THURSDAY, OCTOBER 31, 1872

THE GREAT CIRCUMNAVIGATING EXPLORING EXPEDITION

PREPARATIONS for the expedition which is about to be despatched by the Admiralty for the purpose of dredging, sounding, and otherwise scientifically investigating, the deep sea, have been for some months past in active progress, and are now rapidly approaching completion. The vessel set apart for the purpose is H.M.S. *Challenger*, a main-deck corvette of 2,306 tons, now lying at Sheerness. Her commander is Capt. G. S. Nares, R.N., well known as the author of a valuable work on seamanship, greatly in use in the Royal Navy. Capt. Nares has seen a great deal of active service, including exploration in the Arctic regions, and he has left the charge of the Survey in the Gulf of Suez for the purpose of taking charge of the present expedition. Second in command is Commander J. P. Maclear, R.N., son of Sir Thomas Maclear, late Astronomer Royal at the Cape of Good Hope, who has also seen a great deal of service in various parts of the world, and whose name is familiar to our readers from his having taken part in the Eclipse Expedition to Spain, and also in that to Ceylon. Commander Maclear will undertake the magnetic observations, which will form part of the work of the Expedition. The other naval officers are—1st Lieut., Pelham Aldrich; 2nd Lieut., Arthur C. Bromley; 3rd Lieut., George R. Bethell; Navigating Lieut., Alfred E. Tizard; Sub-Lieutenants, H. C. Sloggett and Lord George Campbell; Pay-master, R. R. Richards; Chief Engineer, James H. Ferguson.

On the scientific staff of the Expedition, the following have received appointments from the Admiralty, bearing date Oct. 1872:—Prof. Wyville Thomson, F.R.S., &c., Director of the Scientific Staff. Under him the following have been appointed:—Mr. J. J. Wild of Zurich, who will accompany Prof. Wyville Thomson as private secretary. (Mr. Wild was for some time private secretary to the Abbé Moigno, and is an accomplished artist); Mr. J. Y. Buchanan, M.A., Edinburgh, Chemist to the Expedition. (Mr. Buchanan has been until now Senior Assistant in the Chemical Laboratory of Edinburgh University, and has had the advantage of pursuing the study of his subject in Germany, at Leipsig and elsewhere); Mr. H. N. Moseley, M.A., Oxon, Naturalist (Mr. Moseley is a pupil of Prof. Rolleston, and has been enabled, by a Radcliffe Travelling Fellowship, to study biology further at Vienna and Leipsig: he was a member of the late Eclipse Expedition to Ceylon); Dr. Von Willemoes Suhm, Naturalist (Dr. Von Willemoes Suhm, who has been some time Assistant to Prof. Von Siebold, of Munich, is a distinguished naturalist, and is well known from his papers in Siebold and Kölliker's "Archiv" on Annelids); Mr. John Murray, of Edinburgh University, Naturalist (Mr. Murray, a Canadian by birth, has had great experience in taxidermy and the collection and preservation of Vertebrata generally, has travelled in Canada, and has also been far into high latitudes on a whaling cruise). Prof. Wyville Thomson will of course devote all his time not consumed by the superintendence of the scientific investigations in their various branches, preparations of reports, &c., to zoological work.

Of the three Naturalists, Dr. Von Willmoes Suhm and Mr. Moseley will undertake especially the Invertebrata procured during the expedition, whilst Mr. Murray will direct his attention principally to the Vertebrata. Mr. Moseley will also undertake botanical collection whenever an opportunity presents itself of landing in interesting localities, and all the scientific staff will give to this branch of biological investigation as much of their time as possible. Algæ, &c., obtained by dredging and otherwise at sea, will also be entrusted to Mr. Moseley. An experienced photographer, a noncommissioned officer of Engineers, forms one of the party. The expedition is under the immediate direction of the hydrographic department of the Admiralty.

The Admiralty authorities having applied to the Royal Society for advice in the conduction of the expedition, a committee of the Society was formed for the purpose of considering the subject, and counselling the Admiralty in the matter. The Committee consists of the President and Officers of the Royal Society, with Dr. Carpenter, Dr. Frankland, Dr. Hooker, Prof. Huxley, the Hydrographer of the Admiralty, Mr. Gwyn Jeffreys, Mr. Siemens, Sir William Thomson, Prof. Wyville Thomson, Dr. Williamson, and Mr. Alfred R. Wallace, and has the power of adding to its number.

The *Challenger* has had her timbers put in thorough repair, and has been specially fitted out for the work for which she is intended. She has an auxiliary screw, with engines of 400-horse power (nominal), and carries about one month's coal. She carries two cutters, a steam pinnace, a South Sea whaling or surf boat, a jolly boat, two gigs, and a dingy. Stages have been erected amidships, from which the dredges will be worked, and immediately aft of the stages is the steam winding-in apparatus. Prof. Wyville Thomson has been several times down to the ship to give directions for the special arrangements for scientific work. The fore magazine is prepared for the stowage of the large quantity of spirits which will be required for the preservation of natural history specimens, and of the many thousand stoppered bottles which will contain them. A chemical laboratory and naturalist's workroom have been fitted up in the afterpart of the vessel; and spirit is laid on to the workroom by means of a pipe leading from a metal cistern placed in the nettings. Several hundred miles of best whaling line have been prepared at Chatham for the *Challenger*, for dredging, and she carries about forty dredges. Amongst the stores are traps of various forms, harpoons, a harpoon gun, and fishing tackle of all kinds, including trawls, trammels, a seine, shrimp-nets, fish-traps, and lobster-pots. From the latter, used in deep water, great results are expected; and it is not improbable that living specimens of Nautilus may thus be procured. Prof. Wyville Thomson is now superintending the construction, in Edinburgh, of the various forms of apparatus required for physical research. Several beautiful instruments of this nature have been devised by Mr. Buchanan; and notably a new deep-sea pressure-gauge, and an instrument for bringing up samples of water from the bottom, which is provided with two taps which are closed by the contact of the apparatus with the bottom, and a safety-valve to allow of the expansion consequent on decrease of pressure as the apparatus is hauled up. A hydraulic machine will be carried on board, capable of testing the accuracy of all the physical apparatus, thermometers, pressure-gauges, &c., from time to time, in a chamber in which a pressure of three tons on the square inch can be obtained. The attempt will be made to use piano wire for sounding, after Sir William Thomson's method. A small aquarium has been devised by Mr. Moseley, which will be used for the study of the development of interesting animals. Except in absolutely calm weather it will be entirely closed, and a constant stream of water will be passed through it from a reservoir by means of finely perforated roses made—at the suggestion of Mr. Lloyd, of the Crystal Palace—of vulcanite. The route to be followed by the *Challenger* is not yet definitely fixed, and is still under the consideration of the Admiralty, who will be guided very much in the matter by the advice of the Royal Society Committee ; but it will be very nearly as follows :—

The vessel, which is at present at Sheerness, will probably go round to Portsmouth about the middle of November, and sail from thence in the beginning of December for Gibraltar, the first haul of the dredge being made in the Bay of Biscay, if the weather should chance to be favourable. From Gibraltar she will proceed to Madeira, thence to St. Thomas, the Bahamas, Bermuda, the Azores ; from thence to Bahia, touching at Fernando Norohna ; then across to the Cape of Good Hope, and, after a stay in that neighbourhood, southwards to the Crozetts and Marion Islands and Kerguelens Land. A run southwards will then be made as far as possible to the ice, and the course thence be made to Sydney. New Zealand, the Campbell and Auckland groups, Torres Straits, New Guinea, and New Ireland will then be visited. A long cruise of perhaps a year will then be made amongst the Pacific islands ; thence the expedition, passing between Borneo and Celebes, and visiting Luzon and its neighbourhood, will proceed to Japan, where a stay of two or three months is expected. Thence northward to Kamskatka, whence a run will be made northwards through Behring's Straits, and then through the Aleutian Islands, southward to Vancouver's Island, and so through the deep eastern region of the Pacific by Easter Island, and possibly by the Galapagos Archipelago to the Horn, and thence home. The voyage is expected to take about three and a half years.

It is difficult to over-estimate the immense benefit which science must derive from an expedition such as this. Apart from the results of intense interest which may be expected from the deep-sea work, the principal object of the expedition, and which must go far to elucidate a subject on which our knowledge is at present of the most imperfect description, abundant opportunity will offer for the accurate investigation of the animal and vegetable life of many highly interesting and yet imperfectly known or totally unexplored regions. The investigation of the floras of such islands as Fernando Norohna and the Marion and Crozett groups cannot fail to yield most instructive results ; and it is needless to speak of the intense interest which centres in New Guinea.

No expedition has ever started under such favourable auspices as the present for yielding valuable scientific results, and great praise is due to the Government for the very liberal and thorough manner in which all arrangements have been carried out.

FIGUIER'S VEGETABLE WORLD

The Vegetable World: being a History of Plants, with their structure and peculiar properties. Adapted from the work of Louis Figuier. New and Revised Edition, with 473 Illustrations. (London: Cassell, Petter, and Galpin.)

NOTWITHSTANDING its ambitious title, this is, on the whole, a satisfactory book. If, however, in dependence on the title, it is ordered in the expectation of finding anything that will replace Lindley's "Vegetable Kingdom," or Baillon's "Histoire des Plantes"—at least, what this latter will be when finished, if it ever is finished —the purchaser will be disappointed. We have here a repetition of the old plan of attempting to compress into one small octavo volume an account of the Morphology, Physiology, Classification, and Geographical Distribution of plants. As far as can be, as we have said, the execution is good ; some parts are even exceptionally well done ; the defects are those of the plan. The style of Figuier's original work, florid and Gallic to excess, is entirely unsuited to the English reader ; the "adapter" has used his pruning-knife with judicious severity, and has produced a book that may fill a useful place in popularising the study of botany, and leading the way to fuller and more special treatises.

The first part of the work, "Organography and Physiology," treats of the structure and different forms of the various organs in a systematic manner, and yet with a fresher style than is usual in text-books. It is, moreover, a relief to find that the majority of the illustrations, which are excellent throughout, are not those which have wearied the eye in many a familiar book. The details of terminology are relieved by information on many interesting points which we do not find in ordinary text-books. Thus in the very early pages we have an account of Knight's and Dutrochet's experiments with vertical and horizontal wheels to determine the effect which gravitation exercises in determining the downward tendency of the roots. Further on is a description and drawing of Hales' apparatus for measuring the force of ascending sap, by which he claims to have determined that the force which impels the sap in the vine is five times as great as that which impels the blood through the large arteries of the horse.

The portion devoted to the "Phenomena of Fertilisation and Germination" is full, and about the best in the book, the illustrations being especially superior to those found in most other works of a similar character. The cut here reproduced (Fig. 2) represents the very curious arrangement by which the fertilisation of *Vallisneria spiralis*, a favourite water plant in aquaria, is effected. The female flowers are borne on long spiral stalks which uncoil when the flower is ready to open, so as to allow it to float on the surface of the water. The male flowers, on the contrary, have very short stalks which are entirely submerged, but detach themselves when mature, rising to the surface, and then only discharge their pollen in the immediate proximity of the female flower; after which the stalk of the female flower again coils up, and carries it down to the bottom of the water, where the seed ripens.

The second part, on "Classification of Plants," is occupied with a brief description of the various systems adopted at different stages of botanical knowledge, with short biographies and portraits of the most distinguished botanists, from Tournefort to Robert Brown.

The third part is devoted to the "Systematic Arrangement of Plants," commencing from the lowest and proceeding to the highest forms. The account of the different orders of flowerless plants is the best with which we are acquainted in any elementary work, and will give the beginner an excellent outline of the immense variety of structure and physiological phenomena to be found among the lower forms of vegetable life. We find a good description of the different modes of reproduction in the

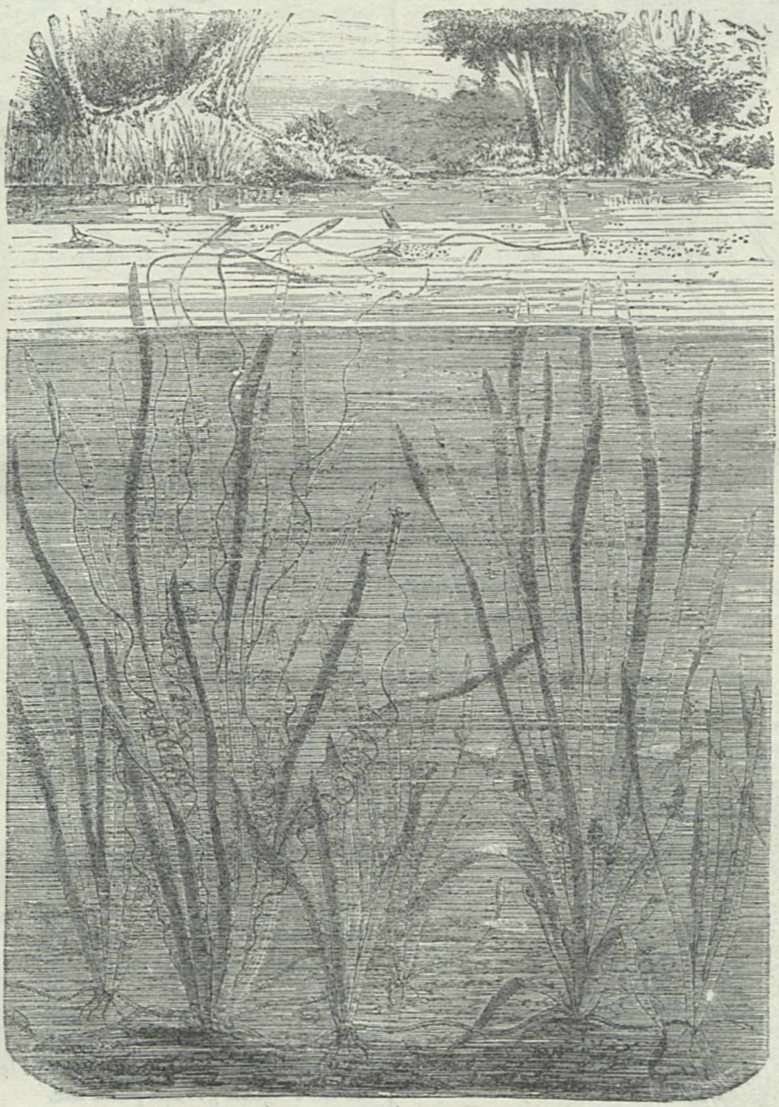


Fig. 2.—*Vallisneria spiralis*

Algæ, which are often so enveloped in technical terms as to be barely intelligible to the student. The illustrations also are excellent, as is the case throughout this section. Those here given of the early stages in the life of a fern taken from Thuret (Figs. 3—7), are such as have been heretofore unknown to English text-books. This section is, in fact, altogether thoroughly satisfactory.

