THURSDAY, JULY 15, 1886

GEOLOGY OF TURKESTAN[1]

II.

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

THE view taken by M. Moushketoff and other modern explorers of the region, as to the Aral-Caspian basin having consisted of several large lakes, or rather seas, connected together by outlets, is, in our opinion, the only one which can adequately explain the ulterior changes undergone by the basin during historical time; and it is also fully in accordance with the orographical configuration of the region. These outlets have gradually dried up, and it is probable that the Aibughir and the Balkhan outlets both existed during the historical period.

The basin of the Aral and Sary-kamysh was long maintained by the inflow of water received by the Amu and the Sir. There may have been a period when both joined together before entering the great lake; but later on, the Amu entered the Sary-kamysh, or western part of the double lake; while the Sir flowed into its eastern or Aral part. As the Amu, undermining the Sultan-uiz-dagh hills, gradually moved further east, and finally, finding its way through this range, began to flow into the Aral, the Sary-kamysh lakes, deprived of its water, dried up much more rapidly. The Aral basin, in the meantime, may have increased in size.

As to the Uzboy, which was considered by the earlier explorers as a former bed of the Amu-daria, M. Moushketoff, in accordance with the majority of the more recent explorers, considers it a marine outlet which connected both the great lakes; and the absolute want of any river-deposits and the wide extension of Caspian shells up the Uzboy serve to confirm this view. The drying up of the Aral goes on now very rapidly. The disappearance of the Aibughir gulf; the conversion of the Sary-cheganak gulf into a mere lake; as also that of the Kamyshly-bash, which the Kirghizes remember to have been connected with Lake Aral; together with the numerous facts mentioned by MM. Severtzoff, Borschoff, Meyendorf, Maksheeff, and Schultz, are well known. The observations of MM. Kaulbars and Dorandt furnish most valuable data of the same kind for other lakes of the region: the Sary-kamysh, now 50 feet below the level of the Caspian, covered a surface of no less than 4400 square miles. And we may add that these facts are not isolated ones, but that the same rapid drying up is going on throughout Western Asia: it is the characteristic of the geological epoch in which we now live.

Many most interesting pages are devoted by M. Moushketoff to wind-agencies and to moving sands. His observations on dunes and analogous sand-hills, accompanied by several drawings, will assuredly be most welcome to geologists. M. Moushketoff distinguishes between two different kinds of sand-hills: the dunes, arising on the shores of lakes, and the *barkhans*. Wind is a powerful agency in the formation of both. Recent meteorological observations have shown that north and north-east winds are much more prevalent than any others in the Turan region. On the lower Amu-daria and at Tashkend they are from 50 to 60 per cent. As to the rains they are so scanty that throughout the year their aggregate amount hardly reaches 69 millimetres at Petro-Alexandrovsk, and 73 at Nukus. The evaporation, as appears from M. Stelling's work, is exceedingly great. Thus, while at Kishineff, for instance, the annual evaporation exceeds the annual amount of rain by only one-fifth, it is five times greater than the amount of rain at Astrakhan, three times greater at Tashkend, twenty-seven times at Nukus, and thirty-six times at Petro-Alexandrovsk. The yearly amount of rain being represented by a column 69 millimetres high at Petro-Alexandrovsk, the evaporation is so great that a column of water 2320 millimetres high would be evaporated every year; at Nukus the respective figures are 71 and 1928 millimetres. These climatic conditions would suffice, in M. Moushketoff's opinion, to explain the geographical distribution of the moving sands which appear more especially to the south of Lake Aral.

Now, among these moving sands two different kinds of moving hills should be distinguished; the *dunes* and the *barkhans*. The former are indebted for their origin to the combined action of water and wind; they are disposed in long waves along the shores of the lakes or rivers—these last (the river-dunes) being local and never reaching more than 10 or 15 feet in height. The marine dunes, attaining as much as 50 feet—not more—have lengths reaching to about 700 yards. They arose in consequence of the retiring of the Aral Sea and the prevailing winds. These dunes have the most varied directions, according to the local direction of the former shore-line.

As to the *barkhans* they are indebted for their origin to the agency of the wind alone. They can arise only under certain climatic conditions, and may appear covering any geological formation, like the moving sands o the Ili River, which are due to the destruction of massive crystalline rocks, or the sands of the Sahara, which are a result of the disintegration of basaltic rocks. Their outer shape is quite characteristic, being always that of a crescent, or, to use Middendorff's comparison, it resembles the hoof of a horse. Sometimes two, three, or four *barkhans* are connected together, and then they appear like a succession of crescent-shaped conical hills, connected by their respective horns. Their height is usually from 30 to 40 feet; there are, however, much smaller ones, and a few reach as much as 80 and even 100 feet. The sand of which they consist varies according to the nature of the rocks to whose disintegration they are due; the angles of inclination of their slopes also vary between 30° and 40° on the side turned to the wind, and between 6° and 16° on the opposite side.

On the whole, on seeing these hills, one would refuse, according to M. Moushketoff, to recognise in them a formation due to the sole agency of the wind, but one must witness a storm in the desert to recognise its full force. Still, during a very strong storm, M. Moushketoff did not see the wind moving particles of sand more than 1 to 2 millimetres in diameter.

[1] Continued from p. 119.

We should very much like to go further into an analysis of the interesting observations on the loess, scattered through M. Moushketoff's "Turkestan"; but can only mention that the loess which is widely spread over the region, both on the outskirts of the Tian-Shan and in the neighbouring lowlands, is always accompanied by what the author describes as a "conglomerate," and which is most probably some kind of more or less modified glacial deposit. Both are inseparable, and the loess invariably covers the "conglomerate" when they are met together. Of course, the loess extends further in the lowlands, and the "conglomerate" in the hilly tracts. Sometimes there are layers of loess amidst the "conglomerate." As to the loess itself, although mostly quite typical, it sometimes appears stratified to a certain extent; but it does not differ at all from the unstratified loess. M. Moushketoff accepts Richthofen's theory as to the eolic origin of loess; but he does not deny that water spreading over a wide surface at the issue of small depressions of the ground, gives the same typical loess as that which may be considered eolic in its origin.

We ought to notice also a special question discussed at length by M. Moushketoff, namely, his thorough researches, made in company with Prof. Beck, on the nephrite (jade) of which the stone on the grave of Timur at Samarkand is made, as to its chemical composition, micro-structure (represented on a coloured plate), and also the different places where nephrite is found throughout the world. But we must merely commend these interesting researches to the attention of mineralogists.

As may be seen from the foregoing notice, the work of M. Moushketoff is an acquisition of the first importance for all those interested in the geography and geology of Turkestan. The chapters containing the descriptive part of the work will be, for a long time to come, an especially valuable source of varied and reliable information.

P. K.

CHEMISTRY FOR THE GOLD-FIELDS

Chemistry for the Gold-Fields: including Lectures on the Non-Metallic Elements, Metallurgy, and the Testing and Assaying of Metals, Metallic Ores, and other Minerals, by the Test-tube, the Blow-pipe, and the Crucible. By James G. Black, M.A., D.Sc., Professor of Chemistry, Metallurgy, and Assaying in the University of Otago, and Otago School of Mines. 8vo, pp. 569. (Dunedin, 1885.)

THE title "Chemistry for the Gold-Fields" the author justifies by stating in his preface that in writing this book he had three objects in view:—

"First.—To put into the hands of miners and prospectors a guide to enable them to identify, by simple tests and cheap appliances, the valuable ores when they find them.

"Second.—To provide a manual in chemistry, metallurgy, analysis, and assaying for the 'Schools of Mines' which are now being established on the gold-fields of the colony.

"Third.—To provide for his own students in the chemistry, metallurgy, and assaying classes in the University of Otago, a text-book in these subjects introductory to the larger treatises"

The book includes an elementary treatise on the chemistry of the various elements, and on this portion of the book it is scarcely necessary to dwell, as it is claimed that "the feature of the book" is to deal with "such subjects as have a direct reference to the mineral resources" of New Zealand, and "the extraction of the metals from their ores." We propose, therefore, to confine our remarks to that portion of the work which relates more especially to the detection of minerals, the methods for assaying them, and their metallurgical treatment. The ores of each metal are described, their chief physical characteristics being stated, as well as the ordinary blowpipe tests, and this latter portion of the subject is made more useful by an appendix on the use of the blow-pipe by A. Montgomery, M.A., the brevity of which is greatly to be regretted.

To the metallurgy of zinc the author devotes little more than three pages, nearly half of which is devoted to the abandoned English crucible process. The Belgian process is briefly described, and in half-a-dozen lines the Silesian process is touched upon. With regard to this latter description the author remarks that "various modifications of this process have now, it is said, been adopted in many of the larger smelting works." This remark could with justice have been appended to many of the descriptions of other processes given by the author. In the metallurgy of lead the use of iron for the decomposition of the silicate is not mentioned, and the description of lead-refining is very incomplete, as also is that of the process for the de-silverisation of lead by the aid of zinc; the use of steam for the de-zincification of the lead is not given. In the description of the Welsh process of copper smelting the coarse metal slag is stated to be a ferric silicate—ferric silicates are, as such, rarely, if ever, produced in metallurgical processes. In describing the refining of copper the author gives equations to show that the reduction of the cuprous oxide on poling is due to the products of the dry distillation of the green wood employed; the action of the anthracite spread over the molten metal is not referred to. The electrolytic refining of copper is not mentioned, and electrolytic processes generally, which would be so important in a country like New Zealand, are ignored.

In describing the Ziervogel process the author remarks, p. 344: "When copper pyrites containing silver is roasted, under certain conditions, the iron and copper may be converted into insoluble oxides, while the silver is converted into sulphate of silver which dissolves in water. The presence of mercury promotes this reaction." This at least suggests that mercury should be charged into the roasting furnace. Again, p. 348, Ziervogel's "process is now carried on on a large scale at Freiberg, in Saxony," the fact being that it has long been abandoned there, except as a very minor incident of a portion of the process. The process of pan-amalgamation, as described by the author, is inaccurate. In describing the methods employed for the production of steel, the Siemens "ore and pig" process is not mentioned, and the basic Bessemer process is only referred to by the sentence: "By a recent invention, however, whereby the converter is partly lined with lime, it is said that sulphur and phosphorus are also removed in the Bessemer process."

The author suggests "a rapid process for distinguishing galena from zinc blende, grey antimony ore, and the other mineral sulphides for which it is sometimes mistaken," which involves solution, evaporation, &c., for lead sulphate, filtration, and submitting the solution to ordinary chemical tests. This is surely not a method adapted to the use of "miners and prospectors."

With regard to assaying, in the case of copper ores not one of the ordinary methods of assay is given, and the ordinary method for assaying silver ores finds a place in an addendum to the volume. The whole book affords additional evidence of the prevalence of the belief in the fallacy that a chemist must of necessity be acquainted with a subject so dependent on his own, yet so widely differing from it, as metallurgy.

OUR BOOK SHELF

Microbes, Ferments, and Moulds. By E. L. Trouessart. "International Scientific Series." (London: Kegan Paul, Trench, and Co., 1886.)

THIS book, which aims at the instruction in microbes not so much of the medical and scientific as of the general public, is a fairly accurate exposition of the present state of our knowledge of the morphological and physiological characters of moulds and bacteria.

The chapters on fungi and moulds, of the various ferments and yeasts, and their chemistry, are the best parts of the book. Those on bacteria, septic and pathogenic, are less commendable, since they contain a good many dogmatic statements not accepted by bacteriologists. The chapter on laboratory research and culture of microbes is imperfect in its account of the now generally employed methods of cultivation on solid nutritive media.

One of the most conspicuous deficiencies of the book in the eyes of the scientific reader is the one-sided account given by the author of many of the discoveries made in bacteriology, since the works of French authors form as it were the basis of the author's account. It is certainly a novel proposition that "the science of microbes is essentially a French science."

The book is well illustrated, and written in a clear and concise manner.

LETTERS TO THE EDITOR

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

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

Luminous Clouds

THE clouds described by D. J. Rowan, on p. 192 in your issue of the 1st inst., seem to have been of the same kind as were described in several letters in NATURE last summer; they were seen by myself in Bavaria. I saw these extraordinary clouds again this year, on the 28th of May, at Freshwater Bay, Isle of Wight, and on the 23rd of June at Bideford. They were seen by A. C. Dixon at Sunderland on the 2nd, 3rd, 13th, 16th, 22nd, and 23rd of June, and on the latter date were very striking. A description of them on the same date, written by E. Greenhow, appeared in the *Newcastle Chronicle*, as seen near Earsdon in Northumberland, erroneously describing them as a kind of aurora. On that night the display at Bideford was comparatively slight: at 10.18 p.m. the upper limit of the clouds distinctly visible was five-eighths of the way from the horizon to γ Andromedæ, and I presume that that was the limit to which the sun was shining upon them; though with field-glasses I could see them very faintly rather higher up.

I never saw them before last summer, and they are quite different from the iridescent clouds that have created such interest the last two winters, resembling them only in their height and brilliancy. If they require a name I hope the word *boreales*, as proposed by Mr. Rowan, will not be adopted; for they appear in the north only because the sun lies in that direction, and if they occurred at any other time of the year, or in any place much further south than this country, their direction would necessarily be different. On all the occasions which I have seen these clouds they have exhibited a very fine structure like cirrus. The colours of the clouds appear to be due to the same cause as the colours of the sky, for they generally correspond with these at similar altitudes, the upper visible portion of the sheet of clouds being green or bluish, and the lower portion a dull yellow, becoming more orange towards the horizon.

