; they fell down and the tuber was broken. I will secure some more, and I hope to be able to forward them to Florence in good state. Meanwhile I send you some seeds. From this tuber, as in the genus Amorphophallus, only one leaf is produced, which in form and segments does not much differ from those of the above-named genus. But what different dimensions! The stalk at the base was 90 ctm. in girth, it was slightly attenuated

at the apex, and reached the height of 3·50 m.; its surface was smooth, of a green colour, with numerous small, nearly orbicular dots, of a white colour. The three branches into which it was divided at the top were each as large as a man's thigh, and were divided several times, forming altogether a frond not less than 3·10 m. long. The whole leaf covered an area of 15 m. in circumference. The spadix of a plant that I found in fruit had the dimensions of the stalk already described; the fruit-bearing portion was cylindrical, 75 ctm. in girth, 50 ctm. long, and was densely covered with olive-shaped fruits 35–40 mm. long and 35 mm. in diameter, of a bright red colour, each containing two seeds." This letter was addressed to the Marquis B. Corsi-Salviati, who received at the same time a number of seeds of this gigantic novelty. Many of them have germinated, so that the species is secured to European collections.

THE Giffard great captive balloon was disinflated last week without accident. The following statistics in connection with the enterprise may be interesting. The Tuileries grounds were opened to the public during 100 days, but the balloon was unable to work owing to the state of the atmosphere during 30 days. The number of ascents was 1,023, the number of passengers 34,000. The number of pioneer balloons sent up 25. During this period the sum of 840,000 francs was collected. The expenses of building the balloons, of machinery, and working, reached about 500,000 francs, so that the enterprise was a financial success.

THE *Daily News* Quebec correspondent telegraphs as follows:—"After long study and many experiments Prof. Bell has made an important discovery in connection with the telephone. It is well known that the telephone has been a comparative failure in England on account of the fatal induction generated by the contiguity of other wires. Prof. Bell has discovered simple and efficacious means whereby not only is induction prevented, but the clearness and force of the telephonic vocalisation greatly increased. Prof. Bell tells me that practical demonstration of the importance of the discovery will be given in London as soon as the necessary preliminaries are complete." We give this statement as published in the *Daily News*, though it must be received with some caution.

A NATIVE Japanese paper states that besides the two docks already existing at Yokoska, a third is to be built which will accommodate the largest ships on the Pacific. It is expected that it will be completed within three years, and the probable cost will be about 55,000*l*.

FROM Stuttgart (E. Schweizerbart'sche Verlagsbuchhandlung) is announced a second collected edition of Mr. Darwin's works in twelve volumes, with 326 woodcuts, seven photographs, twelve charts and tables, and a portrait of the author on copper-plate.

THE publishing house of Hartleben, in Vienna, to mark the seventy-fifth year of its existence, have issued a neatly-printed catalogue of all the works issued by them from 1803 to the present year. A very large proportion of these belong to the various departments of science. The catalogue contains a portrait of the founder of the house, and a sketch of its history.

FROM Mr. Murton's annual report on the Botanical and Zoological Gardens at Singapore we learn that, both botanically and zoologically, the Gardens are in a flourishing state. One of the most important sections of the garden, namely, that devoted to the cultivation of economic plants, continues to receive a large share of attention, patches of Liberian, Cape Coast, and Arabian coffee have been planted, as well as cocoa, China and Assam tea, and ipecacuanha. *Castilloa elastica* and *Manihot Glaziovii*, both valuable rubber, or caoutchouc yielding plants, natives of South America, as well as the Sarsaparilla, Alligator pear (*Persea gratissima*), New Zealand Flax (*Phormium tenax*), Cubeb (*Piper Cubeba*), Camphor (*Camphora officinarum*), Allspice (*Eugenia Pimenta*), and many others, have been introduced. The Liberian coffee plants, sent to Larut in 1875, are reported to be making good growth with large healthy foliage, forming a great contrast to the Arabian coffee growing beside it. The Salt Bush, which is referred to two species of *Rhagodia*, namely, *R. hastata* and *R. parabolica*, has been introduced into Singapore. Both species are described as possessing wholesome and nutritious qualities, and are much relished by stock. The cultivation of the plants is said to be very easy, and in consequence of the rapidity with which, when protected from stock, they grow into large and handsome shrubs, together with their capability of resisting both heat and drought, are strongly recommended for cultivation. Besides the use as fodder, in a fresh state, the plants might also be advantageously given to sheep and cattle after being cut and dried, or in conjunction with other foods. In Singapore the plants seem better able to resist heat and drought than prolonged wet weather, but it is anticipated that, when they become well established, they will survive the effects of wet weather better. Mr. Murton states that the object that will be kept steadily in view in the working of the new economic garden is the introduction of new plants of economic value, and thoroughly testing their capabilities of production in Singapore before recommending them for general cultivation, while it will also afford an opportunity to intending planters in the Malay Peninsula of seeing the various plants adapted for their cultivation, and the amount of success, or otherwise, attending each operation. In the Zoological department little change has been affected to call for note.