More exception may be taken to the portion which treats of flowering plants, especially to the continued use, notwithstanding its defects acknowledged by the author, of the unsatisfactory system of classification adopted by Lindley in his "Vegetable Kingdom." The retention at the present day of such classes as the Rhizogens and Dictyogens as of the same value as Monocotyledons and Dicotyledons, is altogether indefensible. An equally serious defect is the very inadequate amount of attention given to the Gymnogens, and to the elucidation of the peculiarities of their structure which seem to form a connecting link between flowering and flowerless plants. It seems to us a mistake to attempt in an introductory

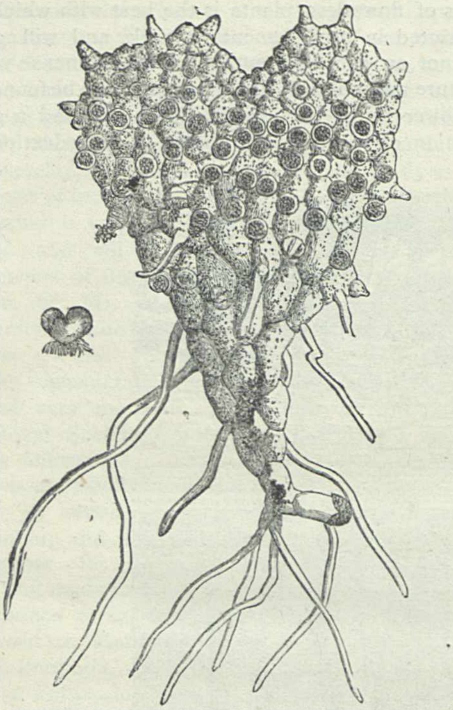


FIG. 3.—Prothallium of *Scolopendrium*, with Antheridia (magnified)

text-book even an outline of the characters of the natural orders of flowering plants;' but if this were necessary to

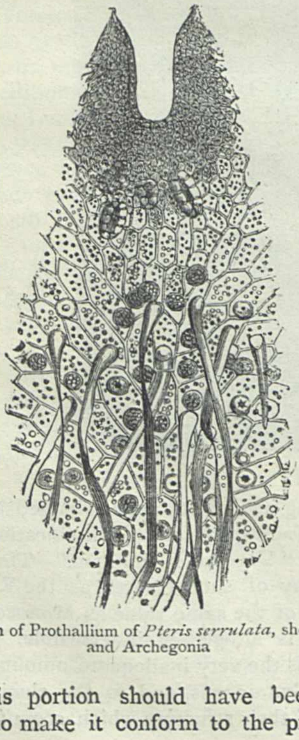


FIG. 4.—Portion of Prothallium of *Pteris serrulata*, showing Antheridia and Archegonia

the plan, this portion should have been completely re-arranged, to make it conform to the present state of botanical science. The chief advantage of the systematic portion of a course of botanical lectures is that it gives the teacher the opportunity of demonstrating the value in

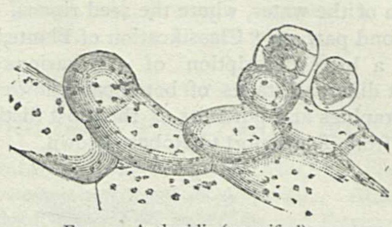


FIG. 5.—Antheridia (magnified)

classification of certain peculiarities of structure, by placing side by side species belonging to the same and to allied natural orders, in a manner better calculated to arrest the

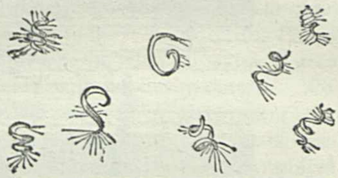


FIG. 6.—Antherozoids

attention of the student than if presented to him in any other way. This advantage, however, is not gained by the introduction of a section devoted to the details of classification into a text-book.

FIG. 7.—Isolated Archegonium, showing the action of the Antherozoids npon the Embryonal Cell

The fourth part of the work, on the "Geographical Distribution of Plants," though too brief, is interesting, and contains much valuable information in a small space.

Altogether, this English version of Figuier's "Vegetable World" is a good book to place in the hands of an intelligent student who is desirous of learning something of the laws which govern plant life. A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Ocean Currents

IF Mr. Laughton will take the trouble to read my previous Reports with attention, he will find that I have based no *argument* upon my "trough" experiment, which I have used merely as an *illustration*. The argument in favour of the *vertical* Oceanic Circulation which I advocate rests upon the *facts* of Deep Sea Temperature. In my forthcoming Report, these facts (including many which have not been hitherto published) are discussed, in connection with the Temperatures of Inland Seas; and if Mr. Laughton will frame a better hypothesis for the explanation of them than that of the Thermal Circulation first advanced by Pouillet, and latterly accepted by Herschel and Sir William Thomson, I will gladly accept it.

Mr. Laughton will also find that I am not ignorant of the geographical facts he mentions respecting the *horizontal* or *superficial* movements of the Ocean. But he must be well aware that a current may be flowing in one direction *on* the surface, and a tidal or other movement in a contrary direction *at a small depth* beneath it. A very careful observer told me a few days since that at a time when the *surface*-current in the Dardanelles, urged on by a south-westerly wind, was blowing *inwards*, he had distinctly seen the movement of the water *at a short distance beneath the surface* to be *outwards*—this being indicated by the direction of the water-weeds. Below this, again, as the researches of the *Shearwater* have shown, there is a deep under-current *inwards*.

In confirmation of this last statement, my friend Mr. Redhouse, who resided many years at Constantinople as Translator to the Embassy, has informed me that the existence of the deep under-current in the Bosphorus has long been perfectly well known to the native fishermen of Constantinople, as well as to European residents who amuse themselves with the sport.

WILLIAM B. CARPENTER

University of London, Oct. 29

London University Examinations

PROF. W. G. ADAMS, in order to controvert my statement that mechanical and natural philosophy have little to do with medicine, enters into theories with regard to the production of animal heat which I must leave him to settle with his colleague, the Professor of Physiology in King's College. As he insinuates a doubt as to my own acquaintance with the thermometer and its uses, on my own behalf I may venture to say that not only did Professors Graham and Brande require a knowledge of this and kindred matters of candidates for the Matriculation and First M.B. Examinations of the University of London, but that years before Mr. Adams was connected with King's College, I was rather a "swell" at natural philosophy and chemistry under the late Dr. Miller's tuition.

Mr. Adam's temperature must, I fear, have been abnormally high, or his barometer of propriety correspondingly low, when he penned the paragraph relating to the report of the sub-committee, and endeavoured to gain support for his views by suppressing the latter half of the quotation. The sentence really stands as follows: "The preliminary scientific examination has tended to give prominence to theoretical and scientific knowledge *at the expense of a sound practical acquaintance with medicine, surgery, midwifery*," &c.; but by the omission of the words in italics Mr. Adams makes the report (contrary to its whole tenor) support his view that "it is in consequence of such knowledge that medical science has advanced with such rapid strides." The illustration of the application of a cupping-glass is not a very happy one, for cupping has for years been notoriously a purely mechanical art entrusted to medically-unqualified men, who could in no sense claim a knowledge of natural philosophy.

In conclusion, may I say that the Senate of the University of London at its session of the 23rd inst., took action in the matter to which I have called attention, and appointed a committee to consider it; and may I express a hope that, should Mr. Adams be really ill, he may not be unfortunate enough to fall into the hands of one of his own medical philosophers?

Cavendish Place CHRISTOPHER HEATH

Can the Stature be in any way affected by the Will?

IT is written that "no man by taking thought can add one cubit unto his stature;" but if there be any truth in the following extract from Babbage's "Passages in the Life of a Philosopher," it appears that man can, at all events, voluntarily deduct nearly an equivalent amount from his height.

At the opening of chapter xviii. of the work just cited, Mr. Babbage makes the following statement respecting the celebrated thief-taker Vidocq, with whom he had an interview:—"He had a very remarkable power, which he was so good as to exhibit to me. It consisted in altering his height to about an inch and a half less than his ordinary height. He threw over his shoulders a cloak, in which he walked round the room. It did not touch the floor in any part, and was, I should say, about an inch and a half above it. He then altered his height, and took the same walk. The cloak then touched the floor, and lay upon it in some part or other during the whole walk. He then stood still, and altered his height alternately several times to about the same amount.

"I inquired whether the altered height, if sustained for several hours, produced fatigue. He replied that it did not, and that he had often used it during a whole day without any additional fatigue. He remarked that he had found this gift very useful as a disguise. I asked whether any medical man had examined the question, but it did not appear that any satisfactory explanation had been arrived at."

Now if this had been the statement of an unscientific person, or one whose powers of observation were presumably untrained, it might be put aside unheeded; but coming, as it does, from one very unlikely to jump to conclusions, it seems to merit some degree of attention.

This, then, being granted, the question arises, how can we account anatomically for this shortening in height? Of this the solution does not appear to be very clear. The only way in which an individual could alter his height would be either by adopting a stoop of his neck and shoulders, or by bending his knees, and flexing his thighs upon his pelvis, or, lastly, by actually shortening his vertebral column.

The two first methods may be disregarded, as they would be pretty evident, even if a cloak were worn, and, if employed by Vidocq, would scarcely have aroused the curiosity and wonder of Mr. Babbage. The last only, namely, a voluntary shortening of the vertebral column, remains then to be considered.

Now, there seems to be a general impression, both among doctors and the laity so-called—though it is difficult to discover any definite and concrete expression of it in the text-books—that, by virtue of the compressibility of the intervertebral fibro-cartilaginous discs, the stature of a man when he goes to bed is shorter than when he gets out of it, the amount of shortening varying, I suppose, according as the individual dangles a cane in the "Row," or is employed somewhat more actively as a "fellowship porter" at the docks.

Granting, then, that there may be some passive, involuntary shortening of the vertebral column to the extent of an inch or an inch and a half* after the application of a weight to its summit for the duration of some hours, how does a voluntary shortening come to be brought about? Since fibrous and cartilaginous structures are not directly acted upon by the will through peripheral nerves, such action must be produced through the medium of muscles; and here we come to the crux, what are the muscles which could be employed in shortening the vertebral column? Hæmally, the only likely muscle in the cervico-dorsal region is the vertical portion of the *longus colli*, which passes from the bodies of cervical vertebræ Nos. 2, 3, 4, to the bodies of the three lower cervical and three upper dorsal vertebræ; and in the dorso-lumbar region there is the *psoas magnus*, which takes origin from all the lumbar and the last dorsal vertebræ, but which, unless the femur (where it is inserted) were fixed, could hardly affect the vertebral column, while neurally there are the numerous dorsal muscles of complex arrangement, such as the *quadratus lumborum*, *sacro-lumbalis*, *longissimus dorsi*, &c.

There seems to be, however, nothing in the arrangement of such muscles as would satisfactorily account for a voluntary shortening and elongation, or rather, restoration to the normal length; of the vertebral column, though it is possible that in some individual cases there may be some special endowment of innervation and co-ordination of muscle which permits of such action,

* Philippus Pieper, in an inaugural thesis, "De Viribus Corporis Human Mechanicis," Berolini, 1821, states, with regard to the elasticity of the vertebral column (p. 5), that in a man of middle height who had been carrying weights the difference at the end of the day was only 11‴. In the last edition of Druitt's "Surgeon's Vade-Mecum" it is stated (p. 341) that "the intervertebral substance is compressible to such an extent that an adult man of middle stature loses about an inch of his height after having been in the erect position during the day. Since the united thickness of the intervertebral substances in an adult man is about 3·875 inches we see that they lose nearly one-fourth by compression, which they do not recover till after some hours of rest." Among works which I have consulted in vain upon this point are, Borelli, "De Motu Animalium," and "De Vi Percussionis" (Lugdun. Batav. 1686), Giraud-Teulon's "Principes de Mécanique Animale" (Paris, 1858); Henle's "Bänderlehe;" and the "Traité de la Mécanique des Organes de la Locomotion," by G. and E. Weber, in tom. ii. of the "Encyclopédie Anatomique." W. and E. Weber's "Mechanik der Menschlichen Gewerkzeuge" (Göttingen, 1836), is unfortunately in none of the large libraries to which I have access.

just as it might permit of the wagging of the ears, or of the scalp movements, which may be occasionally witnessed in those gifted with such accomplishments.

It is in the hope, then, that some one who has studied anatomy from a mechanical stand-point may throw some light upon this somewhat obscure matter, that I have asked a question which, I trust, my be one not unworthy of the consideration of "philosophical" anatomists.

New University Club, Oct. 16 J. C. G.

Magnetic Storm Oct. 14—18

On the 14th of this month a magnetic storm commenced at 10.20 P.M., and lasted until 11 P.M. of the 18th. It was as remarkable for the extent as for the duration of the disturbances. The only lull in the storm was during the afternoon of the 16th.

The general character of the perturbations was the same throughout, consisting mostly of long movements of the needle to and fro on either side of the mean position. There was a very striking coincidence between the curves of the 15th, 16th, 17th, and 18th during the morning hours, the maximum westerly deviation having been attained at about 6 A.M. on each successive day. During the afternoon of the 17th, the greatest movement of the declination needle towards the west was equal to that of the previous morning, whilst the oscillations towards the north were greater than on the other days of the storm. The movements of the vertical-force magnet were frequently too great to be recorded on the photographic paper, and this magnet was several times thrown off its balance. The horizontal-force magnet was more violently disturbed at the very commencement of the storm than at any subsequent period.

The remarkable coincidences that are now being discovered between these magnetic disturbances and other important natural phenomena render it useful to draw attention to those changes in the magnetic force of the earth which present any feature particularly worthy of notice. The storm I am now referring to is on several accounts the most important that has occurred since 1867, and it is to be hoped that some practical spectroscopist has had favourable weather during these few days, as a magnificent array of solar prominences may not improbably have rewarded his interesting labours.

Stonyhurst Observatory, Oct. 23 S. J. Perry

Circular Rainbow

Being, in company with a friend, Mr. Hall, on the east peak of the Berceau (3,640 ft.) on the 25th inst., a circular rainbow was visible at 2.30 P.M. upon the upper surface of light white clouds that drifted from S. up the rocky valley which was E. of where we stood—though the true wind was W. and moderate. The sky was almost of the richly dark Italian blue, across which a few clouds (cirrus) slowly passed.

When first seen the diameter of the outside of the circle was 10°, but it increased gradually up to 15°. The colours of the "bow," which was somewhat less than 1° in width,—were the same as in the common rainbow, and very vivid. When we were a few yards apart, each saw only his own figure within the circle, large and well defined, so that the movement of an arm became visible. Before long the shadow of the mountain on which we stood invaded the lower portion of the circle, depriving it of its colour, but not always destroying its continuity;—and my figure remained complete even where the continuity was destroyed. Light clouds passed across the sun, causing a partial, rarely a complete, disappearance of this most beautiful phenomenon, which we watched with great interest for twenty-six minutes—how long it had existed before 2.30 I know not.

M. Moggridge

Earth Currents and Sun-spots

In the last number of Nature there appears a letter from Mr. W. H. Preece respecting the recent occurrence of electric storms of considerable intensity; and in connection with this interesting subject it may be worth while relating that the solar spots have lately (that is to say, during the last few weeks) been larger than usual. One of them attained great proportions, and was distinctly visible to the unassisted eye (on October 15) through a fog which partially obscured the sun's intense light. On the date mentioned this spot had completed about one-half of its transit across the solar disc, and it is remarkable that on the same day the electric storms attained their maximum, and "the interruptions to business were serious," as remarked by your correspondent. The spot referred to was not so large as several which appeared during the two preceding years, but exceeded in magnitude any of those which have come under my observation during the present year. It disappeared from the sun's western edge on about the 21st of October; but just previously to this the spot had been considerably smaller, and showed indications of dissolution. The spots now visible on the solar surface are not very conspicuous; there are, however, two visible of the larger class—one of these is situated in the north-east quadrant, and the other in the south-east quadrant, and they are situate at about the same distances from the limb. Between these spots there were yesterday two small ones perceptible running parallel with the equator.

Bristol, Oct. 28 William F. Denning

Measurement of Faint Spectra

May I suggest, as a supplement to Mr. Capron's clever arrangement for spectral measurement, a method which I have found useful with faint spectra. It is that a part of the slit should remain fixed, while the upper or lower half, or the middle only, should be movable. In this way two images of the spectrum are formed, one of which may be made to move over the other like a vernier; and thus any line may serve as an index, when, from want of light, it would be impossible to see the brass points. We obtain in this way many of the advantages of Zöllner's reversion spectroscope.

With such an arrangement, and with an embossing edge attached by a spring to the movable slit, so as to register on a card when pressed, I have succeeded in making several tolerable measurements of the faint auroral bands, which it was difficult to perform by direct comparison. It is, of course, necessary to have at least one line of known position in the field.

North Shields, Oct. 22 Henry R. Procter

Merrifield on the Deviation of the Compass

Will you kindly pardon my again troubling you with an explanation?