Sunderland, July 8 T. W. BACKHOUSE

Re Immisch's Thermometer

IN your article, p. 234, referring to this pretty little instrument, you refer to the appellation "metallic" as not a happy one in describing it. This I pointed out to the maker some time ago, and termed it an *avitreous* thermometer, as glass plays no part in its construction beyond that of a protector to the dial. The certificates of verification are printed with the instrument so designated, and probably the erroneous term will soon drop out of use. I must also crave permission to correct a misprint in your correspondent's statement with regard to the number of avitreous thermometers verified here up to the present date: for 500 read 300. G. M. WHIPPLE,

Superintendent Kew Observatory

Kew Observatory, July 10

Kirby and Spence's "Introduction to Entomology"

WITH reference to a just complaint made by "R. M." in his article contained in NATURE for July 1 (p. 190) about the want of good indexes to books, and specially to the early editions of Kirby and Spence's "Introduction to Entomology," may I venture to inform him that should an index to the latter book be desired by "R. M." or any other reader of NATURE, they have only to apply to "E. E. J.," Camerton Court, Bath, to obtain one *gratis*. I found the book so perfectly useless for want of one, that I made one some years ago, a copy of which was accepted by the British Museum authorities, and is now included in their Catalogue. I have a good many copies on hand, which I am always glad to give away on application.

E. E. JARRETT

11, Holles Street, London, W., July 8

ON VARIATIONS OF THE CLIMATE IN THE COURSE OF TIME[1]

II.

IF such a periodical variation in the climate does take place, we should be able to trace it in the older formations, as we cannot assume that it first began to operate in the most recent geological age. We must, therefore, try to discover if such variation can be traced in the earlier times.

During the melting of the Norwegian inland ice it left here and there moraines, and on the map drawn by Kjerulf they are seen to stretch in lines more or less continuously across large parts of Southern Norway. On both sides of the Christiania fjord the outside lines, the so-called "Raer," stretch like gigantic ramparts from Moss and Horten south-east and south-west many miles wide through Smaalenene and far into Sweden, and, on the other side of the fjord, through the province of Jarlsberg and Laurvig to Jomfruland outside Kragerö. And behind this outside line of moraines others follow in more or less broken but distinct continuity, one behind the other, through all Southern Norway. These lines show that the

[1] The following is a short abstract from various papers, viz.: "Essay on the Immigration of the Norwegian Flora during Alternating Rainy and Dry Periods" (Christiania, 1876). "Die Theorie der wechselnden kontinentalen und insularen Klimate," in Engler's *Botanische Jahrbücher*, ii. (Leipzig, 1881). "Ueber Wechsellagerung und deren mutmassliche Bedeutung für die Zeitrechnung der Geologie und für die Lehre von der Veränderung der Arten," in *Biologisches Centralblatt*, iii. (Erlangen, 1883). "Ueber die wahrscheinliche Ursache der periodischen Veränderungen in der Stärke der Meeresströmungen" *l.c.* iv. (Erlangen, 1884) Continued from p 222.

ce did not recede gradually, because it would not then have left behind such great ramparts, but the sand and the gravel would have been spread more evenly. During the melting, however, its edge remained at times stationary, or advanced perhaps a little. At each such event a row of moraines was formed, and as the same are found in large tracts of the country, they cannot be attributed to local circumstances, but we have to assume *that periodical variations of climate were the cause of the manner in which the ice receded.*

We found in the peat-bogs alternately layers of different kinds, peat alternating with remains of forests several times, and we saw how this was easiest explained by periods of change in the climate. But these alternating layers are not peculiar to the peat alone, but found in all stratified formations, loose as well as solid, whether deposited in fresh or salt water, or on land, in all the strata from the Laurentian gneiss to the loose deposits of the present age. Take a geological structure from any age, alternating layers will be found everywhere. Sand alternates with gravel, sandstone with conglomerate, clay with sand, slate with sand or sandstone, marl with clay, chalk with marl, and so on. The layers vary in thickness, from several yards to less than an inch.

The solid rock withers away by the action of air and water in heat and cold; it partly crumbles away mechanically and partly changes chemically. The products of the erosion are carried by wind or running water as dust, in dissolved or original state, and deposited in places more or less remote from those where they were produced. The foaming mountain stream often carries great stones in its course, and the softer the wind and the weaker the current the finer is the matter deposited. When the current becomes weak the gravel sinks first, then the sand, then the clay, and, finally, the chemically-dissolved lime by the animal life in the water. When we, therefore, have a change of beds of different composition through all geological ages, as those mentioned above, it must be due to the circumstance that the speed of the depositing stream was always varying—now increasing, now decreasing.

The *Challenger* Expedition has taught us that all the stratified rocks which geologists hitherto have known must have been formed comparatively near the shore, even if deep-sea formations. They are all of quite a different nature from the strata in the abysses of the great oceans. From this it follows that the variations in the rainfall might have had some influence on the nature of the strata in the known geological formations, since they were formed comparatively near land and are the result of the erosion of the solid rock. A weak river is unable to carry debris far out to sea, but a strong one is capable of supplying the sea-currents with deposits over great areas. When, therefore, the rivers alternately increased and decreased, the sand, clay, and gravel were carried now a greater, now a less distance, into the sea, and thereby the variations of the layers were produced.

It is, however, not the intention to assert that all alternations of layers are due to that long climatic period. When the stratification goes on quickly, and the supply of matter is plentiful, rapid local changes may produce an alternation of strata. In the Norwegian marl-clay, formed during the melting of the inland ice, alternating thin layers of sand and clay are found, varying in colour, sometimes only a quarter of an inch in thickness or even less. These variations must be ascribed to changes during brief spaces of time, and cannot be referred to the long climatic periods. But, of course, such layers are only formed in the immediate vicinity of the coast, and during the constant advance and retrogression of the latter, which may be traced through all geological ages, such shore-formations were most exposed to destruction. They were frequently lifted above the sea, and were more exposed to the destructive agencies—air and currents—than those formed in deeper waters further from the shore. For this reason these quickly-formed layers have at all times been more exposed than others to destruction, and we must, for that reason, conclude that most of the beds which constitute the geological stratified deposits were formed somewhat further from the shore, and that, consequently, the time of their formation was longer. From the thickness of the layer alone it is impossible to form an idea of the time it has taken to form, because in the time a layer in one place upwards of several yards in thickness has been forming, only an inch has formed in another, whilst in a third place in the same time the formation has ceased, or older layers even carried away. But we have a means whereby we may ascertain the time it has taken to form a layer, viz. the study of the remains of the flora and fauna found in the same. The most frequent species have, *ceteris paribus*, the most chance of being preserved. When, therefore, we find that fossils, as is often the case, vary from stratum to stratum, we must assume that this proves that great changes took place in the fauna and the flora during the formation of each stratum. What was stated above with regard to the variations in the peat-bogs of remains of plants from layer to layer *may be applied to variations of strata through all ages.* The examination of the fossils in the strata teach us respect for Time. The fossils vary quickly even in strata of small thickness. In one stratum we find remains of distinct animals and plants, and in the one above—although, perhaps, only an inch above it —we find others quite different. A thin stratum of a couple of inches is sometimes distinguished by peculiar animals and plants, so that the stratum may be recognised over large areas by the aid of the same. When two strata of different nature alternate, it is generally found *that one kind of stratum contains certain fossils, and that those of the others are quite different.* The theory of periodical variations of the climate *explains all this.* Because if the sea-currents varied in strength, the temperature of the water, and consequently the aquatic fauna and flora, must have changed too; with a higher temperature of the sea the moisture of the air and the rainfall must have increased, *and thus a periodical change of the sea-currents would have the effect of causing variations of the strata.* It is exactly such strata of varying nature, and varying forms of fauna and flora, which would build the geological strata of the earth.

We have seen how this theory explains a number of various well-known puzzles to scientific men, viz. the scattered extension of species of plants and animals; the formation of the terraces of shell-banks and shore-lines; the rows in which moraines appear; and, finally, the alternation of peat-layers and various geological strata. It only remains now *to find a natural cause for such a periodical variation of the climate*, but before doing this it is necessary clearly to understand what the theory demands.

It does not require great changes; all the facts on which it is founded may be explained by comparatively small variations in the extremes of temperature and rainfall. No very great variation is required in order that the holly and similar coast-plants should be able to grow by the Christiania fjord, as the theory assumes it once did; because the holly, which cannot stand the winter cold at Christiania (lat. 60° N.), has for many years been successfully cultivated in the open air at Horten, only half a degree further south on the same fjord. And along the coast plants of Oriental origin have, during the last thousands of years, spread from the Christiania and Throndhjem fjords right out to the open shores of Jæderen and Fosen, the former in lat. 58°–59° and the latter in lat. 63°–64° N., and there would hardly be required a very great change to enable them to grow also in the intervening district, the province of Bergen, which would again make their extension continuous.

Whether the surface of a bog becomes covered with forest or not, whether the peat grows or not, whether during the rising the erosion is strong enough to hollow out the shore-line, or the carrying power of the river is great enough for the formation of terraces, whether the edge of the inland ice recedes or advances, whether a deposit of clay or marl is to be found in a certain place near the shore, or whether chalk only is left—*may entirely depend on small variations in the climate, as the conditions will alter as soon as a certain point is reached.* The periodical changes dealt with here were therefore not great; but as they acted simultaneously, and in the same direction, over whole climatic areas, it must be generally-acting forces which caused the same, and not variations in local conditions.

The theory advanced here proves thus that the climate is at all times subjected to periodical changes, the duration of which may be measured in thousands of years, and which act in the same direction within the same climatic area, which for one period are not important, but which, as the alternation of the strata is often remarkably regular, *seem to return after the lapse of a fixed cycle of years.*

It is obvious that periodical changes in the strength of the ocean currents will cause corresponding changes in the climate of the adjacent continents. Thus, for instance, if the warm North Atlantic current, to which North Europe owes its climate, which is mild compared with its latitude, should increase in strength, the climate there would doubtless become still milder. Our shell-banks show that such changes in the temperature of the sea have accompanied climatic variations. We are, therefore, compelled to ask, What is the force which causes this warm sea-current to flow northwards, and may we assume that there is some natural cause effecting periodical changes in the intensity of this force? The question being one as to a climatic period, we must examine the great laws which govern the climate. We must, of course, leave all temporary disturbances of the air out of consideration, and only pay attention to the great and simple laws which are revealed by the synoptic charts of the average distribution of the aërial pressure at various seasons. These charts show us:—in the summer a low pressure over the heated continents, but generally a higher one over the cool oceans; and in the winter a higher pressure over the cold continents, and a lower one over the oceans, which are warmer.

In order to understand this varied distribution of pressure, we shall imagine an atmosphere which everywhere has the same degree of heat and the same height. The warmer the air the more it expands, so that the height of the atmosphere will change if the temperature rises or falls. If we further assume that the air cools or becomes more quickly heated in some places than others, the equilibrium will be disturbed. Over cold areas the height of the atmosphere will decrease. The surface of the atmosphere should thus become uneven, and consequently, in the upper strata of the atmosphere air must flow from the warm regions into the cold ones, so that equilibrium be maintained. For this reason a greater mass of air will lie over cold regions, which have, therefore, a higher atmospheric pressure. But at the surface of the earth, too, the equilibrium will be disturbed, as a higher atmospheric pressure will drive the air from the cold to the warm regions. As long as the temperature of the air varies, movements will be created by the disturbed equilibrium, during which, therefore, air will flow from the cold to the warm regions along the surface of the earth, and *vice versâ* in the upper part of the atmosphere. In winter as well as summer the disturbances of the equilibrium of the atmosphere will proceed from the continents, because the latter are heated and cooled more intensely than the oceans. Over the ice-covered interior of Greenland the sun in the summer cannot create any low pressure, because all its heat is consumed in melting the snow. Even in the summer comparatively cold air and high pressure prevails over Greenland, and this is probably the cause of the atmosphere in the North Atlantic differing from the above-mentioned law, inasmuch as this ocean has a low pressure even in summer. This low pressure, which lies generally near Iceland, is, however, more marked in winter.

The air, according to the law of Buys Ballot, moves *against* the low pressures, so that in the Northern Hemisphere one has the low pressure a little in front to the left when turning the back to the wind. That is but a natural consequence of the rotation of the earth's axis. At lower latitudes this action is more intense. Air, flowing from lower to higher latitudes, retains for a time its original speed of rotation, and will thereby deviate in the direction of the rotation of the earth's axis, *i.e.* towards the east. And *vice versâ* when the air flows from higher to lower latitudes. In this manner southerly winds become south-westerly, and northerly ones north-easterly. In fact, the low atmospheric pressure at Iceland draws the south-west winds up the North Atlantic, and as the cause prevails all the year round, the consequence is that south-west winds blow in this sea summer as well as winter.

The opinion held by Croll, Zöppritz, &c., that winds are the chief cause of sea-currents, is now generally accepted by *savants.* The winds set the surface of the sea in motion, and by frictional resistance the movement is conveyed to lower depths. It depends on the force and the duration of the wind how deep the action will have effect. The main current runs in the direction of the prevailing wind, and its speed is dependent on the average speed of the surface. Winds of short duration are only capable of changing the direction of the current on the surface, but through the *predominance* of such winds through thousands of years, *great currents are created.* Their strength may vary, *but their direction is independent of temporary changes of the wind.* For the upper system of currents, which alone affects the climate, and which reaches to a depth of a couple of hundred fathoms (Mohn), the average direction and force of the wind during the last great epoch are determinal.

Such a great stream is the warm North Atlantic current. It softens the winter even at high latitudes. As the surface imparts heat to the air, the heat lost is replaced from lower depths, and as long as there is a store of heat below the sea will always yield heat to the air.

The mild climate of Norway is, therefore, dependent on this warm current. It runs predominantly in a north-easterly direction, and thus it must, in consequence of the general laws for currents and winds, have run through untold ages, or as long as sea and land have been divided as at present.