THE additions to the Zoological Society's Gardens during the past week include two Arabian Baboons (*Cynocephalus hamadryas*), from Arabia, presented by Mr. C. Wood; two Squirrel-like Phalangers (*Belideus sciureus*) from Australia, presented by Mr. E. S. Waller; two Hooded Crows (*Corvus cornix*), European, presented by Capt. F. H. Salvin; a Burchell's Zebra (*Equus burchelli*) from South Africa, a Yellow-Shouldered Amazon (*Chrysotes ochroptera*), a Blue and Yellow Macaw (*Ara macaco*) from South America, a Dalmatian Dog (*Canis familiaris*), a Passerine Owl (*Glaucidium passerinum*); two Variegated Sheldrakes (*Tadorna variegata*) from New Zealand, six Summer Ducks (*Aix sponsa*) from North America, two Scarlet Tanagers (*Ramphocœlus brasiliensis*) from Brazil, two Grenadier Weaver Birds (*Euplectes onyx*) from West Africa, two Java Sparrows (*Padda oryzivora*) from Java, two Domestic Fowls (*Gallus domesticus*) from Japan, deposited; a Nisnas Monkey (*Cercopithecus pyrrhonotus*) from Nubia, a Red-Fronted Lemur (*Lemur rufifrons*) from Madagascar, a Mantchurian Deer (*Cervus mantchuricus*) from Japan, an American Tantalus (*Tantalus loculator*) from South America, purchased.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

AN influential meeting was held last week in Liverpool to consider the report of a committee appointed at a previous meeting to draw up a scheme for the establishment of a college for higher education in Liverpool. The committee have arrived at the following conclusion: that the most appropriate name will be "University College, Liverpool," unless the name of a founder or large benefactor be adopted. The smallest staff consistent with the objects should be composed of at least seven professors and two lecturers, allotted as follows:—Professorships—Mathematics and experimental physics; classical literature and history; engineering, practical mechanics, and steam; logic, mental and moral philosophy, and political economy; modern literature and history; chemistry, natural history (including botany, zoology, and geology). Lectureships—Jurisprudence and law; physiology. The stipend of each professor should be reckoned at 300*l*. per annum (exclusive of a share of

the fees), which is about the average of the stipends in the colleges recently established; and that of each lecturer at 150*l.* per annum. A further sum will be required for class expenses and for the general expenses of the college. A college consisting of the staff recommended would therefore require a permanent income of at least 3,000*l.* per annum, necessitating a capital of 75,000*l.* This estimate does not include the cost of erecting any building for the purposes of the college, or the rent which might have to be paid for the necessary accommodation pending such erection. The committee suggest the desirability of deferring for the present the question of the government of the college, and they recommend that the management be placed in the meantime in the hands of a committee to be appointed by the adjourned town's meeting. The report was adopted and a committee appointed to carry out its objects.

A MEETING was held on Monday, in the City, for the purpose of formally constituting the "City and Guilds of London Institute for the Advancement of Technical Education." The meeting was, in fact, the first held by the Board of Governors which the provisional committee of the Guilds had recommended should be constituted as the supreme governing body of the new institute. This body consists of representatives from the subscribing Livery Companies, nominees from the Court of Common Council, the Lord Mayor, and other City officials, with a president and twelve vice-presidents. The amount of available income already promised is over 12,000*l.*, but it is anticipated that as soon as any actual progress is made in the work, contributions will be given by the companies who have not yet joined in the scheme. The proposals which the committee have before them include the establishment in London of a central technical school, the establishment and assistance of evening classes, trade schools, &c., and the development of a system of technical examinations such as that now carried on by the Society of Arts. All these proposals were made in the provisional committee's report, and it was proposed to carry them all into execution as soon as sufficient funds were obtained. It was stated at the meeting on Monday that the Commissioners of the 1851 Exhibition were proposing to erect a building at South Kensington in which would be included a technical school, and it was, therefore, understood that either some arrangement would be come to with them or the execution of the proposals connected with the London school would be deferred till it was definitely known what direction the action of the Commissioners would be likely to take. It may be assumed, therefore, that the proposals of the executive committee will embody the other recommendations of the provisional committee, and will include a detailed scheme for carrying them out.