Last week, seeing what I considered a harsh review of my little book, in Nature for Oct. 17, I, in the midst of my work and the heat of the moment, penned a reply to my reviewer, without thinking more of the matter. To-day, whilst giving a lesson on the subject to a pupil, I saw my error; and I beg to plead guilty to that "looseness" which has led to inaccuracy in the passage quoted from page 52. Instead of "deviation" I meant, and should therefore have said, "Vertical iron shows the same indirect magnetic force," &c., and to my class I have always used these words. I now tender my apology to my reviewer for my hasty letter, and beg to thank him for pointing out this "looseness and inaccuracy." I trust you will make this letter as public as my last. John Merrifield

Navigation School, Plymouth, Oct. 26

Rainfall in Bombay

As it may interest some of the readers of Nature to know the amount of rain which fell on one occasion during the heavy monsoon rains which recently occurred at Bombay, and which I regret to see in your Notes had so disastrous an effect upon the library of the Asiatic Society, I quote the following from a letter which I have just received from my friend Mr. C. Chambers, F.R.S., Director of the Colaba Observatory, dated 10th Sept., 1872.

"Just a week ago we were treated to 7·20 inches of rain in two hours, which is nearly twice as heavy as I have known before, *i.e.*, had personal experience of."

In order that we may form some idea of the enormous amount of the downpour, we must imagine the whole rain which has fallen in this neighbourhood since June 8, to have been concentrated in the time named; or, perhaps, better still, to suppose that the heaviest part of the shower which fell about half-past twelve, on the 3rd inst., and lasted for seven minutes, had continued for two hours.

Mr. Chambers was some time ago much troubled by the presence of foreign matter, apparently dust, in the interior of his magnetic instruments. He now writes:—"In NATURE, vol. vi. p. 286, Fig. 2, is a thing very like the organic functions I speak of as being seen on the knife edge and plane of the vertical force magnetograph. I have described it as looking like the 'interlacing tea leaf stalks,' doubtless it was beginnings of life."

Can any of your readers state if it is probable that such objects are to be found in the place he names.

Kew Observatory, Oct. 23 G. MATHUS WHIPPLE

THE APPEAL FOR SKELETONS OF WILD ANIMALS

I AM glad to see that Mr. Moseley has started the question of the acquisition of skeletons of wild animals, a subject which has hitherto been too much neglected by those who have charge of museums. Mr. Moseley might have put his case more strongly than he has done; for not only are the two museums he mentions destitute of skeletons of the wild specimens of the larger *Felidæ*, but, so far as I know, no European museum possesses more than skulls. Possibly there may be an entire skeleton in the very rich museum of Leyden, but there are none in the British Museum, nor at Paris, nor Vienna, so far as I have been able to examine those collections. We are better off at Cambridge, for we not only have a considerable series of skulls of tigers, leopards, and the so-called "maneless" lion of Guzerat, but a fine skeleton of a Puma (*Felis concolor*) sent home from Florida in excellent condition by one of that much-abused class, "sportsmen."

There is, however, a subject even more important than the acquisition of foreign animals, namely, the collection of a good series of skeletons of different ages and sexes of all the European mammals. This is no easy matter, even in the case of the commoner species. We have only lately succeeded in acquiring an adult skeleton of the Red Deer (*Cervus elaphus*); but the one we have obtained (through the kindness of Mr. Balfour, of Trinity College) is an adult Royal stag, so fine as to be worth waiting any length of time for. Again, how many museums possess a skeleton of the brown bear of Europe, or the lynx, or the glutton, or the wolf, or even really good skeletons of such comparatively common animals as the badger, the otter, and the numerous small *Viverridæ*? And yet the bones of these occur more frequently in turbaries than do those of the extinct *Felidæ* in caves, while they are certain to become extinct from the pressure of civilisation and the consequent restriction of their range, far sooner even than those large animals which are directly persecuted, as tigers are in India.

I find it easier almost to get skeletons sent from abroad than to have them collected in England. Any gentleman who unites with love of sport a knowledge of natural history—no uncommon combination—will often send home considerable collections, and take great trouble to procure the different animals that he has been asked to look for. Such a collection we have just received from Lord Walsingham (of Trinity College), formed by him in North-west America. It includes complete skeletons of *Ovis montana*, *Antilocapra americana* (Pronghorn), white-tailed stag, mule deer, black bear, beaver, martin, besides a series of separate skulls. Last year we got an *Otaria* from San Francisco, one of the herd which the intelligent citizens of that capital are wise enough to preserve, and a musk-ox from the German North-Polar Expedition. In short, there are few animals that may not be acquired by energy and perseverance; and travellers in distant countries are fond of showing that they have not forgotten their old university; but it is infinitely more difficult to induce gentlemen, or their keepers, in England or Scotland, to collect the wild animals that still linger in their preserves; and this is the direction in which I venture to think an effort should be made.

The "directions for preparing skeletons" given by Mr. Moseley are excellent. Allow me to make one or two additions to them. It is most important to note the sex of each animal, with the locality in which it was taken and the date of its capture. I do not recommend the soaking of the carcase in water after the muscles have been removed. It loosens the ligaments, and makes the after-process of drying more difficult—a process which is difficult enough in Europe, especially in mountainous districts. Moreover, it is difficult to find a suitable place to do it in abroad. I find the colour of the bones not seriously affected by the non-extraction of the blood. The skeleton may be packed up before it is quite dry if sawdust be substituted for hay or straw. Pine sawdust is especially good for this purpose. It is very fine, dry, and slightly antiseptic.

Museum, Cambridge, Oct. 24 J. W. CLARK

THE ZOOLOGICAL STATION AT NAPLES

SINCE the last notice given in NATURE,* the building is almost finished, and all endeavours are now concentrated upon the arrangements of the interior. Two more months, and the fifty-three tanks of the public aquarium will be ready to be filled with the clear and limpid water of the Mediterranean.

The upper story receives still more attention. My plan of letting the tables having met with great applause from all sides, has worked some changes in the general arrangements of the rooms. The room previously intended for the library has been added to the great laboratory, which now measures 40 ft. in length, 25 ft. in breadth, and 24 ft. in height. It has three great arched windows 20 ft. high and 10 ft. broad, to the north, and three smaller ones looking into the small light-court in the centre of the building. The former three windows will give light to six microscopic tables, whilst the three smaller windows will yield enough light to three tables fitted up for common anatomical work. In the centre of the laboratory a wooden stand will be placed, 27 ft. in length and 8 ft. in breadth, and having three stories. This stand will bear tanks of different sizes—the lowest story the heaviest, the upper the smallest. The latter will be moveable, so as to allow close inspection on the working table. Each of them will receive a small current of sea water, and will have its own outlet, so as to isolate completely its contents from the neighbouring tanks. There will be plenty of room for some sixty or eighty tanks. The water running out of them is collected, and runs down into the tanks of the public aquarium. Four doors unite the laboratory to the three adjacent smaller rooms, which are provided each with a working table and with tanks, whilst the fourth door leads to a corridor and to the staircase. A gallery all round the walls of the laboratory, at the height of fourteen feet, will furnish room for the library. Two small staircases unite it to the floor of the laboratory, and four narrow doors to four adjacent small rooms, of which two may be used as reading-rooms for making notes, &c. It will be absolutely forbidden to take any book out of the building.

On the same floor as this great morphological laboratory, the physiological one is to be found; indeed the door which opens to the corridor leads also immediately to the room destined for this purpose. Its length is 20 ft. by 14 ft.; it has several glass doors to the west, opening upon an ante-room as wide as the room itself, and which, in case of need, can easily be transformed into a laboratory, thus enlarging the physiological laboratory to double its present size; it has a separate tube, with a constant supply of sea-water, and a table for microscopic work. Prof. du Bois-Reymond has promised to assist in arranging instruments and apparatus for experimental use.

* See NATURE, Vol. v. p. 437.

Besides these laboratories, there are rooms with windows and glass doors, all capable of being transformed, when necessary, into laboratories, for every room has its tube with sea-water. But as it is most likely that by-and-by extensive collections will be formed, to assist in working out a most accurate and detailed fauna of the Bay, or even of the Tuscan Sea, these rooms, especially a large one on the south side, will at first be left empty.

Downstairs there is another small apartment on the north side, destined for a botanical laboratory. It has one large and two smaller windows, thus allowing four microscopical tables to be furnished, three of which will be let, whilst the fourth belongs to the botanist of the station, who is to be engaged next winter. In the basement two series of store-tanks will be placed, into which all the animals will be put immediately after being caught by the fishing and dredging expeditions, which will be sent out every day, weather permitting.

The library of the station has received many valuable presents. Thus Prof. Allman, Mr. Darwin, Prof. Flower, Mr. Gosse, Prof. Huxley, Mr. Gwyn Jeffreys, Sir John Lubbock, and Prof. Owen, have promised or sent their biological works; and German publishers, such as Georg Reimer of Berlin, and Braumüller of Vienna, have joined Engelmann, Vieweg, and Fischer, in offering all their biological publications. A catalogue is being prepared, containing a complete list of the actual state of the station library.

By the kindness of Mr. Gwyn Jeffreys, dredges have been procured of the best pattern, such as that experienced zoologist recommended; boats have been built for special dredging purposes, and everything also is being prepared to render the station as efficient as possible.

We hope in our next article to give some information as to the relations, into which the new institute has entered with governments and learned bodies. Here we may still be allowed to point out, that since the foundation of the Naples station has been taken earnestly into hand, similar endeavours have been made both in Austria and France. In both countries the Government has been asked to establish Zoological Laboratories on the coast. We have still to wait the results of such demands.

Naples, Oct. 24 ANTON DOHRN

VESTIGES OF GLACIAL ACTION IN NORTH-EASTERN ANATOLIA

IN a paper dated some months back* I gave an abridged notice of some traces of ice-action, referable to the so-called epoch, in the central plateau of Asia-Minor. A journey undertaken this summer through the north-eastern districts of the peninsula has enabled me to observe several other phenomena of the same class, and to determine in some measure the extent and degree in which that prolonged depression of temperature affected this region.

My route traversed an extensive but rarely visited tract of country, that, namely, of the great Chorok, or Harpagus river-valley from Beyboort to Artween, and the mountain lands that extend beyond that valley east and north up to the frontier of Russian Georgia, returning by the Black Sea coast. The space thus explored extends from long. 40° to 44° E., and from lat. 40° to 42° N.

The valley of the Chorok river, for a distance of about 120 miles—that is, from the neighbourhood of Beyboort to that of the town of Artween—runs almost parallel with the sea-coast in an E.N.E. direction, and is separated from the basin of the Euxine by a lofty chain of mountains, the higher peaks of which reach an altitude of 11,000 feet above the sea-level, and even more. The whole long and narrow strip of land bears the name of Lazistan, or country of the Lazes, a Mingrelian tribe, mentioned by Strabo as tenanting the same region in his time.

* See NATURE, vol. v. p. 444

Near Artween, long. 42,° the valley turns sharp to the north, and finds its way through a narrow and precipitous cleft to the sea.

The southern side is determined by the highlands which form the watershed between the tributaries of the Black Sea and those of the Persian Gulf; but farther east the same range, deflecting somewhat to the north, unites with the prolongation of the Lazistan mountains, and acts as watershed not only to the already-mentioned streams, but also to those of the Caspian, which it separates from the two other fluvial systems. Farther on the Russo-Georgian frontier follows its eastern slope.

Returning to the Chorok valley—one might almost call it trench—I may as well notice that its height above sea-level at Beyboort is about 5,000 feet, and at Artween only 1,000 feet, whence the extreme rapidity of the river, suitably named the Harpagus, may be inferred. The geological character of the mountain chains on either side is extremely varied. Cretaceous and Jurassic strata have in both been extensively superimposed on the plutonic rocks that frequently pierce through and form the higher ranges; volcanic formations, less ordinary in the southern chain, are of frequent recurrence in the northern. Indeed the Lazistan mountains, where they dip into the sea, are almost wholly volcanic in structure. Large tracts of a metamorphic character also occur, but more on the northern than on the southern side.

Roads, in a European sense of the word, throughout all these districts, there are none; even a tolerable horse-track is only an occasional luxury. Hence my entire tour was performed partly on horseback at walking pace, partly on foot; so that I had full opportunity for the most leisurely observation. My route first followed the southern side of the Chorok valley for about seventy miles, then the northern for about fifty more, after which I traversed the eastern highlands to the Russian frontier, a distance of about 160 miles, then turned north till I reached the Black Sea coast, along which I returned.

And having now given these summary indications, which the nature of the country, scarcely ever visited by Europeans, and in general very little known, seemed to make necessary, I will now proceed to the account of the principal phenomena referable to the glacial period.

While travelling at an altitude varying from 3,000 to 7,600 feet according to the exigencies of the route along the southern side of the valley—that is, on the northern slope of the Euphrates watershed—I crossed three large moraines, two of them descending from the slopes of Charmeli Dagh, a lofty granite ridge, streaked with snow all through the year. Their lower extremity was at about 5,000 feet above sea-level, their upper origin attaining nearly 8,000 feet. The mountain sides here are Jurassic or limestone; but the broad streams of angular blocks that follow their depressions were almost exclusively granite of the same kind as that which forms the mountain wall above. Where, however, the general altitude of the chain does not exceed 7,000 feet, as is occasionally the case, no moraines are to be observed, though large angular boulders are not uncommon on the broad ledges. The upper mountain lines are invariably rounded, and, as it were, smoothed off; the sides marked with scooped depressions much too wide for their depth to be attributable to torrent action; low down in the valley the slopes terminate in rifted precipices.

That the epoch to which these moraines belong was posterior to that of the volcanic action which, though long since extinct at the surface, has left so many traces along the north-eastern coast of Asia-Minor, was rendered in one instance sufficiently evident by the constituents of a broad stone-ridge which I crossed near the highest point of the mountain chain, a little to the east of Erzeroom.

Here, at an elevation reaching to upwards of 7,000 feet, the ordinary Jurassic strata were interrupted by a volcanic outbreak of several miles in extent, like a huge patch of black lava and scoriæ extending far up the mountain side, where traces of a large crater were still observable. Above, to a height of full 9,000 feet, towered the granite peaks, and here, reaching down towards the valley, a wide moraine traversed the road. It was mainly composed of volcanic fragments, though mixed with blocks of granite; and must consequently have been formed at a time when the volcano had not only existed, but had also ceased its action.

To assure myself of the true character of the phenomenon, I quitted the path and rode up and along the stone-stream to a considerable distance, till in fact my horse could no longer make his footing sure; and I had fully convinced myself that the moraine was the result of glacial action alone, not of torrents or weather action referable to more recent times.

Not far on I had to traverse the pass called Keskeem Boughaz, or, the entrance of Keskeem; this latter being the name given to the district on either side of the lower Chorok valley. The road here reaches an altitude of 8,200 feet; yet is far overtopped by the granite range of Tortoom, even now streaked with perpetual snow, to the south. Here again I observed a large moraine, winding down from the upper ridge; while the first plateau of Keskeem, about 7,400 feet above sea-level, into which I next descended, was strewn capriciously with large granite boulders, many ten or more feet in diameter. Another volcanic tract succeeds, where the path winds along a valley hemmed in by gigantic cliffs of black lava, dashed with blood-red porphyritic stains. From this point my track followed a level too low to permit of expecting or of finding any further glacial traces in this region.

Summing up the observations made during this stage of my journey, I come to the conclusion that the ice-cap of the north-easterly Anatolian watershed, in post-pliocene times, must have reached downwards, on the northern side of the range at least, to about 7,000 feet above the present sea level; while some of the glaciers issuing from it descended to about 4,500 feet of the same measurement. In what degree the sea-level of the entire eastern portion of the peninsula has changed—it would seem since the epoch referred to—I shall speak further on.

Two phenomena only remain to be noticed; - one, the absence of all organic traces, whether marine or otherwise, in these rocks and strata; an absence which I have heard remarked on by the few natives capable of observing these things; another, the frequent presence, in the moraine or glacial belt, of scratched and striated rocks, especially granite.