We will now see if the force which guides this current is periodically changeable. As we know, the orbit described by the earth round the sun is not circular but elliptical, so that the distance between the two bodies varies according to the seasons; when there is winter in the Northern Hemisphere the earth is nearest to the sun, and the nearer the earth approaches the sun the quicker it travels, so that the winter in the north is shorter than the summer. The difference is five days. In the Southern Hemisphere, on the other hand, the winter is five days longer than the summer. But these relations change through the precession of the equinoxes, the period having a mean duration of 21,000 years. Thus, 10,500 years ago the conditions were the reverse of what they are at present, and the same will be the case 10,500 years hence. The winter at the Northern Hemisphere will then fall when the sun is furthest from the earth, and last longer than the summer, and in the Southern Hemisphere the conditions will be the reverse.

But the orbit of the earth is also subjected to periodical changes, inasmuch as it differs more from the circular sometimes than at others. The further it deviates from it the greater becomes the difference between the length of winter and summer, and the difference may even amount to more than thirty days every year. The length of winter and summer varies therefore in the course of 10,500 years, and the difference increases the more the earth's orbit deviates from the circular. During the 10,500 years in which the winter is longer than the summer there will be several thousand more winter days than summer ones, and in the second half-cycle there will be as many thousand less. Even at present, when the orbit deviates but little from the circular, the excess of winter or summer days for each half-cycle is more than 50,000, and when the deviation is greatest it amounts to nearly 220,000 days, or some 600 years.

As the cooling of the continents contributes to preserve the low atmospherical pressure over the oceans, and thus directs the prevailing winds and currents at sea, the winds thus directed, as, for instance, the south-west winds of the Atlantic, must be stronger in winter than in summer. *And this is indeed the case.* The weather conditions differ in summer and winter. Of course south-westerly winds blow predominantly in the North Atlantic and West Europe all the year, *but they predominate more in the winter.* According to Prof. Mohn, their force in the North Atlantic is about three times as great in the winter as in the summer, and similar conditions prevail in the Pacific Ocean. In the southern temperate seas north-west winds, which correspond to south-west ones with us, are equally predominant when there is winter in that hemisphere. It will therefore be seen that the forces which promote the warm sea-currents in our latitude *are most active in the winter.* And the same is the case in the Southern Hemisphere, so that it must be said that the winter favours these currents, whether it falls when the sun is nearest, as with us, or when it is most distant, as in the Southern Hemisphere. From Prof. Zöppritz's studies of the currents it appears that the wind exercises an influence upon the strength of them even long after it has ceased to blow. The action of the winds is summed up through centuries, *and the total recorded in the sea-currents.*

As we know that the wind conditions vary at different seasons, and that the effect of the wind does not cease as soon as it is discontinued, but leaves traces in the sea-currents for a long time after ; so that, in fact, the strength of the current is dependent on the average force of the wind during last great ages—it can hardly be a matter of indifference whether these thousands of days fall as a surplus to winter or summer in the 10,500 yearly half-cycle. When they fall in the winter, the south-west winds must be more predominant than others ; and, correspondingly, when they fall to the summer, weaker. It seems, therefore, reasonable that the currents must increase or decrease as the equinoctial line moves round. When the winter falls in aphelion our warm currents will increase, and when the reverse is the case they will decrease. We should, therefore, now in the Northern Atlantic have a weaker current, and in North-Western Europe less rain and a greater difference between winter and summer heat, *and this is exactly what the theory demands.*

In regions with different weather conditions the case will be different. For instance, in the eastern part of North America north-west winds are more predominant in the winter and south-west ones in the summer. Winter, in aphelion, would here increase the north-west wind, and one might conclude that these parts under such conditions would perhaps thereby obtain a more severe climate, so that it seems evident that variations in the climate will not simultaneously move in the same direction everywhere in the Northern (or Southern) Hemisphere.

From calculations we have elsewhere demonstrated that the varying length of the season alone during the precession of the equinoxes will cause an increase or decrease in the force of the current of several per cent. of the total. And these figures are doubtless below the true ones, but space does not here permit of developing them. We may, therefore, with a high amount of probability conclude *that the precession of the equinoxes causes periodical variations of the climate which are great enough to explain all the facts on which the theory for these periodical variations is based.*

But the eccentricity of the earth's orbit changes so rapidly that in two consecutive half-cycles it is not as a rule the same. Therefore variations in the strength of sea-currents, and consequently also those in the climate in one half-cycle will not be quite balanced in the next, and it might even be possible that greater and more lasting variations of the climate might be caused by the same agencies. A. BLYTT

The University, Christiania

VEGETABLE PRODUCTS AT THE COLONIAL AND INDIAN EXHIBITION

IN passing through the various courts of the Colonial and Indian Exhibition the prevailing natural resources of each colony are apparent even to the most unobservant, for while the riches of some countries are to be found chiefly in their vegetable products, the wealth of another is in its mineral resources, and of another in its animals.

Regarding the vegetable products, as might be supposed, some of the most interesting objects from a scientific point of view are those which have the least attraction for the general public, such, for instance, as the large and varied collection from the Straits Settlements, or the interesting exhibits from British North Borneo. Amongst the exhibits from the former possessions are various samples of damar, the botanical origin of which is but imperfectly known ; thus, for instance, are specimens of damar sesa, a fossil resin from Larut, Perak, damar meta kuching, or cat's-eye damar, damar renkong, and others. Another fossil resin new to us is called incense or gum Benjamin. Under the name of buah saga are shown some seeds of an *Adenanthera*, probably those of *A. pavonina*, a seed of which is the unit in the Malay jeweller's weight, equal to 4·33 grains troy. The seeds are also eaten by the natives. The tree is found in India, China, and the Philippines. In India the wood, which is of a red colour, hard, and close-grained, is known as red sandal-wood, and is used as a red dye, as well as for cabinet-making and building purposes. On account of their bright red colour the seeds are used as necklaces. Naturally in countries where the bamboo is abundant we should expect to find numerous illustrations of its uses, and various articles of domestic utility, as well as for other applications besides that of ornament, are shown, some of which are very ingenious, such as a trap called grôgoh, used for catching river fish ; it is somewhat of the shape of an eel-pot, and the body of the trap is made of a single piece of bamboo-stem of about 2 inches diameter, and from 14 to 18 inches long. It is split longitudinally for the greater part of its length into fine strips, these are distended to a wide mouth at the top some 6 or 8 inches diameter, tapering to the point from which they spring, where they form the natural stem. By the addition of other fine strips of bamboo fastened round at short intervals a complete funnel-shaped basket or eel-pot is made, the lower or tubular end of which is formed by the hollow bamboo-stem. The ready way in which the natives adapt natural productions is seen in a very simple spinning-top, which is composed of a flattened acorn of the type of *Quercus placentaria*, through the centre of which a piece of wood is driven. In this division also are some very varied sets of betel-chewing appliances as used by the Malays, including the scissor-like implements used for cutting the betel-nuts ; many of these sets are in deftly-worked brass, while others are in more costly metals.

The collection from British North Borneo has many interesting exhibits, notably some remarkably fine specimens of gutta-percha and india-rubber a magnificent plank of the Sumatra or Bornean camphor-tree (*Dryobalanops aromatica*), the crystallised camphor of which is found deposited in cracks and fissures in the wood, occurring sometimes in very large masses; it is largely used by the Chinese, who prefer it to the ordinary camphor of commerce which is produced in their own country. Bornean tobacco is also a prominent object here, and is exhibited both in bundles of cured leaves as well as in cut form. A favourable report has been obtained of this tobacco, and it has been valued above the average of Sumatra tobacco, for which indeed it has been mistaken even by experts.

In the Hong Kong Court the varied uses to which bamboos and rattans are put are largely represented; the difference, however, in the character of the work to which the stems of these two classes of plants are applied is manifest at a glance, for while the rigid stems of the *Bambusas* are used for the rougher or coarser work, those of the pliable species of *Calamus* form the materials from which the finer basket-work, screens, &c., are manipulated. Various examples of the baker's art in the form of biscuits are shown by the Hong Kong and China Bakery Company, Limited, and it is stated, as an illustration of the capabilities of this bakery, that it can turn out 15,000 pounds of ship biscuits or 10,000 pounds of bread per day.

The British Guiana collection almost adjoins that of Hong Kong. Here, as might be expected from the extent of the forests of the colony and the abundance of large hard-wooded trees, timber takes a prominent place, and some magnificent specimens of the best known woods, such as mora (*Dimorphandra Mora*), greenheart (*Nectandra Rodiœi*), wallaba (*Eperua falcata*), and other well-known and useful timbers are exhibited. The heartwood of these timbers is described as "almost everlasting, the beams of old houses being good for over a hundred years in the most unfavourable circumstances of a tropical climate infested with wood-ants and other vermin." Specimens of tibiserie fibre and hammocks made from it are here exhibited. This fibre, which is obtained from the young leaves of the Eta palm (*Mauritia flexuosa*), is of wonderful strength and tenacity, from it the natives make their strongest and most durable cords and hammocks. It is very easily obtained and in any quantity, and if better known in Europe might become a valuable article of commerce. A fine collection of medicinal and tanning barks are here shown, but unfortunately, like the woods from this colony, comparatively few have other than native names. In the catalogue of exhibits it is stated that "the medicinal barks are very varied; a few are well known, but the majority, having never received the attention of chemists or physicians, are as yet untried, but may possibly be found worthy a place in the Materia Medica. Fair quantities are exhibited, and will be distributed to qualified persons who will undertake to report on their qualities. Most of them are common in the colony, and can be easily procured."

It is scarcely correct to say that the medicinal barks of British Guiana have never received the attention of chemists or physicians, for at the close of the International Exhibition of 1862 some twenty different medicinal barks of the colony were experimented upon and their effects tried in various cases by Mr. Charles Hunter, who was some time House Surgeon to St. George's Hospital. The results of his experiments were embodied in a pamphlet, and published at the time by Messrs. Churchill and Sons of New Burlington Street, but we never heard that any of them came into use in this country, and it is to be hoped that better results may be obtained from the present collections.

JOHN R. JACKSON

WHAT IS A GLACIER?[1]

GLACIERS have become so well known from the graphic descriptions of Carpenter, Forbes, Agassiz, Tyndall, and other explorers, that it seems unnecessary at this time to do more than call attention to a few of their more characteristic features by way of an introduction to what I have written concerning those now existing in the United States.

The formation of glaciers in any region depends primarily on the fact that the amount of snow precipitated during a term of years exceeds the amount dissipated by melting and evaporation. In this manner snow-banks of broad extent are formed, the lower portions of which become compacted into ice. The change from snow to ice is known to result from pressure, and as ice is mobile under pressure, either by reason of its inherent plasticity or as a result of regelation, the weight of this mass tends to change its form, and it thus acquires motion, which takes the direction of least resistance.

The essential characteristic of glaciers seems to be that they result from the consolidation of snow in regions of secular accumulation, *i.e.* above the snow-line, and flow to regions of dissipation, *i.e.* below the snow-line. From these primary conditions result a multitude of secondary phenomena.

For convenience of reference we will divide glaciers into *alpine* and *continental;* not that the two classes are always distinct and separable, but for the reason that typical examples of each are well characterised and capable of specific description. Variations occur in each class which may suggest minor subdivisions.

The glaciers with which we are most familiar belong to the class that have their archetype in the mountains of Switzerland, and occur about high peaks, usually in amphitheatres or *cirques* at the heads of high-grade valleys. The snow that accumulates on high mountains, especially in temperate latitudes, is frequently not completely melted during the summer, and thus tends to increase indefinitely. The *névé* of a glacier is such a snow-field. The gorge or valley leading from every alpine amphitheatre furnishes an avenue of escape for the consolidated *névé*-snow, which is forced out through the opening, and flows for a greater or less distance as a stream of ice. Such in brief is the genesis of an alpine glacier. Every glacier of this class is divided into a *névé*, or snow-region, above, and an icy portion below. The line of demarcation is the *snow-line.* As compact ice occurs also beneath the *névé* from which it is formed, this division of a glacier into two portions applies only to the surface. The division line, moreover, shifts with the seasons; at times, perhaps for many years together, the true glacier ice may be concealed by a snowy covering. The *névé* is composed of granular snow, white or grayish-white in colour, and comparatively free from dirt and stones; below the snow-line the glacier is formed of both porous and compact ice, and is usually concealed more or less completely with rock-debris. From a distance these two divisions are frequently distinctly shown by contrast in colour. The stones and dirt that fall on the *névé* sink more or less deeply into the snow and become buried beneath the next addition, and as the *névé* becomes consolidated and acquires glacial motion, this debris is carried along in its mass. But the region below the *névé* being one in which loss exceeds supply, the snow and ice are melted, and the foreign bodies formerly held in the mass become concentrated at the surface, and are then carried along as moraines. Thus in the *névé* region the tendency is to bury foreign objects, and in the glacier proper to concentrate them at the surface.

All the debris carried by glaciers may be designated in general terms as *morainal* material, but when arranged

[1] From Memoir on "Existing Glaciers of the United States," by Israel C. Russell. Reprinted from the Fifth Annual Report of the Director of the U.S. Geological Survey.

in definite ways it receives specific names. When distributed along the margin of an ice-stream it forms *lateral* moraines. Two glaciers uniting, the right lateral moraine of one combines with the left lateral moraine of the other to form a *medial* moraine at the line of contact, the ice-streams flowing on side by side as a single compound-glacier. The debris carried to the extremity of a glacier and deposited about its foot is known as a *terminal* or *frontal* moraine.