THE New South Wales correspondent of the *Colonies* states that, in consideration of the necessity which is now felt] for extending the curriculum of Sydney University and augmenting its teaching powers, the Colonial Government have consented to ask Parliament for an additional annual grant of 5,000*l.* This will enable the Senate to make the following additions to the present course of study:—Mental philosophy, law, history, and English literature; (2) all the education necessary for the medical profession; (3) a complete course of natural philosophy, coupled with mechanics and engineering; (4) the addition of organic chemistry and metallurgy to the chemical school; and (5) biology, including animal and vegetable physiology. The Senate will also be in a position to establish a faculty of science, and to confer the degrees of Bachelor and Doctor of Science, and also degrees in medicine, on those who have received their education in Sydney.

WE have received a "Calendar" of Anderson's College, Glasgow, containing much information as to the founder and the curriculum of that useful institution. It shows that a very complete and thorough education may be obtained there at a very moderate cost.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, November 5.—Mr. A. Grote, vice-president in the chair.—A communication received from Mr. J. H. Gurney, F.Z.S., contained a memorandum from the late Mr. E. C. Buxton, stating that *Asturinula monogrammica*, observed on the Eastern Coast of Africa, had a song which was heard morning and evening.—An extract was read from a letter addressed to the Secretary by Dr. A. B. Meyer, C.M.Z.S., respecting a supposed new bird of paradise, obtained on the West Coast of New Guinea.—An extract was read from a letter addressed to the Marquis of Tweeddale by Mr. A. H. Everett, stating that the anoa of Celebes (*Anoa depressicorms*), or an allied species, was found in the Island of Mindoro, Philippines.—Prof. Newton, F.R.S., exhibited and made remarks on a supposed hybrid between the red grouse and ptarmigan, lately shot in Sutherland by Capt. Houston.—A communication was read from Mr. R. Bowdler Sharpe, F.Z.S., containing a description of a new species of *Indicator*, with remarks on other species of the genus.—A second paper by Mr. Sharpe contained a note on *Pæoptera lugubris*.—A communication was read from Mr. G. B. Sowerby, Jun., wherein he gave the descriptions of ten new species of shells from various localities.—Mr. A. G. Butler, F.Z.S., read a paper in which he gave the description of a remarkable new spider, obtained in Madagascar by the Rev. W. D. Cowan, for which the name of *Cærostris avernalis* was proposed.—A communication was read from Lt.-Col. R. H. Beddome, C.M.Z.S., containlng the description of six supposed new species of snakes of the genus *Silybura*, family Uropeltidæ, from the Peninsula of India.—A communication was read from Mr. Edgar A. Smith, F.Z.S., containing the description of a collection of marine shells, made by Capt. L. W. Wilmer, in the Andaman Islands.—Mr. F. Moore, F.Z.S., communicated a list of the lepidopterous insects collected by Mr. Ossian Limborg in Upper Tenasserim, with descriptions of new species.—Mr. George French Angas, C.M.Z.S., gave the descriptions of six species of bivalve shells in the collection of Mr. Sylvanus Hanley, F.L.S., and of a *Helix* from the Solomon Islands. Mr. Angas also read descriptions of ten species of Marine Shells from the Province of South Australia. Mr. Angas likewise read a list of additional species of marine mollusca to be included in the fauna of the Province of South Australia, with notes on their habitats and local distribution, in continuation of former papers on this subject.—Dr. G. E. Dobson read a note on *Myxopoda aurita*, a new form of chiroptera from Madagascar, remarkable for possessing suctorial disks, as in *Thryroptera*. Mr. Dobson also gave descriptions of some new or rare species of bats based on specimens in the Museum of Natural History of Paris. To the new species the following names were given:—*Pteropus germaini* from New Caledonia, *Cephalotes minor* from New Guinea, *Emballonura raffrayana* from Gibolo, and *Schizostoma brachyote* from Cayenne.