Crossing the river, now at its shallowest in the summer season, but still containing, at a distance of a hundred miles from its mouth, as large a body of water as the Thames during high tide at Richmond bridge, my path led to Artween, the chief village-centre of these regions, along the north-western side of the valley; that is, along the inner slope of the coast range. These Lazistan mountains form a very lofty, but comparatively narrow ridge, of great steepness, and ill adapted to the formation of glaciers; and besides they must have been, even in the glacial epoch, exposed to the comparatively mild atmosphere of the great sea, now represented by the Black Sea and the Caspian only, but which then covered so large a portion of what is now Russia.

Here, however, I again found evident traces of the same cold period, but written in different characters. Not moraines indeed, nor the other analogous appearances indicated in the more inland district, but signs of alternating snows and thaws, of weather-change and water-action on a scale much vaster than is possible in the existing condition of climate, even were the most rigorous winter, such as now is, to be succeeded by the warmest summer. Wide and deep clefts, the work of torrents, yet flowing, but dwindled to comparative insignificance; great sweeps of shattered rock fragments down slopes inaccessible from their steepness, due to frosts of a severity unknown at this day, followed by corresponding thaw; and every mark of climatic disintegration, much beyond, though in kind similar to, that which these crags now undergo. And lastly the water level of the Chorok itself, judging by the eroded shelves and like indications left here and there in the cliffs along its shores, must have been from fifteen to twenty feet above its actual level; a circumstance which can scarcely be attributed to other causes than the melting of great supplies of ice and snow; since there is no reason whatever to suppose that any considerable diminution in the forest growth around has taken place from the earliest to the present times.

That there really was such a difference between the glacial conditions of the Lazistan, or coast mountains, and those of the inland watershed in the epoch alluded to, is in a measure confirmed by their actual state. For though the Lazistan peaks considerably surpass in height those of the southern chain, being some of them above 11,000 feet in elevation, whereas the others average from 9,000 to 10,000 only, yet snow lies all summer through on the latter, much more abundantly than on the former; while on the other hand the annual quantity of rain and snow that in the winter months of the year fails on the Lazistan mountains is at least the double of what is apportioned to the southern or Armenian chain. A depression of 15° to 20° centigrade in the average temperature of the year, would now to a certainty cover the latter with glaciers, while it would furrow the former with torrents of the first magnitude.

Leaving the Chorook valley, my road—or track, to speak more properly, for road in our sense of the word there was none—led north-east up to the great water-shed already often mentioned, and which here, turning northwards also, separates from each other not the Black Sea and Persian Gulf river systems only, but a third also, that of the Caspian. For about forty miles my journey, though passing through a district abounding in other geological phenomena of great interest, yet supplied me with none of the class to which these notes specially refer, for the reason that it lay wholly along valleys and through ravines often below 4,000 feet in sea elevation, and never exceeding that height. But at the Karanlik Dagh, or Mountain of Darkness, so called either from the black and dense fir forests that clothe its sides, or from the thick mists that hang for months along its middle slopes, and at a point as nearly as possible opposite the extreme north-eastern angle of the Black Sea, here about fifty miles distant in a direct line, I began at last the ascent of the main ridge, the backbone of the land. While slowly climbing the limestone ledges of the mountain, and at the height of 6,400 feet, I here once more found athwart my way a colossal moraine, formed of worn granite blocks and partly overgrown with forest, descending from an overtopping height, which I afterwards ascertained to be about 8,000 feet. But before we reached it I traversed an intervening ledge, 7,300 feet above the sea, composed of granite rocks, worn and marked with unequivocal ice action, though now wholly bare of snow. A valley divided this ridge from the highest of all, that called Penek, up which a difficult track, called the "Egri Yokoosh" or "crooked ascent"—and it well deserved its name—brought us at last, landing us on a cold, undulating granite plateau of 9,000 to 9,500 feet in elevation. Here and there its depressions were scooped out into deep little oval lakes, full all summer through of clear blue water, and looking the very memorials of vanished ice; while the gently sloping sides of the plateau itself were strewn with boulders of every size and shape, but all granite, seemingly brought there from the higher peaks of the Penek chain, about five miles off. Nor did these boulders cease to occur, sometimes in greater abundance, sometimes less, till we reached the great basin of Ardahan, near the sources of the Kur, or Cyrus river, here a slender stream, on its way to join the Araxes, and enter with it the Caspian Sea.

The height of the Ardahan plain is 6,500 feet; it is, but for a very gentle easterly slope, an absolute water-like level; the bottom of this lake basin, for such it certainly was, consists of deep alluvial soil, mixed with detritus and large boulders; the sides are all rounded and smoothed off in gentle slopes, and bear every mark of having been long ice-covered. They are of various altitudes, but all alike. I climbed one of the lateral plateaus, at the north-eastern corner of the plain, till I had reached 2,000 feet above the Kur stream; boulders everywhere.

These plateaus stretch east to the Russo-Georgian frontier, about twenty-five miles distant. They contain many notable lakes, some of which I visited; that called Childer, in particular, is about ten miles in extreme length by eight in breadth. Its surface is 6,700 feet above the sea, and it is encased in mounded hills, like those already described. The natives declare its depth to be unfathomable, and, somewhat inconsistently, affirm that a submerged city exists below. But a clever Beg, or Chief of the neighbourhood, a friend of mine, had the curiosity to sail across it in every direction, sounding the bottom, and assured me that its greatest depth, near the northern extremity, did not exceed twenty-two fathoms, while he added, laughing, that of the buried city his line had discovered for him no trace. Karzach lake, not far off, a square-shaped sheet of water about four miles in extent each way, seems to be stilll shallower; while Teh Lake, as it is called, close by which my road passed, is now a mere marsh, though of considerable dimensions. Like the other two it has left, however, on its banks the marks of having been once much deeper and wider than at present. The plateau on which these lakes are situated continues, with alternate elevations and depressions, but always bearing the features already described, for about thirty miles to the north, till, having reached its greatest altitude in Kel Dagh, a mountain about 11,000 feet high, it begins to descend step by step to the plains of Georgia and the Black Sea. From this point its whole character changes, rifts, abrupt precipices, and narrow gorges taking the place of the rounded undulating outlines it bore farther inland. Nor is any further trace of boulders or moraines to be seen, at least below an elevation of nearly 8,000 feet.

It is to be remarked that this entire range, like the central Anatolian watershed, is almost uniform in its geological composition; Jurassic on its lower slopes; granite above. One only exception here occurs, and that is along the deep and rapidly descending chasm through which the torrent Kur finds its way; a chasm traversing the plateau in its greater width, from the basin of Ardahan to the Russian frontier. Its sides, and the rock in its neighbourhood to, in some places, a considerable extent, are volcanic.

My return route, from the Russian frontier near the well-known river Phasis, now the Rion, to Trebizond, lay along the coast; thus affording me excellent opportunities for studying on the northern or sea-side the same Lazistan mountain-chain, which I had already, in some measure, examined on its mainland or inner slope. Rarely stratified, its formations are most often volcanic, or metamorphic, gneiss and shale, with granite above. But if the inner and sheltered side had shown, as I have already noticed, no direct trace of glacial action, still less could I expect to discover any such on the outer or sea slope. However this generalisation was interrupted by one remarkable exception.

High up in the Lazistan mountains, about half way between Trebizond and Batoom, is perched the almost inaccessible district of Hamshun, a highland region tenanted by a colony of wholly different origin from the Mingrelian population around them, namely Armenian, though now all professing, not over-zealously, the Mahometan system. How or when they came there, no record tells. This district I resolved to visit; and three days of such breakneck scramble as even Turkish mountain-tracks had never before afforded me, brought me into the very centre of Hamshun.

Here, at the modest height of 6,900 feet above the sea, I stood on a granite-strewn plateau, thinly green with grass, sheltered from the sea by a tolerably lofty series ot peaks on the N.W.; and backed to the S.E. by the tremendous jagged cliffs, blackish granite dashed with white snow streaks, else naked in all their savageness, but known by the uncouth names of Onoot Dagh, Alti Parmak Dagh, Jamookh Dagh; and, towering over all in startling resemblance to the Alpine Matterhorn, only more fantastic if possible, in its precipitous isolation of peak, Verehembek Dagh, rising full 12,500 feet above the sea, from which it is visible at a distance of about a hundred miles; a natural and unmistakeable beacon to the sailor. The plateau itself was about forty miles in length; and irregular in breadth; its surface too mounded, and often jotted over with boulders. But just as my track led near under the base of Verehembek, at an altitude of 8,300 feet, it crossed a large broad moraine, descending from the higher slope, and having its base in a broad bare valley not far below; thus indicating that here too, at the highest and widest part of the Lazistan chain, perpetual ice had once existed in sufficient quantity to furnish at least one glacier. But, if warrantable conclusions can be drawn from a single instance, the limited ice-cap of the Hamshun highlands extended no farther down than 8,500 feet at most, perhaps 9,000; thus differing by a line of one to two thousand feet from the glacial covering of the inland range.

What correctness there may be in this as in my other conjectures, I, of course, cannot well estimate: but I have now recorded the chief phenomena of this nature noted by me in these regions; it is for those more versed in such matters than myself to read their meaning aright.

Of the volcanic phenomena in the Lazistan or coast-chain, I shall say nothing here; that subject requiring, from its very copiousness, to be treated apart. But there is one fact connected with it worth noticing, as a corollary to what I have written; though a mere notice is all that can be given it for the present. It is, the elevation or depression of the south-east of the Black Sea coast.

In a former paper I remember having remarked that, judging by the actual position of an old river bar, as also by the height of certain cavernous excavations in the neighbouring cliffs, I am inclined to think that the coast near Trebizond itself has been raised to an elevation of about twelve, perhaps fifteen feet in post-glacial times. Having now ridden along the entire shore up to the mouth of the Phasis, I remark that the traces of similar uprising during, certainly not earlier than, the same period, as written on cliffs now a considerable way inland, on estuaries evidently prolonged, and on crags, still as before, coming sheer down into the sea, but wave-marked higher up than the possibility of the most violent storm could now effect; all these would seem to indicate that the same rising has been continued along the entire easterly line of coast, though not to an equal degree; the greatest elevation appearing to have taken place exactly at the south-eastern angle of the Euxine, near Batoom, from which point east and north it would gradually have diminished. West of Trebizond again it distinctly,—if traces of the kind mentioned be not misleading,—diminishes; till at, and to some distance west of Cape Jason it not only ceases, but is exchanged for a depression of the coast several feet, eight or ten seemingly, below its former level. Farther west again a slight rise would appear to have taken place; but allowance must be made for the effects of currents, which are very strong all along the coast.

Trebizond, Oct. 3 W. GIFFORD PALGRAVE

THE SOURCE OF SOLAR ENERGY

ALL incandescent bodies shrink rapidly if permitted to radiate freely, the rate being nearly proportional to the degree of incandescence. The enormous temperature maintained at the surface of the sun must therefore produce rapid shrinking, although we do not know the rate by actual observation. We know, however, what amount of mechanical energy the sun parts with in a given time, and we know the size and the specific gravity of the solar mass.

Demonstration is not needed to prove that motion of the particles within a spherical body towards the centre caused by attraction, develops a certain amount of mechanical energy resulting in the generation of heat within the mass. Nor is it necessary to show that the fixed relation between heat and energy enables us to determine the extent of contraction produced by gravitation, during cooling, if we can ascertain the amount of heat radiated in a given time by a sphere of known size and specific gravity. With reference to the sun, the elements thus specified are of the following magnitudes:—Heat radiated per minute, 312,000 thermal units from one square foot of surface; diameter, 852,584 miles; specific gravity, 0·250 compared

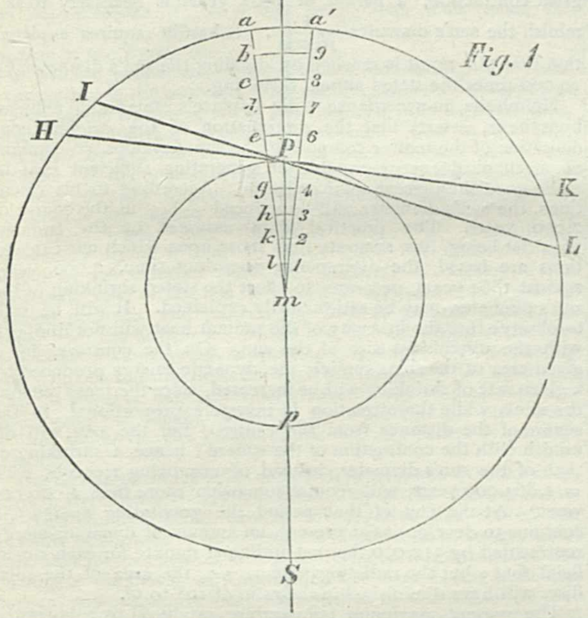


Fig. 1

to that of the earth, or $5·50 \times 0·250 = 1·37$ of water. Hence assuming that the mass is homogeneous, the weight of one cubic foot of the matter composing the sun will be $62·5 \times 1·37 = 85·6$ pounds. It will be seen presently that, in case the sun's mass is not homogeneous, the want of homogeneity will not materially affect the question of attraction and the resulting energy. At first sight it would appear that no probable amount of contraction of the sun could develop by gravitation towards the centre an amount of dynamic energy of $312{,}000 \times 772 = 240,864{,}000$ foot-pounds per *minute* for each square foot of the solar surface. Yet, so vast is the mass contained in a spherical pyramid, the base of which is one square foot and whose length is equal to the sun's radius, that a very small longitudinal contraction suffices to develop by gravitation towards the sun's centre the stated enormous dynamic energy. It will be readily understood that the energy developed by the shrinking of a spherical pyramid, the sides of which are sectors of the great circle of the sun, will represent accurately the energy produced by the shrinking of the entire mass. And, in view of the great dimensions of the sun and the formidable array of figures involved in the computation of the energy exerted within the entire sphere, the advantage of considering only the mass covered by a single square foot of the solar surface will be evident. Let *IKS*, Fig. 1, represent the great circle of the sun, *a m a′* the spherical pyramid referred to, and Fig. 2 the said pyramid drawn to a larger scale, its axis being divided into ten equal parts. It is proposed to ascertain what extent of longitudinal contraction of the spherical pyramid *a m a′* is necessary to produce an amount of dynamic energy corresponding with that developed by the radiation from one square foot of the solar surface in a given time. The investigation will be somewhat facilitated if we compute the amount of energy developed by a definite contraction of the sun's radius, say one foot. Let us therefore suppose that *a a′*, the distance of which is $\frac{852{,}584}{2} \times 5{,}280 = 2{,}250{,}821{,}760$

Fig. 2

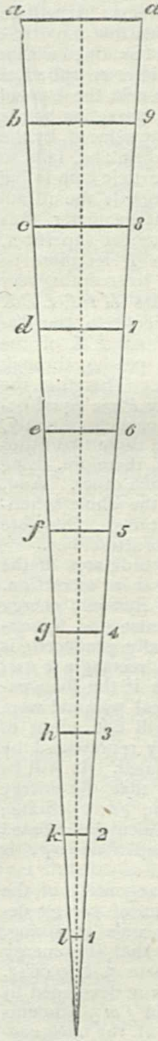
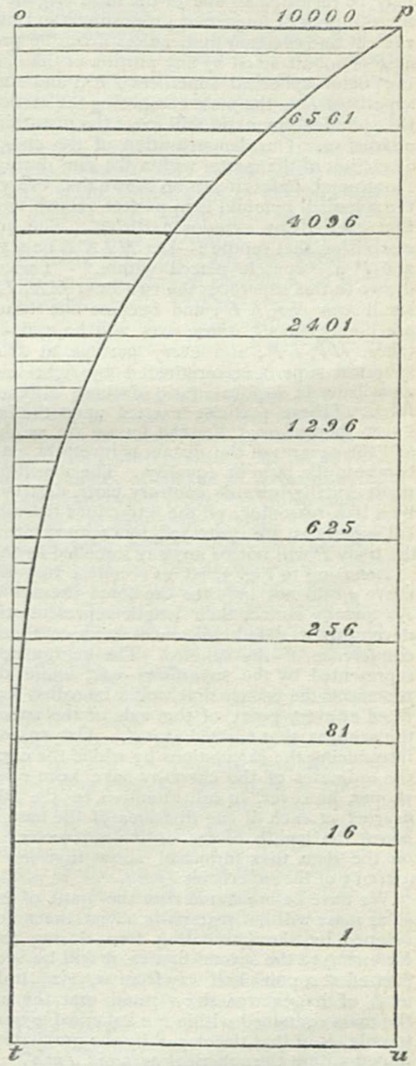