In flowing through a valley ice is subjected to stress, which causes it to fracture and form open fissures termed *crevasses*. When a glacier passes over a steep ascent it becomes broken by a great number of fissures, and not infrequently falls to the base of an escarpment in detached blocks, forming an ice cascade, but heals its scars and flows on as a solid mass below. The fissures formed when a glacier passes over an inequality in its bed are commonly transverse to the direction of flow, but may take other courses, depending on the nature of the obstruction, change of slope, &c. Marginal crevasses, resulting from the friction of the ice-stream against its banks and the consequent more rapid flow of the central portion, usually leave the shore at a moderate angle and tend up-stream.

Glacier ice has been found to exhibit a definite structure, known as lamination, or as ribboned or banded structure, produced by the alternation of thin plates or strata of compact bluish ice with others more porous. As shown by Tyndall's experiments, this arrangement is the result of pressure, and is analogous to slaty cleavage.

Owing to unequal melting, the surface of a glacier is usually extremely irregular, the parts protected by moraines standing in higher relief than the clearer portions. Still further diversity is formed by boulders perched on columns of ice, which they have protected from melting as the general surface wasted away. These are termed *glacial tables*. At other times the ice bristles with a multitude of acicular pyramids, or is melted into holes and ice-wells, each having a stone or mass of dirt at the bottom.

The melting of the surface of a glacier gives rise to many rivulets and brooks, which course over it in channels of ice, frequently plunging into yawning crevasses, and finally joining the sub-glacial stream that issues from beneath every glacier. These glacier-born streams are always heavy with comminuted rock, ground fine by the moving ice.

Such in brief are the principal characteristics of alpine glaciers.

At the present time continental glaciers are confined to the arctic and antarctic regions, and have been less thoroughly explored than the alpine forms common in more temperate latitudes. Glaciers of this class are characterised by their broad extent and by not being confined by definite walls; their *névés* are large, frequently covering nearly the entire glacier, and their surfaces are free from boulders and debris, for the reason that they are regions of accumulation, and also because mountains seldom rise above them. Owing to inequalities in the country over which these great fields pass, they are not infrequently broken by crevasses; and, as on smaller glaciers, the melting of the surface gives origin to numerous streams, frequently of large size, which become ponded and form lakes in basins of ice, or plunge into open fissures and disappear in the body of the glacier. Existing continental glaciers are believed in all cases to flow from the interior towards the coast, and hence may be considered as acquiring motion in all directions from a centre of accumulation. When alpine glaciers increase sufficiently to cover an entire mountain-range and form a confluent ice-sheet, they approach and may pass into the continental type. It is not impossible that a mountains range of very modest dimensions might give origin to a quaquaversal glacier of vast proportions. It is perhaps not out of place to suggest in this connection that the glaciers which formerly covered the New England State and Canada were of this character.

In framing a definition of a glacier it is evident that we must include both alpine and continental types, and also embrace the secondary phenomena that are commonly present. A glacier is an ice-body originating from the consolidation of snow in regions where the secular accumulation exceeds the dissipation by melting and evaporation, *i.e.* above the snow-line, and flowing to regions where loss exceeds supply, *i.e.* below the snow-line. Accompanying these primary conditions many secondary phenomena, dependent upon environment, as crevasses, moraines, lamination, dirt-bands, glacier-tables, ice-pyramids, &c., may or may not be present. Thus, glaciers even of large size may exist without moraines; in such an instance glacier-tables, ice-pyramids, ice-wells, &c., would be absent. We may conceive of a glacier flowing through a channel so even that it would not be broken by crevasses, but such instances must be extremely rare. The most common of the numerous secondary features seems to be the laminated structure of glacial ice, but even this is not always distinguishable in ice-bodies that are unquestionably true glaciers.

Although the definition we have presented may assist in understanding the nature of a glacier, yet it is manifestly open to objections. If we consider the snow-line as defining the limit between the *névé* and the glacier proper, it is evident that there must be numerous exceptions to the rule. As before remarked, during certain years, and in many instances for a term of years, the snow-line is much lower than at other times, and may completely conceal the glacier beneath. Again, an ice-stream may terminate in the sea and be broken up and form icebergs before the differentiation into *névé* and glacier proper has been reached.

From all that has been determined concerning the nature of glaciers it is evident that they form one of the transition stages in the history of the snow that falls in certain regions, and like genera and species in the organic kingdom cannot be limited by hard-and-fast lines, but may be classified by comparison with typical examples. From the snow, hail, and frozen mists of a mountain-top are formed the accumulations of granular ice-snow which we call a *névé*. By pressure and alternate melting and freezing, the *névé* passes into compact ice, which acquires motion and is termed a glacier; but the plane of separation is indefinite, and one merges into the other by insensible gradations.

The morainal material carried by glaciers is deposited when melting takes place, and frequently forms characteristic accumulations that still retain the name of moraines. The debris along the border of an ice-stream is frequently left as ridges or irregular terraces on the sides of a valley, marking the former height of the ice-flood. At various stages in the retreat of the ice the lateral moraines are united by terminal moraines which cross the former bed of the glacier in irregular but usually crescent-shaped piles, between which the valley bottom is usually deeply filled with unassorted debris, and frequently occupied by lakelets. When a glacier is prolonged from the mouth of a valley on a plain, it builds out its lateral moraines perhaps for many miles, and when it retreats these are left as parallel embankments, not infrequently hundreds of feet high and sometimes miles in extent.

The movement of glaciers causes friction, which results, as the study of living glaciers has shown, in the smoothing and scratching of the rocks over which the ice passes. The boulders, pebbles, and sand held in the bottom and sides of the glacier produce smooth and polished surfaces, crossed by scratches and grooves having an exceedingly characteristic appearance, which, when once understood, it is difficult to mistake for the results produced by other agencies. While the rocks beneath a glacier are being worn and rounded, the stones set in the ice are in turn battered and scratched and often ground down to plane surfaces that are not infrequently polished and covered with glacial striæ.

As a rule, alpine glaciers follow pre-existing drainage valleys, which they enlarge and broaden. As frequently stated, a stream-cut gorge is distinctly V-shaped, but after being occupied by a glacier it is found to have become U-shaped in cross-section.

The records of glacial action looked for by geologists are: deposits of morainal material, which frequently differs from the adjacent country rock, and may occur in an irregular manner or be grouped definitely as lateral and terminal moraines; boulders perched in fortuitous positions, as on steep slopes and hill-tops; smoothly rounded rocky knolls; polished and scratched rock surfaces; rock-basins, &c.

NOTES

It is stated that the forthcoming "Life and Letters of Charles Darwin," by Mr. Francis Darwin, will contain a brief autobiographical fragment.

Mr. Murray announces a new edition of Darwin's work on "The Expression of the Emotions in Man and Animals," with the author's latest corrections.

We learn from the *Times* that Dr. Hermann Abich, the distinguished Austrian naturalist, died at Vienna on the 1st inst. at the advanced age of eighty years. He was born at Berlin on December 11, 1806, and attained the grade of Doctor in the University of that city before he was twenty-five. His first scientific tours were in Sicily and Italy. He then became Professor of Mineralogy at Dorpat, and devoted most of his leisure during his residence in Russia to travels in the Caucasus, Armenia, and Northern Persia. His earliest published work was on Vesuvius and Etna in 1833–34, and his latest seems to have been brought out in 1862 on the Geology of Daghestan. By his own request his remains were removed to Gotha for the purpose of cremation.

With reference to the recent catastrophe by which the King of Bavaria and his physician lost their lives, *Science* notes that Dr. Gudden is a sad loss to science, for he was one of the most noted authorities in the sphere of nervous and mental diseases. He has also been at the head of a laboratory in which investigations of the fine anatomy of the brain, spinal cord, and sense-organs have been carried on. He has given his name to a manner of studying the connections of the nervous system which is as ingenious as it has proved fruitful of results. His method consists in extirpating a sense-organ or other part of an animal when young, and then allowing the animal to grow up. At death the animal is examined, and the fibres which have failed to develop will thus be marked out as the paths of connection between the extirpated sense-organ and the brain-centre. For many years he had been at work on the problem as to the mode of connection between the retina and the brain, but his results are not yet before the public.

According to *Science* the first circular of the local committee at Buffalo of the American Association for the Advancement of Science, announces that the meetings will be held in the recently enlarged high-school building. Reduced rates have been obtained over many of the railroads, most of which allow a return ticket at one-third of the usual fare. The Western Union Telegraph Company will place its lines and district telegraph system at the service of members. The Botanical Club of Buffalo is arranging an excursion and reception for the Botanical Section, and the local Entomological Club is doing the same kind service for the Entomological Section. The address of the local secretary is Dr. Julius Pohlman, Buffalo, N.Y.

As our readers are aware, it has been resolved to mark the memorable event of the attainment, on August 31 next, of his hundreth year by the venerable father of modern science, "Le Doyen des Étudiants," as he loves to call himself—M. Chevreul—by striking a medal in his honour. The execution of this medal has been intrusted to M. Roty, old "pensioner" of the Academy of France, at Rome. Contributions towards the commemorative medal are, of course, not to be limited to France, but will embrace the whole scientific world, which everywhere alike claims the author who extended the bounds of science as its honoured citizen. Subscriptions, which will be received up to the 22nd of this month, may be addressed to the President of the Committee, 8, Rue Guy-de-la-Brosse, Paris. A list of the subscribers will accompany the medal, which is to be presented to M. Chevreul on his centenary day, and if the amount of the subscriptions allows of it, a copy of the medal will be sent to the subscribers.

At the sitting, on June 7 last, of the Academy of Sciences at Paris, M. Halphen delivered an address in praise of the labours of M. Bouquet, his immediate predecessor in the seat he holds in that body. From the foundation of the Academy down to the present time, the duty of eulogising departed members has devolved exclusively on the Perpetual Secretaries at the anniversary meetings. The annual death-rate of members has, however, of late been such that a large number of them were in danger of disappearing from the roll without any formal record of their services. The initiative thus taken by M. Halphen was followed up at the next meeting. This step has, of course, been taken in imitation of the arrangements of the Académie Française, in accordance with which each incoming member is required to eulogise his predecessor at a special meeting, an answer being also given in the name of the Academy by another member appointed for that purpose.

Recent soundings have given the following depths for the different Swiss lakes:—Constance, between Uttwyl and Friedrichshafen, 255 metres; Geneva, between Rivaz and Saint-Giugolphe, 256 metres; and between Lausanne and Evian, 330 metres; Brienne, 261; Thun, 217; Lucerne, between Gérau and Rueteren, 214 metres; Zug, 198; Neuchatel, 153; Wallenstadt, 151; and Zürich, 143 metres.

According to Prof. Heim, of Zürich, the total number of glaciers in the Alps is 1155, of which 249 have a length of more than 7500 metres. Of this number the French Alps contain 144, those of Italy 78, of Switzerland 471, and of Austria 462. The total superficial area of these glaciers is between three and four thousand square kilometres, those of Switzerland amounting to 1839 kilometres. The greatest length is reached by the Aletsch glacier, which is 24 kilometres long. As to thickness, it will be remembered that Agassiz, when measuring a crevasse in the Aar glacier, did not reach the bottom at 260 metres, and that he calculated the depth of the bed of ice at a certain point of this glacier at 460 metres.

We have received the *Bulletin* for the past year of the Society for Indo-Chinese Studies of Saigon. Amongst the papers is one by that indefatigable student, Dr. Tirant, on the odoriferous woods of Cochin China, which, though numerous in variety, are of four principal kinds, the most important being aloes and sandalwood. We have already noticed a series of papers by the same writer on the fishes and reptiles of Cochin China. Another interesting paper deals with the textile plant *Sanseviera* as found in Cochin China.

A Commission composed of MM. Becquerie, Berger, and Mascart, having been appointed to examine the question of the safety or danger of erecting a tower to the height of 300 metres, as proposed, in the Champ de Mars, on the occasion of the forthcoming Universal Exhibition, has reported that there is no danger in connection with such a structure if special precautions are taken for its non-insulation. The tower acting as a lightning conductor would, on the contrary, they explain, serve to protect the whole of the Champ de Mars from injury by lightning if the rules laid down by the Commission on lightning conductors were applicable in the case of so exceptional an altitude.

THE report for the current year of the Coventry Free Public Library is a very encouraging document. It shows increase in all directions—in the number of borrowers, the number of books issued, and a large increase in the number of volumes owned by the Library. All the excellent work done by the Institution is paid for by a trifling rate producing a little over 500*l.*, supplemented by the assistance of a private book club. The tables appended by the Chairman, Mr. Odell, showing the number of books issued in each class of literature, the monthly totals and averages, the ages of the borrowers, and more especially the occupations of the latter, are very suggestive. In these days, when more than ever we have, politically speaking, to "educate our masters," the record of the work of the Coventry Free Public Library is very gratifying.

WE have received from Tokio a copy of a Japanese scientific journal (apparently the NATURE of Japan), which has already reached its third volume and fifty-sixth number. It is printed throughout in Japanese, being much the same shape as NATURE, and containing forty-eight pages in each number. The issue before us contains a lecture on human parasites, by Prof. Ijima; some remarks on the historical methods of the Chinese school, by Mr. Suyematsu, formerly of Cambridge; the third of a series of lectures on physical geography by Prof. Kotō; a paper on "Some Phenomena I have witnessed," and another on methods of treating pebrine, by a teacher in the Kornaba Agricultural College. The notes are also of a very general character: they refer to "some simple physical experiments"; an alloy that expands with cold; the uses of coffee; refining ores by electricity; the strength of paper; a new sweet compound; animal bone industry; hypnotism; the Universal Meridian and Time Conference, &c. Then follow letters to the editor, and finally a report of a meeting of the Tokio Physico-Mathematical Society. No proof is wanted nowadays of the remarkable scientific progress in Japan; if it were, it would be supplied by the fact that a journal of this high character can live and apparently flourish.

WE have also to acknowledge the receipt from the Imperial Meteorological Observatory of Japan of the "Monthly and Yearly Means, Extremes, and Sums for the Years 1883, 1884, 1885," with an appendix on observations of clouds. There were twenty-seven stations, including four in Yezo and one in Corea.