CAMBRIDGE

Philosophical Society, October 28.—Annual General Meeting, Prof. Liveing, president, in the chair.—The following were elected Officers and new Members of Council for the ensuing year.—President, Prof. Liveing; Vice-Presidents, Prof. Stokes, Prof. Newton, and Prof. Clerk Maxwell. Treasurer, Dr. J. B. Pearson. Secretaries, Mr. J. W. Clark, Mr. Coutts Trotter, and Mr. J. W. L. Glaisher. New Members of Council, Prof. Humphrey, Prof. Cayley, Mr. W. M. Hicks.—Prof Cayley made a communication to the Society upon the transformation of co-ordinates. He investigated the formulæ for the transformation between two sets of oblique co-ordinates in three dimensions, which, when presented in the notation of matrices, assumed a very elegant form. The paper also contained developments relating to certain expressions that were involved in the transformation.—Mr. J. W. L. Glaisher made a communication to the Society on Henry Goodwyn's "Tabular Series of Decimal Quotients" and "Table of Circles" (London, 1823). The first contains the value, to eight decimal places, of every vulgar fraction, whose numerator and denominator, when the fraction is expressed in its lowest terms, do not exceed 1000. This table, in which the fractions are arranged in order of magnitude, was intended to extend to $\frac{1}{2}$, but only the first part, which ends at $\frac{99}{991}$, was published. The "Table of Circles" contains all the complete periods corresponding to the denominators, prime to 10, up to 1024. The object of the tables was the conversion of vulgar fractions into decimals, the complete quotients being shown. In the first table the fractions are arranged in order of magnitude, and Mr. Goodwyn was thus led to a remarkable theorem, viz., that if all the fractions in their lowest terms having their numerators and denominators both not exceeding a given quantity n be arranged in order of magnitude, then each fraction is equal to the fraction formed by adding together the two numerators and the two denominators

of the fractions on each side of it. Thus if $n=5$, the fractions are $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{1}{2}$, $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$ $\frac{4}{5}$, and, for example, $\frac{1}{3}=\frac{1+2}{4+5}$; also the difference between any two consecutive fractions is equal to unity divided by the product of their denominators. These properties, discovered by Mr. Goodwyn, were afterwards proved by Cauchy. Mr. Glaisher pointed out the great convenience of the arrangement of the periods in Goodwyn's tables, and exhibited a table showing the number of periods corresponding to every denominator up to 1000, and the number of figures in each period. This table was obtained by actual counting from Goodwyn, and in every instance the product of the number of figures in each period and the number of periods was found to be equal to the number of numbers less than the denominator and prime to it, as should be the case. After alluding to other similar tables, and to tables by Gauss, Reuschle, Desmarest, Shanks, &c., reference was made to the fact discovered by Desmarest that the number of figures in the period of the reciprocal of 487^2 is the same as the number of figures in the period of the reciprocal of 487, or in other words, $10^{486}\equiv 1 \pmod{487^2}$. In vol. iii. of *Crelle* Abel proposed the query, "Can $x^{\mu-1}\equiv 1 \pmod{\mu^2}$, if μ be a prime and x less than μ?" Jacobi replied and showed that $3^{10}\equiv 1 \pmod{11^2}$, $14^{28}\equiv 1 \pmod{29^2}$ and $18^{36}\equiv 1 \pmod{37^2}$. The case found by Desmarest is the only one known in which the conditions of Abel's question are satisfied for $x=10$; in fact we have $10^2\equiv 1 \pmod{3^2}$ and $10^{486}\equiv 1 \pmod{487^2}$, and there is no other known case in which $10^{p-1}\equiv 1 \pmod{p^2}$, p being a prime, although there is no reason to suppose that such cases do not exist, and that there is not some value of p for which $10^{p-1}\equiv 1 \pmod{p^3}$. Desmarest has verified that for values of p less than 1000 the congruence $10^{p-1}\equiv 1 \pmod{p^2}$ is only satisfied for $p=3$ and $p=487$. Mr. Glaisher also exhibited the first fourteen printed pages of the factor table for the fourth million, an account of the construction of which was communicated to the Society on February 11, 1878.