Fig. 3



feet from *m*, has fallen through a space of one foot, the intermediate points *b*, *c*, *d*, &c., participating proportionably in the fall. Assuming that the solar mass remains homogeneous during the contraction, it follows from Newton's demonstration ("Principia," lib. i. prop. lxxiii.) that since a particle just within the circumference of the sphere at *a* is ten times farther from the centre *m* than a particle at *l*, the former will be attracted towards *m* with ten times greater force than the latter. It will be readily perceived that, for a given movement towards the centre, the quantity of matter put in motion at *a* will be greater than at *l*, in the ratio of the squares of *a a′* and *l* 1, or 100 : 1. Hence, in accordance with the demonstration referred to, a given radial depth of the solar mass at *a* will exert a force towards *m*

$10 \times 100 = 1,000$ times greater than an equal radial depth at *l*. But, in computing the dynamic energy developed by the shrinking of the sun, it must be borne in mind that a particle at *a* falls through a distance ten times greater than a particle at *l*. The length of the ordinates of the curve *p t*, Fig. 3, representing the ratio of dynamic energy developed at the respective distances from the sun's centre, has been calculated accordingly. A cursory examination of Fig. 2 can scarcely fail to lead to the conclusion that the mass composing the smaller sections of the spherical pyramid towards the centre of the sphere, will be attracted by the larger mass composing the sections towards the circumference. Newton has disposed of this question by a geometrical demonstration which, considering the form of the attracting mass, and the extreme complication arising from the varying direction and unequal magnitude of the attracting forces, may be regarded as one of the most elegant of his masterly demonstrations of important propositions and theorems. It will be evident on reflection that, unless it can be proved that a particle at *P* is not attracted by any portion of the mass contained within the outer spherical superfices *I K S* and the interior spherical superfices *P p*, the mass composing the sections near the base of the spherical pyramid will exert the disturbing attraction before alluded to. Our demonstration of the energy produced by the attraction of the matter within the sun, during shrinking, falls to the ground, unless it can be shown that every particle composing the spherical pyramid is in perfect repose as regards the attraction exerted by exterior particles. The great geometer thus establishes that repose :—Let *H I K L* be a spherical superfices, and *P* a corpuscle placed within.* Through *P* let there be drawn to this superfices the two lines *H K, I L*, intercepting very small arcs *H I, K L*; and because the triangles *H P I, L P K* are homogeneous, those arcs will be proportional to the distances *H P, L P*; and every particle at *H I* and *K L* of the spherical superfices, terminated by right lines passing through *P*, will be in duplicate ratio of those distances. Therefore the forces of these particles exerted upon the body *P* are equal between themselves. For the forces are as the particles directly, and the squares of the distances inversely. And these two ratios compose the ratio of equality. The attractions, therefore, being made equally towards contrary parts, destroy each other. And, by a like reasoning, all the attractions through the whole spherical superfices are destroyed by contrary attractions. Therefore the body *P* will not be anyway impelled by those attractions.

Referring to Fig. 3, let us recollect that the ordinates of the curve *p t* do not indicate the force exerted by mere attraction. As already stated, their length represents the dynamic energy developed at definite distances between the centre and the circumference of the sphere. The energy actually produced is represented by the superficies *o p t*, while the rectangle *o p u t* represents the energy that would be called forth if the force exerted at every point of the axis of the spherical pyramid were the same as that exerted at *a a'*. Our space will not admit of introducing the calculations by which the energy represented by the ordinates of the curve *p t* have been computed. It will be proper, however, to call attention to the fact that the energy exerted at each of the divisions of the base line *o t* is definite; hence the length of the ordinates is exact. Calculations based on the data thus furnished show that the superficies *o p t* is 0·20015 of the superficies *o p u t*.

We have before stated that the want of homogeneity of the solar mass will not materially affect the amount of energy developed by the gravitating force during the sun's shrinking. Referring to the several figures, it will be seen that the energy exerted at a point half way from *m*, viz., ordinate 5, is 0·0625, or $\frac{1}{16}$ of that exerted at *a a'*; and that the energy developed by the mass contained within the spherical pyramid *f m* 5 amounts to only $\frac{1}{31}$ of that developed by the gravitation of the mass contained within the spherical pyramid *a m a'*. Now the volume of the spherical pyramid *f m* 5 represents that of a sphere the diameter of which is one half of the sun, while the spherical pyramid *a m a'* represents the volume of the entire solar mass. The energy resulting from the gravitation of the central spherical mass *P p* being thus only $\frac{1}{31}$ of the energy exerted by the spherical mass *I K S*, it will be perceived that the degree of density of the matter towards the sun's centre will not materially affect the result of our calculations founded on perfect homogeneity.

We may now proceed to ascertain the amount of dynamic energy produced by the assumed shrinking of the axis of the spherical pyramid *a m a'*. Having already demonstrated that the said energy will be 0·20015 of that produced by the gravitation of a homogeneous mass, the section of which is one square foot extending from the surface to the centre, it only remains to determine the weight of one cubic foot at the surface of the sun. The specific gravity of the solar mass being 85·6 pounds per cubic foot, while the sun's attraction is 27·2 times greater than terrestrial attraction, the weight of one cubic foot at the solar surface will be $27·2 \times 85·6 = 2328·3$ pounds. Multiplying this weight by the sun's radius expressed in feet, we have, $2328·3 = 2,250,821,000 = 5,240,633,000,000$, which product, multiplied by 0·20015, shows that the gravitating energy of the matter contained in the spherical pyramid, exerted during a longitudinal contraction of one foot, amounts to 1,048,912,000,000 foot pounds. Dividing this latter product by the solar energy per minute, already stated, we find that 4355 minutes, = 3·024 days will elapse before the energy produced by constant solar radiation equals the gravitating energy exerted during the shrinking of one foot of the solar radius. The length of one year, 365·25 days, being divided by 3·024, we learn that the annual shrinking of the sun's radius amounts to 120·7 feet. The foregoing figures prove that, notwithstanding this apparently great contraction, a period of 1864 years is necessary to diminish the sun's diameter $\frac{1}{10,000}$. It hardly requires explanation that this result is reached by dividing the sun's diameter by 10,000 times the stated annual shrinking.

Helmholtz, in accordance with Laplace's remarkable nebular hypothesis, asserts that the continuation of the original condensation of the matter composing the sun develops an amount of mechanical energy capable of generating sufficient heat to make good the present solar emission. According to his calculations, the sun's diameter will be reduced $\frac{1}{10000}$ in the course of 2,000 years. The practical data assumed by the eminent physicist being less accurate than those upon which our calculations are based, the discrepancy regarding time, 2,000 years against 1864 years, necessary to effect the stated shrinking of the sun's diameter, may be satisfactorily explained. It will be well to observe that the intensity of the radiant heat will not diminish with the diminished size of the sun. On the contrary, for a given area of the solar surface, the dynamic energy produced by a given rate of shrinking will be increased, since the mass remains the same, while the attraction is inversely proportional to the square of the distance from the centre. But the *rate* will diminish with the contraction of the sphere; hence a shrinking of $\frac{1}{10}$th of the sun's diameter, instead of occupying $1,000 \times 1864 = 1,864,000$ years, will require somewhat more than 2,000,000 years. At the end of that period the gravitating energy will continue to develop, as at present, an amount of dynamic energy represented by 312,000 thermal units per minute for each superficial foot; but the radiating surface, *i.e.*, the area of the solar disc, will have diminished in the ratio of 10^2 to 9^2.

The present maximum temperature produced by solar radiation on the ecliptic when the earth is in aphelion, being 67·2, while the intensity of radiant heat diminishes as the area of the radiating surface, it follows that, at the end of 2,000,000 years from the present time, the tropical solar intensity will be reduced to $\frac{9^2 \times 67·2}{10^2} = 54·4°$, unless Prof. Tyndall's opinion is correct, that the earth, in common with the other planets, must "creep in, age by age, towards the sun."* But the pace is no doubt so slow that our calculations will not be seriously affected; hence, applying the foregoing demonstrations to the past, it will be seen that the temperature called forth by solar radiation 2,000,000 years ago must have been, owing to the greater diameter of the sun at that period, about $\frac{11^2 \times 67·2}{10^2} = 81°$ within the tropics. Now we are justified in assuming that the increased evaporation of the sea, and the consequent humidity of the atmosphere, modified the stated solar intensity, calling forth the luxuriant flora of past ages, which geology has made us acquainted with. The computed diminution of solar intensity, $67° - 54° = 13°$, during the next 2,000,000 years will probably be deemed extravagant by those who do not bear in mind that the computation must be based on

* Sir Isaac Newton, in his demonstrations relating to spherical bodies, supposed these to be composed of an infinite number of spherical superficies the thickness of which he thus defines:—"By the superficies of which I here imagine the solids composed, I do not mean superficies purely mathematical, but orbs so extremely thin that their thickness is as nothing; that is, the evanescent orbs of which the sphere will at last consist, when the number of the orbs is increased, and their thickness diminished without end."

* See "Heat as a Mode of Motion," p. 499.

the assumption that a constant power is being exerted during the stated period capable of developing, as at present, the stupendous energy of 240 millions of foot-pounds in a single minute, for each square foot of the surface of a sphere whose diameter exceeds 850,000 miles. This inconceivable amount of work cannot be performed with a less expenditure than the motive energy developed by the fall of a mass equal to the mass contained in the sun, the weight of which is nearly a thousand times greater than the weight of all the planets of the system. Obviously a *continuous* development of such an amount of energy is physically impossible, since there is a *limit* to the distance through which the weight can fall. Now the foregoing demonstration enables us to determine the said limit, with sufficient exactness to prove that although the efficiency of the great motor, during the past, may be measured by hundreds of millions of years, its future efficiency will be of comparatively brief duration.

Statements relating to the permanency of solar heat, based on the assumption that no diminution has been observed during historic times, have no weight in view of our demonstration showing that a shrinking of $\frac{1}{10}$ of the sun's diameter can only reduce the intensity from 81° to 67°·2, difference = 13°·8, in the course of two millions of years. This period being 500 times longer than "historic times" say 4,000 years, it will be seen that the diminution of the temperature produced by solar radiation, has not exceeded $\frac{13 \cdot 8}{500} = 0 \cdot 027$, or $\frac{1}{37}$ deg. Fah. since the erection of the Pyramids.

It will be proper to observe, before concluding our brief investigation of the source of solar energy, that, the development of heat by the shrinking of the sun, however fully demonstrated, leaves the important question unanswered: how is the heat generated by gravitation within the mass transmitted to the surface? If the matter within the sun is a perfect conductor of heat—a very improbable supposition—that fact alone furnishes a satisfactory answer. Imperfect conductivity, on the other hand, calls for other means of transmitting the energy from within, to make good the enormous loss caused by the external radiation. Besides, the falling of the crust at the rate of ten feet per month, attended by increase of internal pressure, and probably ejection of gaseous matter, together with the disturbance occasioned by contraction at the surface, disclose a mechanism of startling perplexity. But the parting with 312,000 thermal units for each square foot of the solar surface, involving an expenditure of kinetic energy fully 240,000,000 foot-pounds per minute, cannot be made good in that brief space of time, unless the sun shrinks at the rate ascertained by our calculations.

The development of solar energy in accordance with the combustion hypothesis (lately resuscitated by M. E. Vicaire) merits no consideration, while careful investigation has proved the meteoric hypothesis to be untenable. It must be admitted, however, that the mechanical difficulties alluded to, especially those relating to the means of transmitting the heat to the surface of the sun, any temporary local derangement of which must be productive of dark spots for a time, are of such a nature that the absolute certainty of solar radiation may be questioned; nor is evidence wanting to show that the solar mechanism is liable to derangement. History informs us that the great luminary has, during several seasons, partially failed to perform its functions. Herschel states, in his "Outlines of Astronomy," that "in the annals of the year A.D. 536 the sun is said to have suffered a great diminution of light, which continued fourteen months. From October A.D. 626 to the following June a defalcation of light to the extent of one-half is recorded; and in A.D. 1547, during three days, the sun is said to have been so darkened that stars were seen in the day-time." Again, the glacial periods, the ascertained abrupt termination and recurrence of which puzzles the geologist, point to periodical derangement of the solar mechanism in past ages.

J. ERICSSON

EXTRAORDINARY WHIRLWIND IN IRELAND

IN a letter to the *Belfast News-Letter*, Mr. C. J. Webb describes an extraordinary whirlwind which occurred in the district around Randalstown, about six miles N.W. of Antrim, near the shores of Lough Neagh, on the 25th of August last. The same phenomenon was witnessed about an hour and a half earlier the same evening at Banbridge, about seven miles S.W. of Dromore. It was first seen near Randalstown about 5 P.M., between that place and Toome, moving rapidly up Lough Neagh from the south, and presenting the appearance of a defined column of spray and clouds, whirling round and round, and not many yards in breadth, while at its base the water was lashed into a circle of white foam. It was next heard of in the neighbourhood of Staffordstown, about a mile from the lake, where it partially unroofed two houses, and damaged any trees or crops which happened to be in its course. From this point it travelled in a straight line for Randalstown, about three miles distant. It passed across a field close to Mr. Webb's house, levelling eight haystacks, and carried a considerable part of the hay up into the air out of sight. The breadth of the storm could be accurately ascertained at this point, and must have extended about thirty yards, as stacks remained unruffled at either side, while those between were thrown down and carried away or scattered about. Everything it lapped up was whirled round and round, and carried upwards in the centre, while dense clouds seemed to be sucked down on the outside, and came close to the earth. Both before and after there was lightning and incessant peals of thunder; but there was no rain till some time afterwards. Mr. Webb next observed its track in a hollow, some three hundred yards further on, where it knocked down a haystack, and then plunged into a wood of fine old Irish oaks. Here it tore numerous branches and limbs from the trees, carrying some along with it, and throwing others to the ground. One noble tree in the centre of the wood seems to have been a peculiar mark for its vengeance, although it would have been completely protected from any ordinary storm, owing to its position. It next passed across a corner of Shane's Castle demesne. Some who were at a short distance from this point describe its approach as causing considerable alarm. It was accompanied by a wild rushing noise, and the crashing of the trees and branches could be heard becoming louder and louder as it advanced. It crossed the valley over the railway viaduct, close to Randalstown, fortunately avoiding the village. It here presented the appearance of a vast whirling column of leaves and branches, mingled with clouds which looked like smoke.

The railway station next suffered, innumerable slates and two and a half cwt. of lead being torn from the roof in an instant. A great part of the railings surrounding the gardens was torn up, and an iron bar one inch thick, belonging to the gate, was bent to an angle of sixty degrees. A small shed at the rear of the station was unroofed, rafters and slates being hurled to the ground. What will give some idea of the excessive pressure of the wind, is the fact that three boards of the flooring of the waiting-room were forced up, owing to the wind finding an entrance to a cellar underneath, though the only aperture was a round hole about one foot in diameter. All this was the work of a few moments. The storm then passed away, leaving comparative calm behind. It next crossed an adjacent bog, scattering the turf in all directions. The last place Mr. Webb heard of its having visited was a farm house about three miles from Randalstown, between Antrim and Ballymena. It would be interesting to ascertain whether it travelled across to the sea-coast.