AN interesting work which has just been published in the *Bulletin* of the United States National Museum (No. xxx. pp. 113-81) is an annotated catalogue of the published writings of Dr. Charles Abrathar White, the distinguished palæontologist to the United States Geological Survey, and the occupant of several other important scientific positions. The editor is Mr. J. B. Marcou, whose object has been to note everything containing any expression of Dr. White's views on scientific subjects, as well as his more elaborate works. The annotations which accompany the catalogue were drawn up mainly from data furnished by the author himself, and all expressions of opinion on geological and palæontological subjects are his own. The catalogue contains in all 151 entries, ranging from articles in scientific periodicals to his contributions on invertebrate palæontogy in the annual reports of the Geological Survey. The whole represents an almost incredible mass of scientific work, performed as it was in a brief quarter of a century, 1860-85.

WE are glad to notice that Dr. White's important work on the Cretaceous invertebrates of Brazil, which were collected by the Imperial Geological Commission under the direction of the late Prof. Hartt, is now in process of publication at Rio de Janeiro by the Brazilian National Museum. It is to appear in the Portuguese and English languages, and will be illustrated by twenty-eight lithographic plates; 214 species in all are published and figured in this work, of which 116 species are diagnosed as new. Four new genera are proposed—three of Gasteropoda, and one of Echinoids. The former are *Orvillia*, *Cylindritella*, and *Cypræctæon*. The latter is *Heteropoda*, the generic diagnosis of which was supplied to the author by Prof. P. de Loriol, of Geneva.

THE following facts exemplify the strong migratory instincts of trout. At the fish culture establishment at Delaford, where the utmost care is taken to isolate the various species of Salmonidæ, a few of the fish occasionally are found in ponds long distances from those in which they were originally located. Considering that each pond is so constructed as to prevent such a contingency, the occurrence is very remarkable, and can only be accounted for in two ways, viz. that the fish either burrow through holes that probably are made by rats and moles, or they jump out of the water and so proceed to the next pond. It is not likely that they are borne thence by birds, as the appearance of the fish on the occasions referred to does not justify such an assumption. It will be interesting to inquire further into the subject with a view of eliciting the real facts of the case.

A FISH Culture Conference is to be held at the Colonial and Indian Exhibition on July 26 at the instigation of the National Fish Culture Association. The Marquis of Exeter will preside, and papers will be read by Mr. J. Willis-Bund, the Rev. C. J. Steward, Mr. Oldham Chambers, and others, upon fresh-water and marine fish. The Conference will commence at 10.30 a.m. and last until 10 p.m.

A PAIR of electric eels (*Gymnotus electricus*) arrived the other day at the Colonial and Indian Exhibition Aquarium from British Guiana, but have since unfortunately died. They were very fine specimens, and measured 4½ feet in length, their normal size being 6 feet. They require a temperature of 75°, and provided the water is maintained at this standard they will live and thrive in captivity. The water should not be too deep, however, and must be kept clean.

FROM the report issued by the Central Meteorological Institute of Sweden for last year it appears that there are thirty-four public stations for observation, and some half-a-dozen private ones, in that country. In addition to these there are nearly 400 places where the fall of rain is registered, and other partial observations made. These observations have been duly published in the Institute's journal, "Monthly *Résumé*" of the weather in Sweden, edited by Dr. H. E. Hamberg, which has now reached its sixth year of publication. In addition to this, the publication of a short climatological description of each country, founded on the observations of the last twenty-six years, has been continued, whilst Dr. Hamberg has added an important contribution in the shape of the work "On the Influence of Forests on the Climate of Sweden." The twenty-second part of a work "Meteorological Observations in Sweden," a *résumé* of the observations made at the public meteorological station, has also appeared, and finally synoptical tables have been framed of the weather at all stations on any day of 1884, showing the quantity and nature of the rainfall, thunder, fog, dew, frost, transparency of the air, "sun-snake" (a phenomenon chiefly observed in the northern part of Sweden), aurora borealis, &c. Reports on the forming and breaking up of the ice have been received from fifty-eight stations, besides seventy-seven observations of periodical features of animal and vegetable nature.

THE Swedish Academy of Sciences has issued a work entitled "The Correspondence of Carl von Linnæus," containing a record of all the correspondents of this famous naturalist, Swedish as well as foreign, with their addresses, date of birth and death, &c., as well as the date of each letter to and from.

THE first African city lighted by electricity was not Algiers or Cairo, but Kimberley, with forty-two Brush lamps, each of 2000 candle-power. The current is also utilised there for the killing of dogs, a step suggesting the execution of death sentences by the same means, as proposed in America and in France by M. Charson, a member of the Senate.

MR. R. N. CUST, the Secretary to the Royal Asiatic Society, is engaged on a work on the languages of the tribes of Polynesia, including those of Australia.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea* ♂) from Guiana, presented by Madam G. Sangiorgi; a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. D. Evans; a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Capt. Pitman; a Common Cormorant (*Phalacrocorax carbo*), British, presented by Mr. O. Moulton Barrett; two Golden Eagles (*Aquila chrysaetus*) from Scotland, a Lined Finch (*Spermophila lineola*) from South America, deposited; two Ostriches (*Struthio camelus* ♂ ♀) from North Africa; a Lear's Macaw (*Ara leari*) from South America; a Lineolated Parrakeet (*Bolborhynchus lineolatus*) from Mexico, purchased; a Bennett's Wallaby (*Halmaturus bennetti* ♀), a Vulpine Phalanger (*Phalangista vulpina* ♂), three Canadian Beavers (*Castor canadensis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE STRASBURG OBSERVATORY.—Herr W. Schur has published, in No. 2736 of the *Astronomische Nachrichten*, a supplementary report on the work done at the Strasburg Observatory during the ten months preceding May of this year, so as to exhibit the state of the instruments and of the computations relating to the observations made with them on the eve of his departure for Göttingen, where he has been appointed Director in the room of the late Prof. Klinkerfues. During the interval to which the report refers, Herr Schur was chiefly occupied with observations of the moon with the altazimuth and of comets with the great refractor, also with the examination of the micrometer-screw of the latter instrument. The meridian-circle has chiefly been employed in the observation of southern stars—amongst others the eighty-three stars of Auwers' Southern Fundamental Catalogue, and certain stars for investigating astronomical refractions. The direct and reflection observations to the end of the preceding year give for the geographical latitude of the meridian-circle, $+48° \, 35' \, 0''\cdot 11$, which agrees well with a former determination with Repsold's transit, using Horrobow's method, viz. $+48° \, 35' \, 0''\cdot 23$. In former reports Herr Schur has drawn attention to the discordance between the nadir points determined with observer north and observer south, which, for his observations, amounts to a considerable quantity; in the mean, from a large number of observations, ½ (north–south) being as much as $+0''\cdot 50$. This large value agrees both in sign and in magnitude with the quantity determined from observations of zenith stars for similar positions of the observer, viz. $0''\cdot 77$, and Herr Schur concludes that his observed zenith distances of stars require a correction of about $-0''\cdot 6$. In the case of the other Strasburg observers, the corresponding correction is comparatively insignificant. Herr Schur's successor at Strasburg is Dr. Kobold.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *JULY* 18–24

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

At Greenwich on July 18

Sun rises, 4h. 6m.; souths, 12h. 5m. 56·5s.; sets, 20h. 6m.; decl. on meridian, 21° 1′ N.: Sidereal Time at Sunset, 15h. 52m.

Moon (two days after Full) rises, 20h. 42m.*; souths, 1h. 31m.; sets, 6h. 27m.; decl. on meridian, 14° 5′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 41	13 54	21 7	13 21 N.
Venus	1 33	9 38	17 43	21 46 N.
Mars	11 3	16 48	23 33	3 38 S.
Jupiter	10 9	16 18	22 27	0 58 N.
Saturn	3 7	11 15	19 23	22 20 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich)

July	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
19	e^2 Aquarii	5½	3 30	near approach	35 —
19	e^1 Aquarii	6	4 1	near approach	220 —
24	μ Ceti	4	23 32	0 24†	52 267

† Occurs on the following morning.

July	h.	
19	10	Mercury at greatest elongation from the Sun, 27° east.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	July 18,	23 32	*m*
			,, 23,	23 11	*m*
R Piscium	1 24·8	2 18 N.	,, 23,		*M*
S Ursæ Majoris	12 39·0	61 43 N.	,, 24,		*M*
V Bootis	14 25·2	39 22 N.	,, 22,		*M*
U Coronæ	15 13·6	32 4 N.	,, 21,	22 22	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 22,	2 58	*m*
			,, 22,	23 6	*m*
X Sagittarii	17 40·4	27 47 S.	July 24,	2 0	*M*
U Sagittarii	18 25·2	19 12 S.	,, 19,	2 0	*M*
S Vulpeculæ	19 43·7	27 0 N.	,, 24,		*m*
χ Cygni	19 46·2	32 38 N.	,, 18,		*m*
S Delphini	20 37·8	16 41 N.	,, 22,		*M*
δ Cephei	22 24·9	57 50 N.	,, 18,	21 30	*m*

M signifies maximum; *m* minimum.

Meteor Showers

Meteors begin to be somewhat numerous in the latter half of the present month. Amongst the radiants represented are the following:—Near π Andromedæ, R.A. 10°, Decl. 38° N.; near β Cassiopeiæ, R.A. 6°, Decl. 58° N.; near η Draconis, R.A. 245°, Decl. 64° N.; near σ Serpentis, R.A. 266°, Decl. 12° S.; near α Cygni, R.A. 312°, Decl. 46° N.; from Lacerta, R.A. 342°, Decl. 40° N.; and the great *Perseid* shower, maximum August 10, radiant R.A. 45°, Decl. 56° N., begins to furnish individual meteors about this time.

GEOGRAPHICAL NOTES

ACCORDING to the *Colonies and India*, the Secretary of the Victorian branch of the Geographical Society of Australasia has written to the Royal Society of Victoria asking the latter to appoint a committee to confer with that already appointed by the former Society on the question of sending an exploring expedition to the Antarctic regions. It is urged that a conference should take place as soon as possible, and that various scientific associations should be invited to co-operate in sending out one or more expeditions.

THE latest news from the Chitral Mission is that Col. Lockhart is returning to India from Zebah, in Badakshan, leaving Col. Woodthorpe in charge of the party.

IT is stated that Mr. A. R. Colquhoun, who is at present Civil Commissioner at Mogoung, in Upper Burmah, is about to start on a journey of exploration into Upper Assam, and the regions lying between this and Burmah.

THE latest official information concerning Dr. Wilhelm Junker, the African traveller, comes from Zanzibar. It reports that while he was staying with the King of Unyoro, the latter was attacked and defeated by the King of Uganda. The King of Unyoro and Dr. Junker succeeded, however, in making their escape. Dr. Junker lost all his collections, but saved his journals.

AT the March meeting of the Geographical Society of Stockholm it was decided not to distribute the *Vega* medal—the greatest honour the Society can confer—this year. Only three travellers have as yet received it, viz. Nordenskjöld, Pallander, and Stanley. The *Vega* fund was awarded to Dr. F. Svenonius, for explorations in the Lapland highlands during the summer.

A RECENT number of the *Verhandlungen* of the Berlin Geographical Society (Band xiii. No. 5), contains an important paper on Corea, by Dr. Gottsche, who travelled widely over the peninsula on behalf of the Japanese Government. During two journeys he traversed all the eight provinces of the country, and visited 80 of the 350 district towns. The general features are already tolerably well known to English students from Mr. Carles's reports laid before Parliament, and his paper in the *Proceedings* of the Royal Geographical Society, but as Dr. Gottsche is a geologist, and travelled specially for scientific observation, he supplements Mr. Carles's papers in this direction. The climate, he shows by meteorological tables, lies between that of Japan and of North China, while in the North the climate in winter is of almost Siberian rigour. As for the geological formation, granite, gneiss, and crystalline schists play a predominant part. Here and there these are broken by the older volcanic formations, as diabase and quartz porphyry; palæozoic strata occur rarely, and the later sedimentary formations not at all. Active volcanoes do not exist on the mainland, and earthquakes have been unknown within the memory of man. The only metal in which Corea is rich is iron; the belief that gold abounds is a delusion. The fauna is rich, and of much interest, for palæarctic and sub-tropical types meet here. With regard to the flora, unfortunately a large portion of Dr. Gottsches' collection was lost, and the remainder was handed to Dr. Engler of Breslau for examination and report. In conclusion, he says that though Corea may never be popular with the ordinary traveller for pleasure, it will well repay the visitor on scientific objects intent. Prof. Enting, who travelled in the interior of Arabia in 1883-84 on an antiquarian mission, especially in search of inscriptions, gives a long and comprehensive account of the regions through which he went.

THE new number (Heft ii. Bd. 9) of the *Deutsche Geographische Blätter*, the organ of the Geographical Society of Bremen, contains the conclusion of Dr. Oppel's paper on the Congo basin. The present instalment refers to the explorations of past years, the lower, central, and upper Congo region, north and south of the stream, the climate, meteorology, botany, zoology, ethnography, &c. It will thus appear that the paper is an encyclopædic one on the great West African river. The next paper is a continuation of Herr Valdau's account of his journey to the north of the Cameroons, especially around Lake Mbu, and between that and Balundu, and the coast. Herr Steinvorth gives a most interesting account of a little Slav colony or oasis in Hanover called the Hanoverian Wendtland, where the people down to this day have in great part preserved their original speech, customs, and other peculiarities. The writer describes all these in some detail, and comes to the natural conclusion that here we have not a pure Wendt people, but one largely mixed with Germans, and thinks, after discussing the peculiarities of the dialect spoken, that this colony is worthy of the attention of the student of comparative language. This is followed by a general article (which is anonymous) on the new Chilian province of Tarapaca, dealing especially with the silver mines and saltpetre industry. Herr Seelstrang supplies a paper of more direct geographical interest on the region about the source of the Rio Chubut, hitherto one of the least-known parts of the Argentine Republic. The rest of the number (which is of considerable size) is occupied by geographical intelligence, reviews of books, &c.