PARIS

Academy of Sciences, November 4.—M. Fizeau in the chair.—The following papers were read:—Researches on the stability of the ground and of the vertical of Paris Observatory, by M. Mouchez. M. Wolf is occupied with the former question. M. Gaillot has been studying the latitude given at different epochs. The variations of a few tenths of a second in this, at different times of the year, are thought due to the influence of temperature either on the instruments, or (rather) on the astronomical refractions, whose coefficient has not yet been adequately determined; or they may be due to a systematic error of the declination of stars distributed regularly over the twenty-four hours of right ascension, these hypotheses being more admissible than that of a variation of the vertical.—On the reciprocal displacements between oxygen, sulphur, and halogen elements, combined with hydrogen, by M. Berthelot.—Reciprocal displacements between weak acids, by the same. Two weak acids opposed to each other divide the base, the division being regulated by the state of partial decomposition of the two salts dissolved, which depends both on the proportion of water and on that of the corresponding acid.—On the reaction between mercury and hydrochloric gas, by M. Berthelot. 13·5 gr. of mercury and 48 cub. ctm. of pure hydrochloric gas put in a very resistant sealed glass tube and heated to the highest possible temperature for an hour, yielded a little over 1 cub. ctm. of hydrogen, indicating decomposition of about one-twentieth of the hydrochloric gas.—Preliminary note on the compound nature of the chemical elements, by Mr. Lockyer. Besides calcium, several substances considered as elements are compounds.—On the native iron of Greenland and the basalt containing it, by Prof. Lawrence Smith. He gives an analysis of a memoir on the subject. He is convinced the iron is of terrestrial origin, and in many cases so intimately united with basalt that the felspathic and other crystals of the latter penetrate the iron particles. The iron is probably a secondary product formed by decomposing action of beds of lignite and other organic matters which the immense basaltic dykes have penetrated.—On a universal law relative to the dilatation of bodies, by M. Levy, a reply to objections.—On the maturation of the grain of ergot. The substance which plays the part of sugar in this grain, the author finds identical with *synanthrose*, the saccharine matter found in *Synantheræ*, and more especially in Jerusalem artichokes. It is the only saccharine matter present, and it diminishes rapidly in proportion as maturation advances (but does not wholly disappear), being replaced by starch, formed doubtless at its expense. Wheat, oats, barley, and maize, do not contain synanthrose, but cane-sugar. Thus one may readily detect in flour the fraudulent addition of ergot flour.—On the dangers of the use of methylic alcohol in industry, by M. Poincaré. Animals kept eight to sixteen months in air, ever renewed, but charged with vapours of methylic alcohol, undergo hypertrophy and fatty degeneration of the liver, a like alteration of the muscular fibres of the heart, epithelial cells, uriniferous tubes, and the lung cells, also congestion of the nervous centres, &c.—M. Gelis stated that, owing to large demand, he proposed manufacturing 200,000 kilogrammes of sulphocarbonate of potassium (for phylloxera) for the coming year, and he desired the Academy to obtain from the railway companies reduced prices of transport.—Mr. Warton presented a marine compass with nickel needles.—On the direction of the vertical of Paris Observatory, by M. Gaillot. See first paper.—On a simple property, characterising the mode of distribution of weight of a solid, placed on an elastic horizontal ground, between different parts of its base, when the latter is a horizontal ellipse, by M. Boussinesq.—On certain ordinate series with reference to powers of a variable, by M. Appell.—On the rectification of a class of curves of the fourth order, by M. Darboux.—On an iodised derivative of camphor, by M. Aller. The formula is $C_{10}H_{15}IO$.—On the region of the solar spectrum indispensable to vegetable life, by M. Bert. The part thus necessary to life is that between the lines B and C; but it is not sufficient; for behind red glass plants may live, indeed, long, but they get elongated to excess and slender, with narrow and little-coloured foliar limbs; the blue and violet rays rectify this.—On relations presented by phenomena of motion proper to reproductive organs of some phanerogams with cross and direct fertilisation, by M. Hæckel. Motion provoked in both male and female organs seems to serve physiologically for cross fertilisation, while spontaneous motion assumes direct fertilisation in plants which are not sensibly profited by crossing. The former oftener characterises the more highly-organised plants, the latter seems proper to the less highly-organised.—Reproduction of felspars by fusion and prolonged maintenance at a temperature near that of fusion, by MM. Fouqué and Levy. The experiments here described were on oligoclase, labrador, and albite.—On two specimens of natural crystals of sulphate of magnesia (epsomite) of remarkable dimensions, by M. De Rouville.

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