NOTES

THE British Association Committee on Mathematical Tables, of which Prof. Cayley is the chairman, has determined to tabulate the Elliptic Functions, or more accurately, the Jacobian Theta Functions, which are the numerators and denominators of the former, and their logarithms. The tables, which are of double entry, will therefore give eight tabular results for each

8,100 arguments; besides certain other quantities, depending only on the modulus, that will be added. Forms have been printed, and the calculation has already been commenced. The Elliptic Integrals (the inverse forms to the Functions) were, as is well known, calculated by Legendre, and published in his "Traité des Fonctions Elliptiques, 1826." It is unquestionable that the Elliptic Functions are the most widely used transcendents in analysis that have not yet been tabulated, and it is believed that the tables will be found very generally useful in all the mathematical sciences. The great labour has no doubt alone prevented any previous attempt. The work proposed by the committee will, when completed, be most likely the largest piece of numerical computation, with general application throughout the whole of mathematics, that has been undertaken since the original calculation of the logarithms of numbers and trigonometrical functions of Briggs and Vlacq, 1620–1633.

DR. FREDERICK WELWITSCH, the well-known African explorer and botanist, died at his residence in London on Sunday, the 20th inst., in the 66th year of his age. A native of Carinthia, Dr. Welwitsch studied medicine at Vienna, and early devoted himself to botanical pursuits. When on a visit to Portugal, he was induced to take up his residence at Lisbon as Director of the Botanical Gardens there, and in 1853 was despatched by the Portuguese Government to Angola to investigate the natural history of that region, where he remained from 1853 to 1861. His collections of the vegetable productions of that country are unrivalled in extent and completeness, have established a new region in geographical botany, and have been copiously used in the compilation of the two volumes already published under the auspices of the authorities at Kew of the "Flora of Tropical Africa." Dr. Welwitsch was not himself an extensive writer, but the number of species new to science discovered by him and described by others is very large, among the most remarkable of which is one of the most extraordinary vegetable productions known, dedicated to him by Dr. Hooker, the *Welwitschia mirabilis*. He was also an accomplished zoologist, and his entomological collections are of great extent and value. It is understood that the British Museum will have the first option in the purchase of the most valuable part of his collections.

THE death on Monday, 21st inst., is announced of the physicist, M. Jacques Babinet, the academician, at the age of 78 years. He was elected to the Academy in 1840. Another member of the Academy, M. Puiseux, has also just died.

SIR JOHN LUBBOCK and Mr. Grant Duff are now travelling in Asia Minor; and it is expected they will bring home some very important and interesting information on the pre-historic remains of that region, an almost untried hunting-ground.

THE *Gardener's Chronicle* states that it is proposed that the sum of 48,000*l.* shall be included by the French Government in the Budget of 1873 for the commencement of the entire rebuilding of the museums and conservatories of the *Jardin des Plantes*, a move which has been long in contemplation. In addition, the vote for civil buildings for 1873 includes a sum of 8,000*l.* for the construction of laboratories of chemistry and zoology in the Museum for the *Ecole des Hautes Etudes*, and for the completion of the reptile house.

THE Board of Trinity College, Dublin, has elected Dr. Benjamin M'Dowell to the Professorship of Anatomy and Surgery, and has resolved to found a new Professorship of Comparative Anatomy, endowed with 100*l.* a year and a portion of the fees for dissections. The professor will have to deliver eighteen lectures each year.

THE Swiney Lectureship, which has just been vacated by Dr. Cobbold, will be filled up in February. It is a travelling Lectureship, open to Doctors of Medicine of Edinburgh University, and is tenable for five years.

THE statue to the memory of Sir Humphrey Davy has just been erected at Penzance, his native place. The statue, which cost 600*l.*, is a colossal one, and stands on a massive granite pedestal in front of the Post Office, and a few yards from the house in which the great chemist, philosopher, and inventor was born.

WE learn from the *Mechanics' Magazine* that a committee of the Derby and Chesterfield Institute of Engineers has been appointed to consider the possibility of erecting a memorial hall, to cost 20,000*l.* to 30,000*l.*, in memory of George Stephenson.

IN reference to Mr. J. R. Hind's letter to the *Times*, printed in its issue of Oct. 19th, on the subject of the probable existence of a planet revolving round the sun within the orbit of Mercury, we propose to revert to the subject as soon as Mr. Hind has further discussed the subject; as we learn that in consequence of errors in some of the calculations made by some who have previously inquired into the subject, a revision of some of the results announced in the letter in question is necessary.

AN admirable article has appeared in *Engineering*, under the heading, "Great Britain in Formâ Pauperis." The burden of the writer is the parsimonious, nay, even ungratefully insolent manner, in which the neighbourly request of Austria for a reciprocity of assistance (such as she and other nations afforded to England in 1851 and 1862) in the forthcoming Universal Exhibition at Vienna has been met by the Government and the Treasury. It appears, that whereas France, torn and bleeding at every pore, votes 60,000*l.*, her conqueror, Prussia, an equal sum, with a supplementary vote, Italy the same sum, Spain 1,200,000 reals, the minor states of Europe in proportion, even little Switzerland voting 16,000*l.*, Great Britain, wealthy and powerful, the ancient friend and ally of Austria, who has contributed to her exhibitions over 100,000*l.*, votes the noble, magnanimous sum of six thousand pounds sterling! We fully sympathise with the indignant comments of our contemporary at the lamentable parsimony for which our Government has made us responsible.

THE *Gardener's Magazine* announces its full adhesion to the views enunciated in our article on the potato disease, that it is in its origin cosmical, and probably connected with the great cycle indicated by the recurrence of sun-spots.

THE total number of entries at the various medical schools of London for the session just commenced is 1496, of which 476 are of new students, the former number being 21, and the latter 8 in excess of those last year. Guy's and University College Hospitals occupy the first place, each with 83 fresh entries. Westminster brings up the rear with 4.

THE prizes of the Charles Science and Art School, Plymouth, were distributed on Friday, Oct. 21, by Sir Massey Lopes, Bart. M.P., who spoke very encouragingly of the success of the schools.

MR. THOMAS WEBSTER, Q.C., F.R.S., will read a paper before the members and friends of the London Association of Foremen Engineers and Draughtsmen "On the Promotion of Practical Science and Technical Education by Museums of Inventions established and maintained by the Surplus of the Inventors' Fee Fund," at the meeting to be held on Saturday, the 2nd of November, at the City Terminus Hotel, Cannon Street, at 8.30 P.M.

THE Council of the Institution of Civil Engineers invite communications dealing in a complete and comprehensive manner with such subjects as (*a*) Account of the Progress of any Work in Civil Engineering, as far as absolutely executed —Smeaton's Narrative of the Building of the Eddystone Lighthouse may be taken as an example; (*b*) Descriptions of distinct classes of Engines and Machines of various kinds; (*c*) Practical Essays on Subjects allied to Engineering, as for instance, Metallurgy; and (*d*) Particulars of Experiments and Observations connected with Engineering Science and Practice. A list of thirty seven special subjects recommended for competition is appended. For approved original communications, the Council will be prepared to award the premiums arising out of special funds devoted for the purpose.

THE Crystal Palace Company's school of Art, Science, and Literature, has issued its prospectus for the thirteenth session, 1872-73, of classes for gentlemen, conducted by eminent professors and teachers.

THE following are the Science Lectures for the People to be given this winter at Manchester:—The first on Tuesday, Oct. 29, by Prof. Roscoe, F.R.S., On the Rainbow; and these other lectures will follow:—Prof. Geikie, F.R.S., On the Ice Age in Britain; Prof. Balfour Stewart, F.R.S., The Sun and the Earth; Prof. Clifford, On Atoms; Prof. Barrett, On Faraday's Electrical Discoveries; Dr. J. H. Gladstone, F.R.S., The Life of Faraday; Mr. William Pengelly, F.R.S., Prehistoric Man. The fee for each of these lectures, as before, is one penny! Many people will wish they lived in Manchester.

THE following lectures will be delivered in Gresham College, Basinghall Street, E.C., by E. Symes Thompson, M.D.; On Draughts, Friday, Nov. 8; On Mineral and Vegetable Tonics, Monday, Nov. 11; On Prescriptions, Tuesday, Nov. 12. The lectures are illustrated by diagrams and experiments, are free to the public, and commence each evening at seven o'clock.

THE following lectures are announced to be delivered in connection with the Torquay Natural History Society:—Introductory Address, by Dr. Wilks (President), Nov. 4. The Fertilisation of Flowers, by Dr. Wilks, Nov. 25. "Natural Selection," by Dr. Wilks, Dec. 2. Museums and Our Museum, by the Rev. T. R. R. Stebbing, M.A., Dec. 9. Fossils as characteristic of Strata, by J. E. Lee, F.G.S., F.S.A., Dec. 16. The Share of the Italians in the Progress of the Natural Sciences, by Signor Olivieri, Lit. and Phil. Doctor, Jan. 27, 1873. The Unity and Progress of Man, by J. B. Paige Browne, March 3. Monte Rosa—its Peaks, Valleys, and Glaciers, by Dr. Wilks, March 17. Teleology, by Rev. T. R. R. Stebbings, M.A., March 24. Curiosities of Natural History, by Dr. C. Paget Blake, April 7. Aërostation, by W. Froude, F.R.S., April 21.

IN addition to our announcements of last week, Mr Van Voorst announces as follows:—Mr. W. Saville Kent, of the British Museum, is engaged upon a new "Manual of the Infusoria:" the treatise will be devoted entirely to the Ciliate, Flagellate, and Suctorial Protozoa, to the exclusion of the Desmids, Diatoms, Rotifers, and other foreign organisms comprised under the above title by Ehrenberg, Pritchard, and other writers; the Rev. Thomas Hincks is preparing for publication "A History of British Polyzoa" with figures of all the species, uniform with his "Hydroid Zoophytes;" "The Birds of the Humber district," by John Cordeaux of Great Cotes, Ulceby, is in the press; a second edition, with new plates and additions, of "Falconry in the British Isles," by Capt. Salvin and Wm. Brodrick, is in preparation.

THE Zoological Society has just issued a revised list of the valuable animals now or lately living in the Society's Gardens. It contains a list of nearly 500 Mammalia, upwards of 1,000 Aves, and nearly 300 Reptilia, Batrachia, and Pisces, with their habitats and dates of acquisition, and is illustrated by 30 very well-executed woodcuts. As the list is published at the very low price of 2*s.*, it ought to be in the hands of every one who is in the habit of using the Gardens.

PROF. MIGUEL COLMEIRO, director of the Botanic Garden at Madrid, announces the publication of the second edition of a "Treatise on the Elements of Botany, organographic, physiological, systematic, and geographical," in two vols., with numerous illustrations. Prof. Colmeiro is the author of thirty separate papers on botanical subjects.

A SECOND edition is announced as in the press of Gardiner's "Flora of Forfarshire," edited by Mr. John Sadler, author of the "Flora of Edinburgh." Many important additions will be made to the original work, in which the editor will be assisted by resident botanists, and the author's valuable notes on the different species, and on various localities of special interest, will be retained.

JOHN HEYWOOD'S recently-published School Atlas is a marvel of cheapness. It contains twelve coloured maps about 10 in. by 8 in., of Europe, the two hemispheres, England and Wales, the British Isles (physical), Scotland, Ireland, Asia, Africa, North and South America, and Australia; and the price is Sixpence!

THE following we take from the *School Board Chronicle*:—"Some curious statistics have been published, establishing a suggestive comparison between the expenses of education and police supervision in the cities of St. Petersburg, Berlin, and Vienna. With regard to education, the expenses of the Russian capital are estimated at one per cent. of the total budget; Vienna stands as high as nine per cent.; and Berlin reaches thirty-one. Costs of philanthropic institutions are represented by the proportions of Berlin, twenty-two; Vienna, fifteen; and St. Petersburg, nine per cent. Of course, the ratio becomes inverted when we turn to the expenses of the police force. Here we find Prussia down for seventeen, Austria for twenty-one, and Russia for fifty-one (figures of comparison). Berlin employs one policeman for every 495 of its inhabitants, Vienna one for every 416, and St. Petersburg one for every 210. The practical teaching of these statistics is, that while Berlin pays twice as much for schools as for prisons and police, Vienna pays two and one-third times less, and St. Petersburg fifty times less."

THE same journal prints the following item of information:—"Reports concerning the four Prussian academies for the scientific pursuit of agricultural knowledge inform us that these institutions have been frequented during the past summer term by 173 students. Of these 65 were newly matriculated, and 10 unmatriculated. Classified according to their nationality there were 117 from Prussia, 13 from other German States, and 43 foreigners. In order of academic population Proskau stands first with 63 students; then comes Poppelsdorf, near Bonn, with 43; after that the institution at Berlin with 37; and last of all the Academy at Eldena with 30 students.

THE following, in reference to education in Greece, is again from the same journal:—"From 1835 to 1869, the number of students at the University of Athens had increased from 35 to 1,205; the number of gymnasia in Greece, which was 3 in 1835, had risen to 16 by the year 1866. During the same period of time the number of secondary schools had increased from 21 to 189, and that of the pupils frequenting them from 2,500 to 7,300; within 33 years, also (1833-66), the national elementary schools had increased from 17 to 1,070, and the scholars from 8,000 to 65,000. Among the secondary schools there were, in 1869, 6 institutions for girls, numbering 680 pupils. As a sorrowful set-off to such cheering news, it must be mentioned that there are still in Greece 240,000 children and youths who receive no education whatever; that is to say, more than three times the number of those who frequent the schools.

INTERNATIONAL METRIC COMMISSION

THE following methodical statement of the resolutions come to by the International Commission on Weights and Measures at its recent meeting at Paris was presented to the French Academy of Sciences by M. Tresca, one of the secretaries of the Commission.

I. *In reference to the Metre*

1. As a starting-point for carrying into effect an international measure, the Commission takes the metre of the Archives, in its present condition.

2. The Commission declares that, considering the actual condition of the platina measure of the Archives, it thinks the marked or line metre (*mètre à traits*) may be deduced from it with certainty. Nevertheless, this opinion of the Commission requires to be confirmed by the different processes of comparison which can be employed in this investigation.

3. The proportion (*équation*) of the International Metre will be deduced from the present length of the metre in the Archives, determined according to all the comparisons which have been made by means of the processes which the International Metric Commission will be in a condition to employ.

4. While deciding that the new International Metre ought to be a line-metre (*mètre à traits*), of which every country will receive an identical copy made at the same time as the universal prototype, the Commission will feel bound afterwards to construct a certain number of standards marked by projections (*étalons à bouts*) for those countries which desire them; and the proportions of such metres to the new prototype *à traits*, will also be determined under the care of the International Commission.

5. The International Metre will have the length of the metre at zero (centigrade).

6. There will be employed for the manufacture of the metres an alloy composed of 90 parts of platina and 10 of iridium, with a margin (*une tolerance*) of 2 to the 100, more or less.

7. In manufacturing the measures, the ingot must be formed by a single casting by means of the processes used in the working of the known metals. The number and form of these measures will be determined by the International Commission.

8. These measures will be annealed for many days, at the highest temperature—notwithstanding that they are never likely to be subjected to anything but the most feeble strains—before taking them to be compared with the standard instruments.

9. The bars of platina alloy upon which the line-metres are to be traced, will have a length of 102 centimetres, and their transverse section will be represented by the model described in a note of M. Tresca.

10. The bars intended for the construction of the projection metre measures (*à bouts*), will have a similar transverse section, but symmetrical in the vertical direction, conformably to the special figure which represents it; the nobs or projections (*bouts*) will then be wrought with a spherical surface of one metre radius.

11. During all the operations which the standard metres must undergo, they will be supported on the two rollers (*rouleaux*) indicated by General Baron de Wrede; but, for their preservation, they will be placed in a suitable case.

12. Each of the International Metres ought to be accompanied by two mercurial thermometers, isolated, and carefully compared with an air-thermometer; it is deemed necessary that these thermometers should be verified from time to time by means of the air-thermometer.

13. The method of M. Fizeau will be employed to determine the dilatation of the platina alloy used in the construction of the metres.

14. The prototypes will be submitted to the processes by means of which the coefficients of the absolute dilatation of the complete metres can be best determined. These measures will be separately made, at five different temperatures at least, between zero and 40° centigrade.

15. The comparison of the prototypes with each other ought to be made at, at least, three temperatures comprised between these same limits.