IN the *Bolletino* of the Italian Geographical Society for May, Signor Sommier describes the excursion which he made with Signor G. Cini to Cape North in January 1885. Some interest attaches to this journey, which is the first made across Lapland and Finland in midwinter for purely scientific purposes. The travellers proceeded by train from Christiania to Throndhjem, and thence by steamer in darkness and storm to Hammerfest and Skarsvaag, in the island of Magerö, the northernmost group of habitations in Europe, and the nearest permanent settlement to Cape North. Here they received a friendly welcome from the local "Landelsmand," and reached the goal of the expedition on foot with much greater ease than had been anticipated. The weather was unusually calm and mild, with a temperature of only −2° C. At some points the evergreen lichens and other growths (*Betula nana*, *Empetrum nigrum*, *Diapensia lapponica*, &c.) were visible through some centimetres of transparent ice clothing the surrounding rocks. The only animals seen, besides the eider and other water-fowl, were the raven, crow, magpie, Arctic fox, and frankoline, the latter (*Lagopus mutus*) everywhere present in large numbers. Several photographs were taken, and after a stay of eleven days in the neighbourhood, during which the glass never fell below −16° C., the travellers returned by water to Hammerfest and Bossekop, at the head of the Alten fjord. Thence the route was continued overland under great hardships—eastwards to Lake Enare, southwards through Kittilä to Haparanda, and round the west side of the Gulf of Bothnia to Sundsvall, whence Stockholm was reached by train. At Karasjok, on the road between Bossekop and Enare, the travellers made the acquaintance of the same Lapp family that visited London last year, and much valuable information was collected on the Lapps, Quäns, and northern Finns. This forms the subject of two communications sent by Stephen Sommier to the *Archivio per l'Antropologia e l'Etnologia* (xvi., 1, 1886), and separately printed under the title of "The Lapps and Northern Finns." The account of the trip to Cape North has also been issued in separate form by the Italian Geographical Society (Rome, 1886).

THE LUNAR SURFACE AND ITS TEMPERATURE

A MONOGRAPH by the writer, relating to the temperature of the lunar surface, read before the American Academy of Science, September 1869, contained the following:—"Are we not forced to dissent from Sir John Herschel's opinion that the heat of the moon's surface, when presented to the sun, much exceeds that of boiling water? Raised to such a high temperature, our satellite, with its feeble attraction, could not possibly be without an envelope of gases of some kind. Indeed, nothing but the assumption of extreme cold offers a satisfactory explanation of the absence of any gaseous envelope round a planetary body, which, on account of its near proximity, cannot vary very much from the earth as regards its composition. The supposition that this neighbouring body is devoid of water, dried up and sunburnt, will assuredly prove one of the greatest mistakes ever committed by physicists." This assertion was based on demonstrations showing that the circular walls of the great "ring mountains" on the lunar surface are not, as supposed, composed of "mineral substances originally in a state of fusion." The height and diameter of these walls being recorded in "Der Mond," computations based on the safe assumption that the areas of their transverse sections cannot be less than the square of their height, establishes the important fact that the contents of the wall of, for instance, Tycho, the circumference of which is 160 miles, height 2·94 miles, amounts to $2{\cdot}94 \times 160 = 1382$ cubic miles. The supposed transfer of this enormous mass, in a molten state, a distance of 25 miles from the central vent imagined by Nasmyth, and its exact circular distribution at the stated distance, besides its elevation to a vertical height of nearly 3 miles, involve, I need not point out, numerous physical impossibilities. Other materials and agencies than those supposed to have produced the "ring mountains" must consequently be sought in explanation of their formation. A rigid application of physical and mechanical principles to the solution of the problem proves conclusively that water subjected successively to the action of heat and cold has produced the circular walls of Tycho. The supposition that these stupendous mounds consist of volcanic materials must accordingly be rejected, and the assumption admitted that they are inert glaciers which have become as permanent as granite mountains by the action of perpetual intense cold.

Independently of the foregoing demonstration, the fallacy of the volcanic hypothesis will be comprehended by its advocates on learning that the quantity of lava requisite to form the circular walls of Tycho would cover the entire surface of England and Wales to a depth of 125 feet.[1]

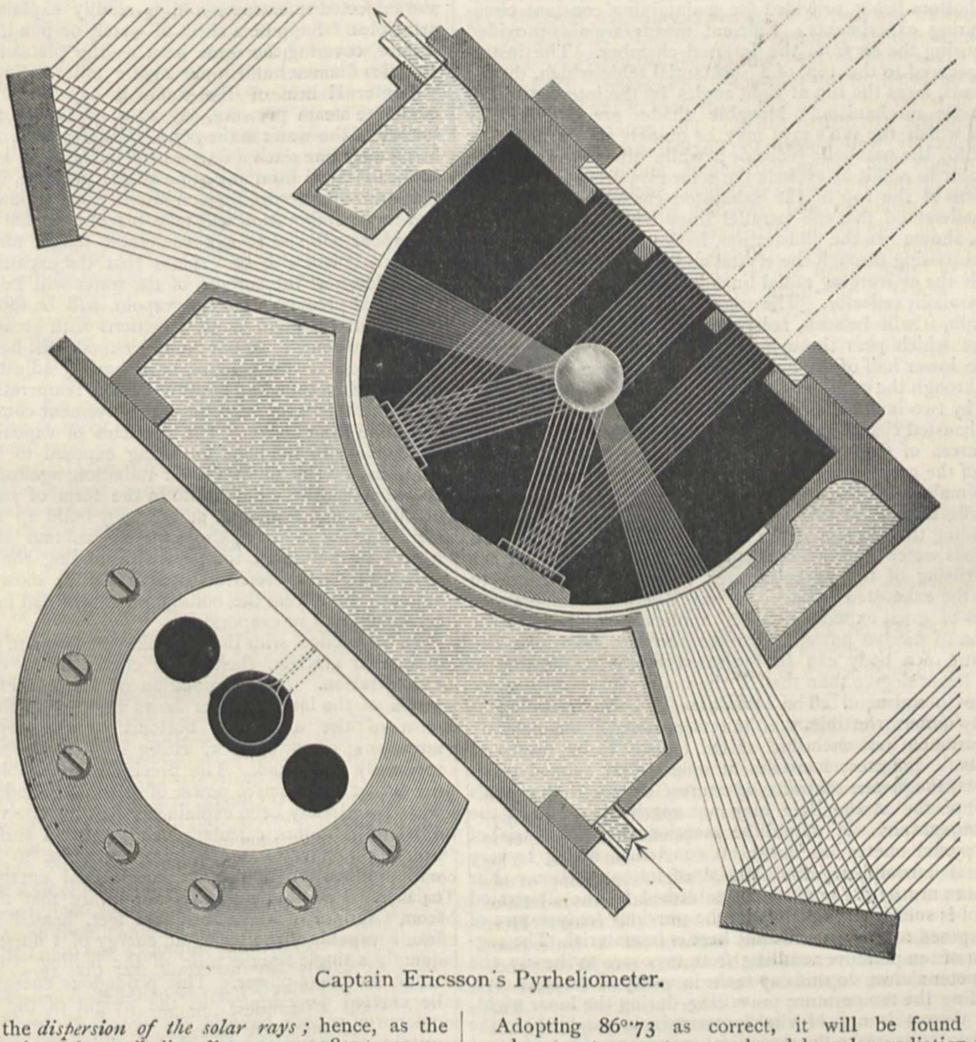
Before proceeding further with our demonstration it will be necessary to establish the maximum temperature which solar radiation is capable of imparting to the lunar surface. This temperature, of course, varies with the distance of the primary and its satellite from the sun. By means of an actinometer the bulb of whose thermometer receives an equal amount of radiant heat on opposite sides, I was enabled to determine with desirable accuracy, sixteen years ago, that, when the earth is in aphelion, solar radiation on the ecliptic imparts a maximum temperature of 67°·2 F., and that the retardation of the radiant energy occasioned by the want of perfect atmospheric diathermancy reaches 0·207. Consequently the temperature produced by solar radiation at the boundary of the terrestrial atmosphere is

$$67 \cdot 2 \times 1 \cdot 207 = 81^\circ \cdot 11 \text{ F.},$$

when the earth is in aphelion. Agreeably to observations during the winter solstice, compared with observations at midsummer, at equal zenith distance, the augmentation of solar intensity when the earth is in perihelion amounts to 5°·84 F.; hence the temperature produced by solar radiation reaches

$$81 \cdot 11 + 5 \cdot 84 = 86^\circ \cdot 95 \text{ F.},$$

when the rays enter our atmosphere during the winter solstice. It should be observed that on theoretical grounds the increase of temperature, when the earth is in perihelion, will be in the



Captain Ericsson's Pyrheliometer.

inverse ratio of the *dispersion of the solar rays*; hence, as the aphelion distance is to the perihelion distance as 218·1 to 210·9, it will be seen that the temperature produced by solar radiation when the earth is in perihelion will be

$$\frac{218 \cdot 1^2 \times 67^\circ \cdot 2}{210 \cdot 9^2} = 71^\circ \cdot 86 \text{ F.}$$

Adding 0·207 for retardation caused by imperfect atmospheric diathermancy, solar intensity during the winter solstice will be

$$71 \cdot 86 \times 1 \cdot 207 = 86^\circ \cdot 73 \text{ F.}$$

Calculation based on *observation*, as before stated, proves that the perihelion temperature is 86°·95, thus showing a trifling discrepancy between theory and observation.

[1] Area of England and Wales, 58,320 square miles; contents of the walls of Tycho, 1382 cubic miles; hence $\frac{1382}{58320} \times 5280 = 125 \cdot 12$ feet.

Adopting 86°·73 as correct, it will be found that the yearly *mean* temperature produced by solar radiation when the rays enter the earth's atmosphere will be

$$\frac{81^\circ \cdot 11 + 86^\circ \cdot 73}{2} = 83^\circ \cdot 92 \text{ F.},$$

while the temperature produced by the sun's radiant heat is only 81°·11 during the summer solstice, as before shown. Hence the temperature of the lunar surface when presented to the sun while the earth is furthest from the luminary can only be augmented 81°·11 F.

The remarkable fact that the moderate heat produced by solar radiation is capable of increasing the temperature of bodies previously heated to a high degree demands consideration in connection with the subject under investigation; also the nature of the device, before referred to, for ascertaining the temperature produced by solar radiation. The accompanying illustration represents a combination of said device and a pyrheliometer differing materially from Pouillet's instrument, by showing the true intensity of the "fire" in the sun's rays.

The illustration presents a top view and a vertical section of the new instrument through the centre line. The upper part, composed of bronze, is cylindrical with a flat top, the bottom being semispherical, composed of ordinary glass. The top of the cylindrical chamber is provided with three circular perforations covered by a thin crystal carefully ground and polished. A thermometer having a spherical bulb is introduced through the side of the chamber, the bulb being central to the transparent semispherical bottom. A short parabolic reflector, shown in section on the illustration, surrounds the instrument, adjusted so that its focus coincides with the centre of the bulb of the thermometer. The compound cylindrical and spherical chamber is inclosed in a vessel containing water, appropriate openings at top and bottom being provided for maintaining constant circulation during experiments. Efficient means are also provided for exhausting the air from the internal chamber. The instrument is secured to the top of a substantial table which, during experiments, faces the sun at right angles by the intervention of a parallactic mechanism. Movable shades are applied, by means of which the sun's rays may be quickly cut off from, or admitted to, the parabolic reflector; while other shades enable the operator to admit or exclude the solar rays from the circular perforations at the top of the exhausted chamber. It will be readily understood that the parallel lines within the exhausted chamber, shown on the illustration, indicate the course of the solar rays passing through the crystal and the perforations at the top, while the converging radial lines indicate the rays reflected by the parabolic reflector. The upper hemisphere of the thermometric bulb, it will be seen, receives the radiant energy of the sun's rays which pass through the large central perforation; while the lower half of the bulb will be acted upon by the rays passing through the small perforations. These rays are reflected upwards by two inclined circular mirrors attached to the bottom of the exhausted chamber. It should be particularly observed that the areas of these inclined mirrors *together* should exceed the area of the great circle of the bulb of the thermometer sufficiently to make good the loss of radiant energy caused by the imperfect reflection of the said mirrors, and also to make good the loss attending the passage of the solar rays through the crystal. A capacious water cistern, connected by flexible tubes with the external casing of the pyrheliometer, enables the operator to maintain the exhausted chamber at any desirable temperature. Engineers of great experience in the application of heat for the production of motive power and other purposes deny that the temperature of a body can be increased by the application of heat of a lower degree than that of the body whose temperature we desire to augment. The soundness of their reasoning is apparently incontrovertible, yet the temperature of the mercury in the instrument just described raised to 600° F. by means of the parabolic reflector, increases at once when solar heat is admitted through the circular apertures, although the sun's radiant intensity at the time may not reach one-tenth of the stated temperature. It should be mentioned that the trial of this new pyrheliometer has not been concluded, owing to very unfavourable atmospheric conditions since its completion. For our present purpose the great fact established by the illustrated instrument is sufficient, namely that the previous temperature of a body exposed to the sun's radiant heat is immaterial. The augmentation of temperature resulting from exposure to the sun, the pyrheliometer shows, depends upon the intensity of the sun's rays.