16. The Commission decides that two apparatus be constructed, the one with a longitudinal movement for tracing these metres, the other with a transverse movement for their comparison.

17. The comparisons will be made by immersing new standards in a liquid and in air; but the standard of the Archives must not be immersed in any liquid before the end of the operations.

18. The tracing of the line or traced metres (*à traits*), and their first comparison with the metre of the Archives, will be for the first effected by means of M. Fizeau's process.

19. For the determination of the proportions of the various standards, there will be employed moreover all the means of comparison already known and approved, according to circumstances, either by actually bringing the different forms into contact, or by the method of Messrs. Airy and Struve, or by that of MM. Stamkart and Steinheil.

20. The relations between the Archive metre and the new International traced metre, as well as the relations between the other traced standards and the International Metre, will be determined by comparing the results of all these observations.

21. Operations will be performed, on the other hand, by setting out from the International Metre for the construction of the standards with projections (*étalons à bouts*), which may be asked for by various states.

II. *In reference to the Kilogramme*

22. Considering that the simple relation established by the authors of the metric system between unity of weight and unity of volume is represented by the actual kilogramme in a manner sufficiently exact for the ordinary uses of industry, and even of science; considering also that the exact sciences have no real need of a simple numerical relation, but only of a determination as exact as possible of that relation; and considering the difficulties which would result from a change of the existing unity of metric weight, it is decided that the international kilogramme will be derived from the kilogramme of the Archives in its present condition.

23. The International Kilogramme ought to be decided by weighing in a vacuum.

24. The material of the International Kilogramme will be the same as that of the International Metre, viz.: an alloy of platinum and iridium, as stated in No. 6.

25. The material of the kilogramme will be founded and cast in a single cylinder, which will afterwards be subjected to furnace heat and mechanical operations, such as will give to its whole mass the necessary homogeneity.

26. The form of the International Kilogramme will be the same as that of the kilogramme of the Archives, viz., a cylinder whose depth is equal to its diameter, and whose corners may be easily rounded.

27. The determination of the weight of the cubic decimetre of water ought to be made under the direction of the International Commission.

28. The balances which will be used for weighing ought to be, not only those which may be placed for the present at the disposal of the Executive Committee by institutions and men of science who possess them, but also a new balance constructed according to conditions of the greatest exactness.

29. The volumes of all kilogrammes will be determined by the hydrostatic method; but the kilogramme of the Archives will neither be placed in water nor in a vacuum before the end of the operations.

30. To determine the weight of the new kilogramme, in comparison with that of the Archives, in a vacuum, two auxiliary kilogrammes will be made use of, as nearly as possible of the same weight and the same volume as that of the Archives, according to the method indicated by M. Stas. Each of the new kilogrammes ought also to be compared in air with the kilogramme of the Archives.

31. When the International Kilogramme is constructed, all others will be compared with it, in air and in vacuum, for the determination of their proportions.

32. For this purpose is employed the method of alteration and that of substitution, with a counterpoise of the same material.

33. The corrections for losses of weight in air will be effected by means of the most precise and least disputed data of science.

III. *In reference to the carrying out of the Commission's Decision*

34. The making of the new prototypes of the metre and the kilogramme, the tracing of the metres, the comparison of the new prototypes with those of the Archives, as well as the construction of the auxiliary apparatus necessary to these operations, are entrusted to the care of the French section, with the concurrence of the Permanent Committee, provided in the following article.

35. The Commission has chosen from its members a Permanent Committee, which will do duty till the next meeting of the Commission, with the following organisation and powers:—(*a.*) The Permanent Committee will be composed of twelve members, belonging to different countries. Five of these members

constitute a quorum: it will choose a president and secretary, and will meet as often as it deems necessary, but at least once a year. (*b.*) The Committee will direct and superintend the execution of the decisions of the International Commission, in reference to the comparison of the new metric prototypes with each other, as well as the construction of balances and other auxiliary apparatus necessary for these comparisons. (*c.*) The Permanent Committee will perform the work indicated in (*b*) with all appropriate means which may be at its disposal; it will meet for the performance of its task at the International Bureau of Weights and Measures, the establishment of which will be recommended to the nations interested. (*d.*) When the new prototypes will be constructed and compared, the Permanent Committee will give a report of its work to the International Commission, which will sanction the prototypes before distributing them to the different countries.

36. The Commission suggests to Governments interested how great would be the utility of founding at Paris an International Institution of Weights and Measures, upon the following bases:—1st. The establishment would be international and declared neutral. 2nd. Its seat will be at Paris. 3rd. It would be founded and supported at the common cost of all the countries which adhere to the treaty that might be made between the interested states for the creation of the establishment. 4th. The establishment will depend upon the International Metric Commission, and will be placed under the superintendence of the Permanent Committee, who will choose the director. 5th. The International Bureau would serve the following purposes:—(*a.*) It will be at the disposal of the Permanent Committee for the comparisons which will serve as a basis for the verification of the new prototypes with which the Committee is charged. (*b.*) The preservation of the international prototypes, in accordance with the directions laid down by the International Commission. (*c.*) The periodical comparison of the international prototypes with the national standards and with the tests, as well as that of the standard thermometers, according to the rules laid down by the Commission. (*d.*) The construction and verification of the standards which other countries may require in future. (*e.*) The comparison of the new metric prototypes with the other fundamental standards employed in the different countries and in science. (*f.*) The comparison of standards and scales which may be sent for its verification, either by Governments or by scientific societies, or even by mechanicians and servants. (*g.*) The Bureau would execute all the works which the Commission or its Permanent Committee would require of it in the interest of metrology and the propagation of the metric system.

37. The Bureau of the Commission is required to apply to the French Government, and request it to be good enough to communicate diplomatically the views of the Commission concerning the foundation of an International Bureau of Weights and Measures to the Governments of all the countries represented in the Commission, and to invite these Governments to conclude a treaty to create harmoniously, and as soon as possible, such an International Bureau upon the bases proposed by the Commission.

IV. Concerning the means of Preserving the Standards and the Guarantee of their Invariability

38. The Commission is of opinion that the International Standard ought to be accompanied by four identical measures, maintained at a temperature as invariable as possible; another identical measure ought to be preserved, for the sake of experiment, at an invariable temperature in vacuo; it would take means to establish tests in quartz and beryl, to be compared at any time with the complete measure, in whole or by portions. (The other means are reserved.)

39. The Commission thinks that in the interest of geodesy the French Government should cause to be re-measured, at a convenient time, one of the new French bases.

All these resolutions were made by the Commission most harmoniously, and in a spirit of complete confraternity; all the votes were nearly unanimous.

BIRTH OF CHEMISTRY

III.

Practical Chemistry of the Ancients.—Metallurgy: gold, silver, electrum, copper, bronze, tin.

In the preceding articles we have discussed such theories of the ancients as involve the conception of change of matter (notably the assumed transmutation of the elements), and which hence concern the early history of chemistry. Having done with theory, we have now to inquire to what extent the ancients were acquainted with practical chemistry, what metals or other elements were known to them, and what processes dependent upon chemical action. We do not, of course, use the term "practical chemistry" strictly in its present sense, because chemistry as a science was altogether unknown to the ancients. Some have indeed endeavoured to prove that the Egyptians must have been acquainted with the science, from the skill with which they used various metallic oxides for colouring glass; but we have no proof of this. Neither Herodotus, nor Pliny, nor Vitruvius, indicates any knowledge of chemistry as a science among either Egyptians, Greeks, or Romans. Pliny, in his celebrated "Natural History," has laboriously amassed all the practical science and pseudo-science which the ancients possessed, and we find no mention of either chemistry or alchemy. At the same time it is impossible that the Egyptians and Sidonians can have attained their marvellous skill in the manufacture and colouring of glass, and in the extraction and working of metals, without the acquirement of a considerable amount of knowledge of the properties of matter, and of certain chemical changes. But this knowledge could never be worked up into a comprehensive system; it resulted from the labour of artizans, and the gulf between the philosopher and the manipulator was both wide and deep. There could be no union of practice and theory. Between Herakleitos with his theory that fire is the primal element, the actuating force of the Universe, and the man who wrought metals never so deftly, who applied fire to the use and service of mankind, there was no sympathy, no reciprocal transference of ideas. To reason concerning the properties of matter with one's eyes shut was all very well, but to experiment with matter, to endeavour to determine the cause of such and such a change by experiment, was utterly unworthy of a philosopher. Anaxagoras is said to have made an experiment to prove that there is no vacuum. Aristotle found that a bladder of air weighed in air weighed more than the empty bladder (which, if the experiment be properly made, is by no means the case), and hence concluded that the air has weight. But these are solitary exceptions; the way to study Nature, if she is to be studied at all, is, they maintained, to apply the pure, unaided intellect to the study, and to keep mind and matter as distinct as possible. From all this it resulted that your workers in metals and in curious arts, your makers of glass and pigments, kept their knowledge of matter to themselves, as secrets to be handed down from father to son.

Seven metals were known to the ancients, viz., gold, silver, copper, tin, iron, lead, and mercury. The first six are mentioned by Homer, and appear to have been known from remote antiquity, while mercury was not known till a later date; it was, however, common in the first century B.C. The Greek word μεταλλον, whence *metallum* and *metal*, signifies *a mine*, hence it was applied to anything found in mines, notably metals; μέταλλον is connected with μεταλλ'ω, "to search for diligently."

Gold has been valued from the earliest ages, on account of the peculiarity of its colour, its lustre, and its unalterability in air. The metal is invariably found in the native state, that is, uncombined with other substances, hence no metallurgical operation is necessary for its extraction. It is very often met with in surface deposits, and in early times was undoubtedly far more common in alluvium and the beds of rivers than now. It would thus be easily extracted by washing, and the grains could readily be fused together into a mass. Gold mines formerly existed in Ethiopia, in which the gold was found in a matrix of quartz, like much of the Australian gold of the present day. These mines were worked by the Egyptians, who employed large gangs of slaves for the purpose. The quartz was crushed, and the gold obtained from it by washing. We find representations of gold washings, and the subsequent fusion of the metal, on Egyptian tombs, at least as early as 2500 B.C., that is to say, about the time of Joseph in Hebrew history. The woodcut (Fig. 1) on the following page is given by Sir Gardner Wilkinson, and is taken from a tomb at Beni Hassan: it represents gold washing, and the fusion and weighing of the metal.

It is obvious that the process is only indicated, and not accurately or minutely portrayed. Another form of furnace is depicted below (Fig. 2), and a blowpipe somewhat different from that shown in Fig. 1. The raised portion of the furnace is doubtless for the purpose of concentrating the heat upon the crucible, on the principle of the reverberatory furnace.

Gold once obtained was soon made into ornaments; very fine gold wire was used by the Egyptians for embroidery 3,300 years ago. Many of the Egyptian and Etruscan gold ornaments are very beautiful; we may notice particularly the gold myrtle wreath found in an Etruscan tomb a few years ago. The Egyptians also used gold for inlaying, and it was beaten into leaf and used for gilding as early as 2000 B.C. In the Odyssey the gilding of the horns of an ox about to be sacrificed is mentioned.

Silver, like gold, is often found native, and from several of its ores the metal may be extracted by the action of heat alone. It has been known from the earliest ages, and was used chiefly for ornaments and embroidery. Gold was used for money before silver, which was first known as "white gold." The oldest silver Greek coin is a coin of Ægina, and was, perhaps, coined in the eighth century B.C. But the oldest coins in existence are the *electrum* staters of Lydia. Electrum consists of about three parts of gold to one of silver. Probably the metals were first found in nature thus alloyed, and as no method of separating them was then known, they were worked up together. Electrum was so called from its resemblance as regards colour to amber (ἤλεκτρον), which received its name from ἠλέκτωρ, the sun. It will be remembered incidentally that the science of Electricity was so called by Gilbert of Colchester, because the attractive force was first observed in amber. Amber is mentioned more than once by Homer. Electrum as a metal is first mentioned in the *Antigone* of Sophocles. It was found naturally alloyed, as in the pale gold of the Pactolus, which contains a good deal of silver; and was also made artificially. Probably all very pale gold was called electrum; Pliny states that gold containing a fifth part of silver is called electrum. In the British Museum there are many coins made of this alloy.

Copper was in use before iron. It is, as is well known, usual to denote various early ages by the substances then used for domestic implements. Thus we have the "age of stone," the "age of iron," &c. The stone age is followed by the age of copper, this by the age of bronze, and the age of bronze by the age of iron. Homer wrote in the age of copper; the shield of Achilles is made of gold, silver, tin, and copper; the arms and implements and utensils of his heroes are of copper. Mr. Gladstone has argued at some length that by chalcos (χαλκος) Homer meant copper, not bronze, as it is so often rendered. Chalcos is spoken of as a cheap and common metal, while tin was very scarce and rare; and it is scarcely probable that so many things, even down to the commoner utensils, could have contained ten or twelve per cent. of tin. Again, Mr. Gladstone points out that Homer speaks of chalcos as ερυθρος, red, a term that could not apply to bronze; and he goes so far as to say, "If chalcos be not copper, then copper is never mentioned in Homer" (*Juventus Mundi*, p. 530). At the same time we must remember that copper is very soft for cutting-instruments, and a small quantity of tin hardens it; some of the Greek bronzes only contain 1 per cent. of tin. Dr. Percy found in a bronze bowl of great antiquity from Nineveh, copper 99·51, tin ·63. Ancient nails have been found containing copper 97·75, tin 2·25; and Mr. Gladstone suggests that, as tin is sometimes found associated with copper in nature, this may account for their composition. Copper is sometimes found native, sometimes in the form of ores, from which the metal is easily extracted. It appears to have been both cheap and plentiful at an early date. Romulus is said to have coined copper; it was also used for money by the Egyptians. Great confusion exists among old writers regarding the words signifying bronze and copper: Pliny clearly did not understand the difference between copper and bronze. The words *æs* and χαλκός appear to have been applied indiscriminately both to copper and to alloys of copper containing a large proportion of that metal. Copper was alloyed with tin at such an early date, because copper is soft and is unsuitable for cutting-instruments, while the addition of tin hardens it. The fusing point of copper is between that of gold and silver, and is far below that of iron, while the fusing point of tin is only 446° F. Thus the two metals could be alloyed without any special metallurgical difficulties or the requirement of an inordinate temperature. Copper was first obtained by the Romans from Cyprus, where it was very plentiful; they called it *Æs Cyprium*, which became corrupted into *Cuprum*, from which we get our present chemical symbol for

FIG. 1.—Gold Washing: Fusion and Weighing of the Metal, from early Egyptian Tomb

copper, *Cu*. According to Solinus *æs* was found at Chalkis, in Eubœa, hence χαλκος, the Greek word for copper. We read of "ores of æs," and of brass and bronze being dug out of mines, whereas the term *brass* is applied by us to an alloy composed of copper and zinc, and *bronze* to an alloy of copper and tin. Zinc as a metal was unknown to the ancients, and brass appears to

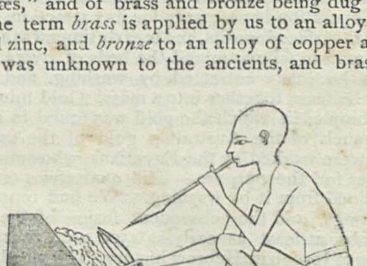


FIG. 2.—Furnace and Blow-pipe from Egyptian Tomb

have been made in Pliny's time by heating together metallic copper, calamine (a native carbonate of zinc), and charcoal; the latter reduces the calamine, and the metallic zinc and copper then combine. According to Dr. Thomas Thomson, *aurichalchum*, or golden copper, was the proper name for brass. *Æs* is to be always translated copper or bronze, *not* brass, of which latter very little use appears to have been made. Among other alloys of copper, the ancients possessed the celebrated *Æs Corinthiacum*, which, according to Pliny, was formed accidentally during the burning of Corinth, by Mummius, B.C. 146. There were four varieties of this, one of which contained equal proportions of gold, silver, and copper; the others were most probably various admixtures of copper and tin. The commonest kind of ancient bronze contained in 100 parts, 88 parts of copper, and 12 parts of tin. Two specimens of bronze from Nineveh were found by Dr. Percy to contain respectively—

	Bronze hook.	A small bell.
Copper	89·85	84·79
Tin	9·78	14·10
	99·63	98·89

The proportion of copper and tin (about 10 to 1) is, remarks Mr. Layard, the composition of our best modern bronze, while the increase of tin in the case of the bell proves that the Assyrians were well acquainted with the increase of sonorousness produced by changing the proportions of the metals. Modern bell metal contains about 80 parts of copper to 20 parts of tin. Sometimes a small quantity of lead was introduced by the ancients into their bronzes. Thus, a certain bronze for statues was formed by fusing together 100 parts of copper, 10 parts of lead, and 5 parts of tin. In a very ancient bronze armlet (probably Phœnician) found in this country, and belonging to a period anterior to the Roman occupation, Prof. Church found—

Copper	86·49
Tin	6·76
Zinc	1·44
Lead	4·41
Oxygen and loss	·90
	100·00

Bronze was very much used in Egypt for vases, mirrors, arms, &c. These, according to Sir G. Wilkinson, usually contain from 80 to 85 per cent. of copper, with from 15 to 20 per cent. of tin. By the use of some acid substance, the surface was sometimes covered with a green or brown patina. Although the casting of the metals was not known in Greece in the time of Homer, bronze was probably cast in Egypt 2000 years B.C.