Regarding the temperature prevailing during the lunar night, its exact degree is not of vital importance in establishing the glacial hypothesis, since the periodical increment of temperature produced by solar radiation is only a fraction of the permanent loss attending the continuous radiation against space resulting from the absence of a lunar atmosphere; besides, all physicists admit that it is extremely low. Sir John Herschel says of the night temperature of the moon that it is "the keenest severity of frost, far exceeding that of our Polar winters." Proctor says: "A cold far exceeding the intensest ever produced in terrestrial experiments must exist over the whole of the unilluminated hemisphere." The author of "Outlines of Astronomy" has also shown that the temperature of space, against which the moon at all times radiates, is − 151° C. (− 239°·8 F.), Pouillet's estimate being − 142° C. (− 223°·6 F.). Adopting the latter degree, and allowing 81°·11 for the sun's radiant heat, we establish the fact that the temperature of the lunar surface presented to the sun will be 223°·6 less 81°·1, or − 142°·5 F., when the earth is in aphelion. It will be well to bear in mind that when the earth is in the said position, the sun's rays acting on the moon subtend an angle of 31′ 32″, hence the loss of heat by radiation against space will be diminished only 0·000021 during sunshine. Nor should Herschel's investigation be lost sight of, showing that stellar heat bears the same proportion to solar heat as stellar light to solar light. Stellar heat being thus practically inappreciable, the temperature produced by stellar radiation cannot be far from absolute zero—an assumption in harmony with the views of those who have studied the subject of stellar radiation, and consequently regard Pouillet's and Herschel's estimate of the temperature of space as being much too high.

Having disposed of the question of temperature, let us return to the practical consideration of the glacial hypothesis. The formation of annular glaciers by the joint agency of water and the internal heat of a planetary body devoid of an atmosphere and subjected to extreme cold is readily explained on physical principles. Suppose a sheet of water, or pond, on the moon's surface, covering the same area as the plateau of Tycho, viz. 50 miles diameter and 1960 square miles. Suppose, also, that the internal heat of the moon is capable of maintaining a moderate steam pressure, say 2 lbs. to the square inch, at the surface of the water in the pond. The attraction of the lunar mass being only one sixth of terrestrial attraction, while the moon's surface is freed from any atmospheric pressure, it will be evident that under the foregoing conditions a very powerful ebullition and rapid evaporation will take place, and that a dense column of vapour will rise to a considerable height above the boiling water. It will also be evident that the expansive force within this column at the surface of the water will be so powerful at the stated pressure that the vapour will be forced beyond the confines of the pond in all directions with great velocity. No vertical current, it should be understood, will be produced, since the altitude of the column, after having adjusted itself to the pressure corresponding with the surface temperature of the water, remains stationary, excepting the movement consequent on condensation from above. The particles of vapour forced beyond the confines of the pond, on being exposed to the surrounding cold, caused by unobstructed radiation against space, will of course crystallise rapidly, and in the form of snow fall in equal quantity round the pond, and thereby build up an annular glacier. As the radius of the vaporous column exceeds 25 miles, it will be perceived that, notwithstanding the rapid outward movement, before referred to, some of the snow formed by the vapours rising from the boiling pond will fall into the same, to be melted and re-evaporated.

In connection with the foregoing explanation of the formation of annular glaciers, their exact circular form demands special consideration. An examination of Rutherford's large photograph of the lunar surface shows that, apart from the circular form of the walls, the bottoms of the depressions are in numerous cases smooth, rising slightly towards the centre uniformly all round. The precision observable proves clearly the action of formative power of great magnitude. Referring to what has already been explained regarding the vaporous column of 25 miles radius, calculation shows that a surface temperature exerting the moderate pressure of 2 lbs. to the square inch will produce an amount of mechanical energy almost incalculable. Practical engineers are aware that the steam rising from a surface of water 10 square feet, heated by a very slow fire, is capable of producing an energy of 1 horse-power; consequently a single square mile of the boiling pond will develop 2,780,000 horse-power. This prodigious energy will obviously be exerted *horizontally*, as the weight of the superincumbent column of vapour balances its *expansive* force precisely as the weight of our atmosphere balances its expansive force. But unlike the earth's atmosphere, which is restrained from horizontal movement by its continuance round the globe, the vapour of the column of 50 miles diameter is free to move beyond the confines of the pond. A very powerful horizontal motion, especially of the lower part of the vaporous mass, will thus be promoted, acting in radial lines from the centre, the principal resistance encountered being the friction against the water. Considering that the friction against the surface of the ocean, caused by the gentle trade-wind, is sufficient to produce the Gulf Stream, we need no figures to show the effect on the water in the boiling pond produced by the vaporous mass propelled by an energy of 2 lbs. to the square inch, in radial lines towards its confines. A circular tidal wave of extraordinary power, together with a return under-current towards the centre, will obviously be the result. But agreeably to the laws supposed to govern vortex motion, these currents cannot be maintained in a radial direction. A rotary motion, rapidly augmenting, will take place, producing a vortex more powerful than any imagined by Descartes. The radial currents of the vaporous column having assumed a spiral course, will rapidly acquire a velocity exceed that of a cyclone. The practical effect of the powerful movement of the vortex, it is reasonable to suppose, will resemble that of a gigantic carving-tool whose thorough efficiency in removing irregularities has been proved by the exact circular outline presented by thousands of lunar formations. The terraces within the "ring mountains" indicated on Beer and Mädler's chart, it may be shown, were produced by evaporation resulting from low temperature and reduced energy after the formation of the main glacier.

There is another feature in the lunar landscape scarcely less remarkable than its circular walls and depressions. In the centre of nearly all of the latter one or more conical hills rise, in some cases several thousand feet high. Has the rotary motion of the boiling vortex any connection with these central cones? A brief explanation will show that the connection is quite intimate. The under-rated estimate that 10 square feet of surface under the action of slow fire is capable of developing one horse-power proves the presence of a dynamic energy exceeding 5,000,000,000 of horse-power at the base of the vaporous column resting on the boiling water of a pond as large as that of Tycho. No part of this power can be exerted vertically, as already explained, on the ground that the weight of the vapour restrains such movement. The great velocity of the vortex resulting from the expenditure of the stated amount of dynamic energy will of course produce corresponding centrifugal force; hence a maelström will be formed capable of draining the central part of the pond, leaving the same dry, unless the water be very deep, in which case the appearance of a dry bottom will be postponed until a certain quantity of water has been transferred to the glacier. It should be observed that the central part of the bottom, freed from water, will also be freed from the surrounding cold by the protection afforded by the vaporous mass. The quantity of snow formed above the centre, at great altitude, will be small, and of course diverged during the fall. Evidently the dry central part, prevented, as shown, from cooling, will soon acquire a high temperature, admitting the formation of a vent for the expulsion of lava, called for as the moon, whose entire dry surface is radiating against space, shrinks rapidly under the forced refrigeration attending glacier-formation. Lava-cones similar to those of terrestrial volcanoes, and central to the circular walls, may thus be formed, the process being favoured by the feebleness of the moon's attraction. The existence of warm springs on the protected central plains is very probable; hence the formation of cones of ice might take place during the last stages of glacier-formation, when those plains no longer receive adequate protection against cold.

In accordance with the views expressed in the monograph read before the American Academy of Science, continued research has confirmed my supposition that the water on the moon bears the same proportion to its mass as the water of the oceans to the terrestrial mass. I have consequently calculated the contents of the circular walls of the "ring mountains" measured and delineated by Beer and Mädler, and find that these walls contain 630,000 cubic miles. The opposite hemisphere of the moon being subjected to similar vicissitudes of heat and cold as the one presented to the earth, the contents of the circular walls not seen cannot vary very much from those recorded in "Der Mond"; hence the total will amount to 1,260,000 cubic miles. Allowing for the difference of specific gravity of ice, the stated amount represents 1,159,000 cubic miles of water. But "Der Mond" does not record any of the minor circular walls which, as shown by the large photograph before referred to, cover the entire surface of some parts of the moon. On careful comparison it will be found that the contents of the omitted circular formations is so great that an addition of 50 per cent. to the before-stated amount is called for. An addition of 25 per cent. for the ice-fields, whose extent is indicated by cracks and optical phenomena, is likewise proper. The sum total of water on the moon, therefore, amounts to 2,028,600 cubic miles.

Adopting Herschel's estimate of the moon's comparative mass, viz. 0·011364, and assuming that the oceans of the earth cover 130,000,000 square miles, it will be seen that the estimated quantity of water on the moon corresponds with a mean depth of 7250 feet of the terrestrial oceans.[1] This depth agrees very nearly with the oceanic mean depth established by the soundings for the original Atlantic cable, viz. 7500 feet; but the result of the *Challenger* Expedition points to a much greater depth. This circumstance is by no means conclusive against the supposition that the satellite and the primary are covered with water in relatively equal quantities. The correctness of Sir John Herschel's demonstration proving the tendency of the water on the lunar surface to flow to the hemisphere furthest from the earth must be disproved before we reject the assumption that the quantity of water on the surface of the moon bears the same proportion to its mass as the quantity of water on the earth to the terrestrial mass.

JOHN ERICSSON

[1] $\frac{2028600 \times 5280}{130000000 \times 0{\cdot}011364} = 7250$ feet mean depth of terrestrial oceans corresponding with water on the moon.

SCIENTIFIC SERIALS

Rendiconti del Reale Istituto Lombardo, May 27.—Determination of the heat of fusion in the alloys of lead, tin, bismuth, and zinc, by Prof. D. Mazzotto. By the cooling process usually adopted for determining the specific heat of liquids, the author finds the point of fusion and the heat of fusion for these various chemical alloys as under:—

	Point of fusion	Heat of fusion
Tin and lead	181°	10°29
Tin and zinc	196	16·20
Tin and bismuth	138	11·065
Bismuth and lead	126	4·744

Two of these coincide and two others differ little from the composition of the chemical alloys as given by Rudberg.—Education and crime in Italy, by S. Amato Amati. In order to ascertain the influence of public instruction on the criminal classes in the Peninsula, the author has compiled a number of comparative tables based on official returns ranging from the year 1871 to 1883 inclusive. For the last three years of this period the results are as under:—

	Criminals	Unlettered	Could read and write	Educated
1881	8693	5511	3031	151
1882	7009	4139	2671	199
1883	6490	3741	2596	153

According to the three last census returns the total percentage of unlettered was as under:—

	Males	Females	Total
1861	65·47	81·52	73·50
1871	60·16	77·18	68·64
1881	53·89	72·93	63·45

—Meteorological observations made at the Brera Observatory, Milan, during the month of May.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 6.—"Further Discussion of the Sun-spot Spectra Observations made at Kensington." By J. Norman Lockyer. Communicated to the Royal Society by the Solar Physics Committee.

I have recently discussed, in a preliminary manner, the lines of several of the chemical elements most widened in the 700 spots observed at Kensington.

The period of observation commences November 1879, and extends to August 1885. It includes, therefore, the sunspot curve from a minimum to a maximum and some distance beyond.

It is perhaps desirable that I should here state the way in which the observations have been made. The work, which has been chiefly done by Messrs. Lawrance and Greening, simply consists of a survey of the two regions F—*b* and *b*—D.

The most widened line in each region—not the widest line, but the *most widened*, is first noted; its wave-length being given in the observation books from Ångström's map. Next, the lines which most nearly approach the first one in widening are recorded, and so on till the positions of six lines have been noted, the wave-lengths being given from Ångström's map, for each region.

It is to be observed that these observations are made without any reference whatever to the origin of the lines; that is to say it is no part of the observer's work to see whether there are metallic coincidences or not; this point has only been inquired into in the present reductions, that is, seven months after the

TABLE A.—IRON

Iron Lines observed in Sunspot Spectra at Kensington among the most Widened Lines

	1st Hundred, Nov. 12, 1879, to Sept. 29, 1880	2nd Hundred, Sept. 29, 1880, to Oct. 15, 1881	3rd Hundred, Oct. 18, 1881, to June 27, 1882	4th Hundred, July 1, 1882, to August 28, 1883	5th Hundred, August 30, 1883, to June 23, 1884	6th Hundred, June 24, 1884, to Feb. 12, 1885	7th Hundred, Feb. 18, 1885, to August 24, 1885
5165.8	—		—				
5161.5		—		—			
5158.5		—		—			
5151.2		—	—				
5150.0		—	—	—			
5145.7	—	—	—	—			
5141.8	—	—					
5138.6	—	—					
5136.8	—	—	—				
5133.0			—		—	—	—
5126.5			—				
5123.2		—	—				
5121.0	—		—				
5109.8		—					
5107.0	—	—		—			
5098.2	—	—					
5096.3	—						
5090.2		—					
5082.2		—	—	—			
5078.8	—	—	—	—		—	
5077.9	—	—	—	—		—	
5075.8	—	—					
5074.0	—	—					
5071.9	—	—					
5068.1	—	—					
5064.4	—						
5051.0	—	—					
5049.4	—	—					
5047.8	—	—					
5041.2	—	—		—			
5040.1	—	—		—			
5038.2		—	—		—		
5027.2		—					
5026.2		—					
5019.2		—					
5014.2		—					
5011.5	—	—					
5006.5	—						
5005.2	—						
5004.9	—						
4984.8	—	—					
4983.5	—	—					
4982.5	—	—					
4981.8	—	—					
4956.7	—	—					
4919.8	—	—			—		
4918.0	—	—			—		
4909.5				—			—
4907.0	—						—
4890.6	—	—		—			
4890.0	—	—		—	—		
4888.0	—	—					
4886.5		—					
4884.2		—					
4877.4	—						
4875.5		—					
4871.3	—	—		—	—		
4870.2	—	—		—	—		
4863.2		—					

last observations now discussed were made. In this way perfect absence of all bias is secured.

It may further be remarked that the number of lines widened throughout a sunspot period is about the same, so that the conditions of observation vary very little from month to month, and from year to year.