Several compounds of copper were used by the ancients, both the red and black oxide were obtained by heating copper to redness, and allowing it to cool in the air; they distinguished between the scales which fell off during cooling, and those which were caused to fall off afterwards by blows of a hammer. These oxides were principally used for colouring glass. Verdigris or acetate of copper was obtained as now by covering plates of copper with the refuse of grapes after the expression of the vine juice. Copper pyrites and a rude kind of sulphate of copper would appear from Pliny's obscure account to have also been known.

It follows from the above remarks concerning bronze, that tin, like copper, was known at a very early date. This is the more remarkable, because it has always been a comparatively scarce metal, and it was obtained from distant localities. Formerly it was almost entirely supplied by Spain and Britain. The Phœnicians, who were the earliest traders, obtained it first from India and Spain, and afterwards from Britain. The Greek name for tin, kassiteros (κασσιτέρος), was perhaps derived from the Insulæ Cassiterides, or Scilly Islands, from whence the Phœnicians asserted that they procured tin; but it has been suggested that in all probability they invented the story because they desired a monopoly of the metals, while in reality they procured all their tin from the mainland of Cornwall, where it has always abounded. Tin must have been very valuable, or the Phœnicians would not have traded so far for it. Homer evidently considers it of far greater value than copper. In the time of Pliny it was worth about eight shillings the pound. The metal was known in Egypt 2000 B.C. Pliny mentions that it was found in the form of small black grains in alluvial soils, from which it was obtained by washing; this account would agree with a description of the so-called *stream tin*, which is tin ore separated from the parent vein, and carried down by streams. It is an oxide of tin, and the metal is obtained from it by strong ignition with charcoal. Tin was used for tinning copper vessels, for making mirrors, and in the manufacture of bronze. In the Iliad the greaves of the armour of Achilles are made of tin, and it enters into the composition of the shield; it was also used for coating copper.

G. F. RODWELL

(*To be continued.*)

SCIENTIFIC SERIALS

THE *Bulletin de l'Académie Impériale des Sciences de St. Petersbourg*, xvii., No. 2, commences with a proposed new classification of the Balænoidea, by J. F. Brandt, with the view of including extinct forms recently met with in Central and Southern Europe, and in Central Asia. He bases it mainly on skeleton structure, with special reference to form of cranium. The next paper contains some algological studies by Christopher Gobi. He describes how moisture, with heat and light, acts on chlorophyll in the cells of Chroolepus, accumulating it at the periphery, and leaving a nucleus of red pigment at the centre. He also describes a new species of the plant, which he terms *Chroolepus uncinatus*. It is found on the maple, ash, and linden, and its chief characteristic is a hook-shaped zoosporangium with subsporangial cell at the end of a series of irregular cylindrical-shaped cells forming the stalk. The growth of the zoosporangia takes place only at night. This new species is most closely allied to the *C. umbrinus*. —C. J. Maximowicz gives a full description, in Latin, of certain plants in Japan and Mandshuria.—The last paper is by C. J. Maximowicz, on the influence of strange pollen on the form of fruit. He experimented with two very distinct species of lily, *L. davuricum* and *L. bulbiferum*, kept in a room warmed by sunlight. He fertilised the flower of each with pollen from the other, and the process was repeated in several individuals. When the capsules developed, each was found to have the form characteristic of the other plant. The form of the seeds in both was intermediate between those of the parents.

Annalen der Chemie und Pharmacie, No. 9, 1872.—The first article, by Dr. Schreder, describes a new product of styphnic acid, obtained by reaction of cyanide of potassium with the neutral potassa salt of the acid. He names it *Resorcin-Indophan*, and gives as its formula $C_9H_4N_4O_6$. It is soluble in water, but insoluble in alcohol and ether. The potassa, soda, and baryta salts of the substance are discussed.—In a paper on some combinations of vinyl, Dr. Baumann describes the action of sodium methylate on an excess of iodide and bromide of vinyl at ordinary temperature; experiments on the action of cyanides of potassium and of silver on bromide of vinyl; and the conversion of bromide and chloride of vinyl into isomeric bodies.—An essay on camphoric acid, by F. Weeden, contains an account of a new modification, called meso-camphoric acid, obtained by action of hydriodic and hydrochloric acid on dextro-camphoric acid; its formula is $C_{10}H_{16}O_4$. He also treats of substitution products of camphoric acid anhydride and of amido-camphoric acid.—A paper on "Carbazol," a substance prepared from coal-tar oil, is furnished by C. Graebe and C. Glaser; and Herr Graebe also communicates a note on "Vapour Densities of some Aromatic Compounds of High Boiling-point."

Poggendorff's Annalen der Physik und Chemie, No. 6, 1872.—This opens with a detailed account, by Dr. Rudolph Kœnig, of his various experiments with manometric flames. His apparatus is based on the effects of sound-waves upon a membrane presented to them, which, in its turn, affects a stream of gas flowing to a jet, causing the latter to dance. The jet is imaged on the mirror-covered sides of a revolving box, and its successive motions (caused by the sound and varying with it) appear from the reflection, which, through the box's motion, becomes a luminous line of images. Dr. Kœnig has successfully employed this method in the study of various acoustical effects—combinations of notes, vowel sounds, "overtones," interference, &c., and the varieties of flame-forms produced are fully shown by numerous drawings.—In the paper following, S. Lamansky describes a series of careful experiments on the heat spectra of the sun and the lime light. The absorption bands in the ultra red of the former had the same position, though the prisms were varied, those used being flint glass, bisulphide of carbon, and rock salt. The position and intensity of the heat maximum and the intensity of absorption were found to vary with the time of year and of day at which the observations were made. The heat spectrum of limelight is continuous, and its maximum further removed from the end of the visible spectrum than in the case of sunlight.—E. Hagenbach continues the account of his experiments on fluorescence of various substances; and H. Weber communicates a paper on the Heat Conductivity of Iron and of German Silver.—The serial also contains (of original articles) a short note from Prof. Clausius in reply to Prof. Tait's last communication; a description of an improved Holtz machine, by W. Musaeus; a note on the spectrum of aurora, by A. v. Oellingen; and one or two others not calling for special notice.

THE *Scottish Naturalist* for October opens with an article by Mr. J. Allen Hooker, on "The Study of Entomology," containing some very useful hints to young entomologists as to the direction in which their studies and observations can be most usefully turned, some of which are all but entirely neglected by collectors in this country. Mr. James Hardy then describes his new "Ragwort-seed Fly," *Anthomyia Jacobææ*; and Dr. Buchanan-White concludes his account of the nest of *Formica rufa* and its inhabitants. A number of items of information of especial interest to Scottish zoologists and botanists fill up the number. In both the last two numbers there are instalments of the "Insecta Scotica," the Lepidoptera of Scotland by Dr. Buchanan-White, and the Coleoptera of Scotland by Dr. D. Sharp.

SOCIETIES AND ACADEMIES

PHILADELPHIA

Academy of Natural Sciences, April 9.—Prof. E. D. Cope read a paper on "Intelligence in Monkeys." "I have two species of *Cebus* in my study, *C. capucinus* and a half-grown *C. apella*. The former displays the usual traits of monkey ingenuity. He is an admirable catcher, seldom missing anything, from a large brush to a grain, using two hands or one. His cage door is fastened by two hooks, and these are kept in their places by nails driven in behind them. He generally finds means sooner or later to draw out the nails, unhook the hooks, and get free. He then occupies himself in breaking up various objects, and examining their interior appearances, no doubt in search of food. To prevent his escape I fastened him by a leather strap to the slats of the cage, but he soon untied the knot, and then relieved himself of the strap by cutting and drawing out the threads which held the flap for the buckle. He then used the strap in a novel way. He was accustomed to catch his food (bread, potatoes, fruit, &c.) with his hands, when thrown to him. Sometimes the pieces fell short three or four feet. One day he seized his strap and began to throw it at the food, retaining his hold of one end. He took pretty correct aim, and finally drew the pieces to within reach of his hand. This performance he constantly repeats, hooking and pulling the articles to him in turns and loops of the strap. Sometimes he loses his hold of the strap. If the poker is handed to him, he uses that with some skill for the recovery of the strap. When this is drawn in, he secures his food as before. Here is an act of intelligence which must have been originated by some monkey, since no lower or ancestral type of mammals possess the hands necessary for its accomplishment. Whether originated by Jack, or by some ancestor of the forest who used vines for the same purpose, cannot be readily ascertained. After a punishment the animal would only exert himself in this way when watched; as soon as an eye was directed to him he would cease. In this he displayed distrust. He also usually exhibited the disposition to accumulate to be quite superior to hunger. Thus he always appropriated all the food within reach before beginning to eat. When different pieces were offered to him, he transferred the first to his hind feet to make room for more, then filled his mouth and hands, and concealed portions behind him. With a large piece in his hands, he would pick the hand of his master clean before using his own, which he was sure of."

PARIS

Academy of Sciences, October 14.—M. Faye, President. M. Tresca presented to the Academy the resolutions of the International Metrical Commision, which will be found in another column. — M. Yvon Villarceau then read a paper on the constant of aberration and the speed of light, considered in their connection with the absolute movement of translation of the solar system.—M. J. Bertrand presented observations on the last number of the "Journal für die reine und angewandte Mathematik," Berlin (Band 75, Erstes Heft); the observations consisted of a reply to Helmholtz's answer to the objections raised against his electro-dynamic theory.—M. Max Marie then read, "An extension of the Method of Cauchy to the study of Double Integrals, or theory of elementary contours in space."—A note from M. Ch. V. Zenger, on the action of conductors disposed symmetrically around an electroscope, followed. It was referred to the Commission on lightning conductors.—Some new documents from M. Buss relative to his governor for motive power engines were referred to MM. Tresca and Morin. A project for military aërostation, from M. J. Boué, and another for aërial navigation from M. H George, were referred to the Commission on Aërostation.—M. E. Guillier's proposed process for the destruction of *Phylloxera* by the use of a "mixture of the ashes of healthy vine wood, soot, river sand, washing water, essence of turpentine, and ammonia," M. Ajot's proposal for the same purpose, and M. Loarer's* note on the appearance on some exotic plants of certain insects believed to have come from transported *Phylloxera* eggs, were all referred to the *Phylloxera* Commission.—M. F. Massieu's note on the determination of the maximum tensions of vapours was then read, and was followed by a note from M. T. du Moncel on the action of carbon powder rammed down round the negative electrodes of carbon batteries. The author finds that coarse carbon powder thus used greatly diminishes the resistance in the battery.—This paper was followed by one from M.M. Schützenberger and Géradin, on a new process for the estimation of free oxygen.—M. A. Petit's note on "antifermentescible substances" followed. By the above name the author means bodies which prevent fermentation, he finds bichloride and binoxide of mercury the most powerful in this way.—M. E. J. Marey then read a note on the paces of horses studied by the graphic method. The author exhibited a number of traces obtained by an instrument which followed the muscular movements and traced them on paper.—Next came M. A. Sanson's paper entitled "Researches on the Fleeces of precocious Merinos."—M. Stan. Meunier then read a paper on the characters of the crust produced on terrestrial rocks by atmospheric agency, compared with the black outer crust of grey meteorites.—After which M. Chasles made some remarks on presenting a work entitled, "Il S. Offizio, Copernico e Galileo," &c., by M. Govi. He was followed by M. Larrey, who addressed the Academy on presenting the Report of the Director-General of the Medical Department of the English Army, for 1870; and after M. Bouley had made a long and very favourable critique on Mr. Fleming's work on hydrophobia, the session was adjourned.

* In the report of the meeting for the 30th September this author proposed the use of sulphide of arsenic to destroy the *Phylloxera*, and his name was then wrongly given "Louvet."

BOOKS RECEIVED.

ENGLISH.—On the Culture of the Observing Powers of Children (Youmans and Payne: (H. S. King and Co).—The English Elocutionist: C. Hartley (Groombridge).—Human Physiology: J. L. Nichols, M D. (Trübner).

FOREIGN.—Die Sonne: Parts 2 and 3: P. A. Secchi.—Medizinische Jahrbücher: S. Stricker, 1872, Parts 2 and 3.—Bulletin de la Société Impériale des Naturalistes de Moscou, 1872, No. 1.—Bericht über die Senckenbergische Naturforschende Gesellschaft, 1871-1872.

DIARY

FRIDAY, NOVEMBER 1.

GEOLOGISTS' ASSOCIATION, at 8.—On the Influence of Geological Reasoning on other Branches of Knowledge: Dr. Hyde Clarke.

SUNDAY, NOVEMBER 3.

SUNDAY LECTURE SOCIETY, at 4.—On Ancient and Modern Egypt; the Pyramids and the Suez Canal: W. B. Carpenter, M.D., F.R.S.

MONDAY, NOVEMBER 4.

ANTHROPOLOGICAL INSTITUTE, at 8.—Man and Ape; and The Origin of Serpent Worship: C. Staniland Wake.

TUESDAY, NOVEMBER 5.

SOCIETY OF BIBLICAL ARCHÆOLOGY, at 8 30.—Adjourned Discussion upon Israel in Egypt: Revd D. Haigh, M.A.—On an Assyrian Prayer: Henry Fox Talbot.—On the Religious Beliefs of the Assyrians, No. II.: Henry Fox Talbot.—On the Tomb of Jacob at Shechem: Prof. Donaldson.—A T Conjugation such as exists in Assyrian, shown to be a character of early Shemite speech by its vestiges found in the Hebrew, Phenician, Aramaic, and Arabic Languages: Richard Cull.

ZOOLOGICAL SOCIETY, at 8.30.—Report on additions to the Society's Menagerie: the Secretary.—On *Platypsyllidæ*, a new family of Coleoptera: Dr. G. L. Le Conte.—On Lepidoptera collected by Dr. Van Patten in Costa Rica: Messrs. A. G Butler and H. Druce.

WEDNESDAY, NOVEMBER 6.

MICROSCOPICAL SOCIETY, at 8.—On the Structure of the Valves of *Eupodiscus Argus* and *Isthmia enervis*: H. J. Slack.—Proposal for a standard of comparison of the magnifying powers of Compound Microscopes J. E. Ingpen.

THURSDAY, NOVEMBER 7.

LINNEAN SOCIETY, at 8.—On the "Piopio" of New Zealand (*Keropia crassirostris Gmel*): T. H. Potts.—On the buds developed on leaves of *Malaxis*: George Dickie, M.D.

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ERRATA.—Vol. vi., p. 459, first column, line [illegible] from top, for "58·7 − 53·8 = 4°·9," read "58·7 − 53·08 = [illegible]" and p. 460, first column, line nineteen from top, for "most" read "not."