It may be further remarked that the absolute uniformity of the results obtained in the case of each of the chemical elements investigated indicates, I think, that the observations have been thoroughly well made; and, as a matter of fact, they are not difficult.

I first give tables (A, B, C) showing that for each of the chemical elements taken—iron, nickel, and titanium—the num- of lines seen in the aggregate in each hundred observations is reduced from minimum to maximum, and that this result holds good for both regions of the spectrum.

TABLE B.—NICKEL

List of most Widened Lines observed at Kensington

Lines	4865·3	4872·5	4903·9	4917·6	4935·1	4979·6	4983·5	5016·8	5034·6	5079·8	5080·6	5098·5	5099·2	5114·9	5136·8	5141·8	5145·7	5155·1	5168·3	5175·6
1st hundred							│		│						│	│	│			
2nd hundred							│	│	│	│	│	│			│	│	│			
3rd hundred										│	│				│		│	│		
4th hundred										│	│						│	│		
5th hundred																		│		
6th hundred											│									
7th hundred																		│		

TABLE C.—TITANIUM

List of most Widened Lines observed at Kensington

Lines	4869·5	4884·2	4913·2	4964·5	4981·0	5006·6	5013·3	5035·2	5035·8	5037·8	5038·0	5038·7	5052·3	5061·3	5064·4	5071·8	5086·5	5119·9	5126·6	5144·5	5147·0	5151·2
1st hundred					│	│		│	│						│	│						
2nd hundred	│	│	│	│	│		│	│		│		│	│	│		│	│					│
3rd hundred								│		│		│	│					│	│		│	│
4th hundred									│		│			│						│	│	
5th hundred										│	│									│	│	
6th hundred																				│		
7th hundred	No lines.																					

I next give another table (D) showing that during the obser-

TABLE D.—*Unknown Widened Lines observed at Kensington*

	1st hundred	2nd hundred	3rd hundred	4th hundred	5th hundred	6th hundred	7th hundred
4865	..	...	...	...	...	1	...
4885	...	...	...	...	...	...	1
4888·3	1	...	...	...	...	...	...
4891·8	..	...	...	...	1	...	...
4910	...	...	...	2	...	...	...
4944	..	...	1	...	...	...	...
5017·2	...	1	...	...	...	...	...
5028·9	...	1	...	...	...	...	...
5030	..	1	...	...	...	...	...
5034·8	11	...	3	...	...	...	...
5037	...	...	...	...	...	1	...
5038·9	...	...	1	1	...	...	...
5042	...	...	3	...	...	...	...
5042·3	...	...	4	...	...	...	...
5043	...	1	...	...	...	...	...
5044·6	...	3	...	...	...	...	...
5061	...	...	2	...	...	...	3
5061·5	..	...	...	...	...	...	2
5062	...	...	...	..	...	...	5
5062·4	...	...	...	...	...	2	...
5062·8	...	...	...	3	...	2	...
5065	...	...	8	...	...	...	...
5067	...	1	...	...	...	...	...
5069·5	...	1	...	...	...	...	...
5070·8	...	1	...	...	...	...	...
5077	...	...	.	1	...	...	...
5079·5	...	...	...	...	...	2	...
5080	...	...	...	1	...	...	...
5081·5	..	...	...	...	...	...	3
5082	...	...	...	...	...	2	...
5083	...	...	...	...	...	2	...
5083·3	...	1	2	3	...	...	...
5084	...	1	...	...	...	...	3
5084·5	...	...	...	...	...	...	2
5086	..	...	17	..	1	...	...
5086·8	..	1	...	...	...	...	...
5087·7	...	1	...	...	...	..	...
5088·1	...	1	...	...	...	...	...
5088·6	...	1	...	...	...	...	...
5089·0	...	...	...	1	...	...	...
5101	...	...	...	...	...	...	1
5103·5	...	...	...	...	1	...	...
5112·1	...	6	22	4	2	1	...
5115·5	...	...	...	...	...	...	9
5116	3	6	24	3	...	...	...
5116·2	...	...	7	...	...	...	...
5118	4	...	14	...	...	...	...
5127	...	...	...	1	...	...	...
5127·5	...	...	1	...	...	...	...
5128·8	...	...	...	...	...	...	1
5129·6	...	17	19	4	...	...	...
5130	...	...	1	..	...	...	...
5132	...	14	21	6	...	...	...
5132·5	...	...	1	...	...	...	...
5132·8	...	...	...	3	...	...	...
5133·5	...	...	1	...	1	3	17
5133·8	...	30	47	43	62	3	27
5134	...	...	...	...	12	41	10
5134·4	...	...	...	...	...	19	...
5135	...	...	...	...	16	36	11
5135·5	...	33	15	...	53	36	20
5135·8	...	...	37	52	13	2	...
5136	...	...	4	...	9	22	27
5136·5	...	...	3	1	...	...	...
5137	...	...	2	2	1	...	...
5137·5	...	...	4	...	72	79	22
5137·8	...	12	35	64	13	10	3
5138	...	...	..	...	1	...	3
5139	...	...	...	...	1	...	1
5139·4	...	1	2	3	...	...	...
5140·4	...	2	...	...	...	...	...
5142·2	13	4	...	1	...	...	...
5142·8	...	21	7	19	2	...	...
5143	...	..	...	...	...	...	20
5143·2	...	...	2	...	...	...	...
5144·2	1	3	...	2	...	...	...
5144·5	...	...	...	...	1	...	...
5145·5	...	...	...	...	...	1	...
5146	..	...	36	12	...	...	...
5146·5	...	...	...	2	...	...	.
5148	...	...	..	...	...	...	1
5148·8	...	...	1	2	...	...	...
5149	2	32	31	36	4	...	35
5149·2	...	...	...	1	...	...	...
5149·5	...	...	..	4	...	...	29
5149·8	...	8	2	8	..	8	...
5150	...	...	...	1	...	...	...
5151·8	...	...	...	...	1	...	...
5153·8	...	...	..	...	1	...	...
5154	...	...	...	...	...	...	1
5155·4	...	...	...	...	1	...	...
5156	1	12	37	74	82	91	95
5156·5	...	...	...	...	8	...	...
5157·2	...	...	...	4	...	...	...
5159	...	...	1	8	13	11	41
5159·5	1	...	31	59	80	86	57
5160	...	...	1	4	...	9	...
5160·4	...	1	...	5	...	...	4
5162	...	...	9	7	61	67	62
5162·2	1	...	23	49	21	30	...
5175	...	...	...	...	...	...	3

vations the lines recorded as most widened near the maximum have not been recorded amongst metallic lines by either Ångström or Thalèn, and that many of them are not among the mapped Fraunhofer lines, though some of them may exist as faint lines in the solar spectrum when the observing conditions are best.

The reduction of the latitudes of the spots is not yet completed.

The result of these observations may be thus briefly stated. As we pass from minimum to maximum, the lines of the chemical elements gradually disappear from among those most widened, their places being taken by lines of which at present we have no terrestrial representatives. Or, to put the result another way—at the minimum period of sunspots when we know the solar atmosphere is quietest and coolest, vapours containing the lines of some of our terrestrial elements are present in sunspots. The vapours, however, which produce the phenomena of sunspots at the sunspot maximum are entirely unfamiliar to us.

The disappearance of the lines of iron, nickel, and titanium, and the appearance of unknown lines as the maximum is reached, is shown by curves in Fig. 1.

The results, in my opinion, amply justify the working hypothesis as to the construction of the solar atmosphere which I published some years ago (*Proc.* Roy. Soc., 1882, p. 291). In the region of the spectrum comprised between 4860 and 5160, I find in the case of iron, to take an instance, that sixty lines were distributed unequally among the spots in 1879 and 1880, many iron lines being visible in every spot. In the last observations, about the maximum, only three iron lines in all are seen among the most widened lines. These three lines also have been visible in four spots only out of the last hundred. The same thing happens with titanium and nickel, and with all the substances for which the reductions are finished.

I am quite content, therefore, to believe that iron, titanium, nickel, and the other substances very nearly as complex as we know them here, descend to the surface of the photosphere, in the downrush that forms a spot at the period of minimum, but that at the maximum, on the contrary, only their finest constituent atoms can reach it. It may also be remarked that these particles which survive the dissociating energies of the lower strata are not the same particles among the constituents of the chemical elements named which give the chromospheric lines recorded by Tacchini, Riccò, and myself.

Having thus found the working hypothesis to which I have referred stand the severe test which the sunspot observations apply to it, I have gone further, and have endeavoured to extend it in two directions.

First. I found that the view to which the hypothesis directly leads, that the metallic prominences are produced by violent explosions due to sudden expansions among the cooler matters brought down to form the spots, when they reach the higher temperature at and below the photosphere level, includes all the facts I know touching spot and prominence formation. Thus, for instance, the close connection between metallic prominences and spots; the entire absence of metallic prominences with rapid motion from any but the spot-zones; the fact that the faculæ always follow the formation of a spot and never precede it; that the faculous matter lags behind the spot as a rule; the existence of veiled spots and minor prominences in regions outside the spot-zones; the general injection of unknown substances into the lower levels of the chromosphere which I first observed in 1871, and which have been regularly recorded by the Italian observers since that time—all these phenomena and many others which may be referred to at length on another occasion, are demanded by the hypothesis, and are simply and sufficiently explained by it.

With regard to the extensions of volume to which I have re-

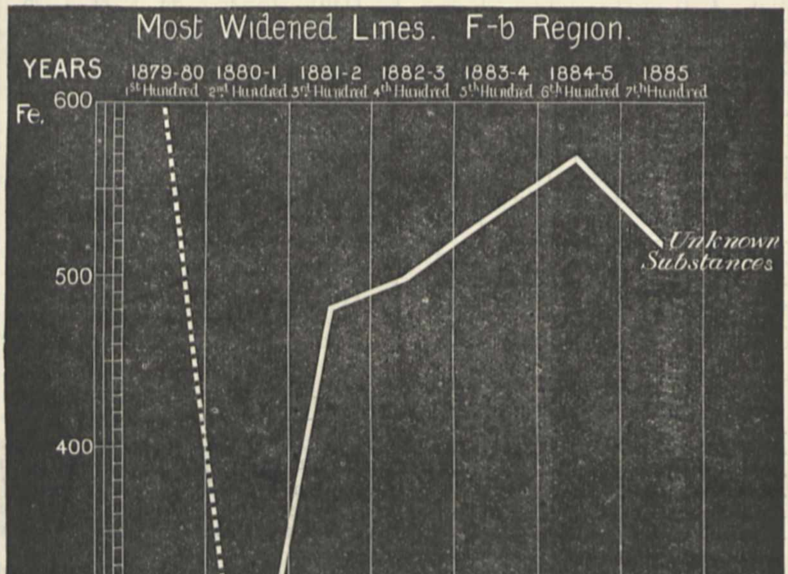


FIG. 1.—Number of appearances of known and unknown lines.

ferred, I find that if we assume that metallic iron can exist in any part of the sun's atmosphere, and that it falls to the photosphere to produce a spot, the vapour produced by the fall of 1,000,000 tons will give us the following volumes:—

Temperature		Pressure		Volume in cubic miles
2,000° C.	...	380 mm.	...	0·8
10,000	...	760 ,,	...	1·8
20,000	...	5 atmos.	...	0·7
50,000	...	760 mm.	...	8·8
50,000	...	190 ,,	...	35·2

If we assume the molecule of iron to be dissociated ten times by successive halving, then the volume occupied will be 1024 times greater, and we shall have—

Temperature		Pressure		Volume in cubic miles
50,000° C.	...	760 mm.	...	9,011
50,000	...	190 ,,	...	36,044

In these higher figures we certainly do seem nearer the scale on which we know solar phenomena to take place; the tremendous rending of the photosphere, upward velocities of 250 miles a second, and even higher horizontal velocities according to

Peters, are much more in harmony with the figures in the second table than the first.

I may mention, in connection with this part of the subject, that the view of the great mobility of the photosphere which this hypothesis demands, so soon as we regard metallic prominences as direct effects of the fall of spot material, is further justified by the fact that, if we assume the solar atmosphere, that is the part of the sun outside the photosphere, to be about 500,000 miles high, which I regard as a moderate estimate, the real average density of the sun is very nearly equal to one-tenth that of water, instead of being slightly greater than that of water, as stated in the text-books.[1]

We can then only regard the photosphere as a cloudy stratum existing in a region of not very high pressure. It is spherical because it depends upon equal temperatures.

The second direction in which I have attempted to develop the hypothesis has relation to the circulation in the sun's atmosphere. I have taken the facts of the solar atmosphere as a whole, as they are recorded for us in the various photographs taken during eclipses since 1871, and also in drawings made before that time, the drawings being read in the light afforded by these photographs.

I find that the working hypothesis at once suggests to us that the sunspot period is a direct effect of the atmospheric circulation, and that the latitudes at which the spots commence to form at the minimum, which they occupy chiefly at the maximum, and at which they die out at the end of one period in one hemisphere, probably at the moment they commence to form a second one in the other (as happened in 1878–79), are a direct result of the local heating produced by the fall of matter from above descending to the photosphere, and perhaps piercing it. The results of this piercing are the liberation of heat from below and various explosive effects due to increase of volume, which, acting along the line of least resistance, give, as a return current, incandescent vapours ascending at a rate which may be taken as a maximum of 250 miles a second, a velocity sufficient to carry them to very considerable heights.

The view of the solar circulation at which I have arrived may be briefly stated as follows :—

There are upper outflows from the poles towards the equatorial regions. In these outflows a particle constantly travels, so that its latitude decreases and its height increases, so that the true solar atmosphere resembles the flattened globe in Plateau's experiment (see photographs, 1878, and Fig. 3).

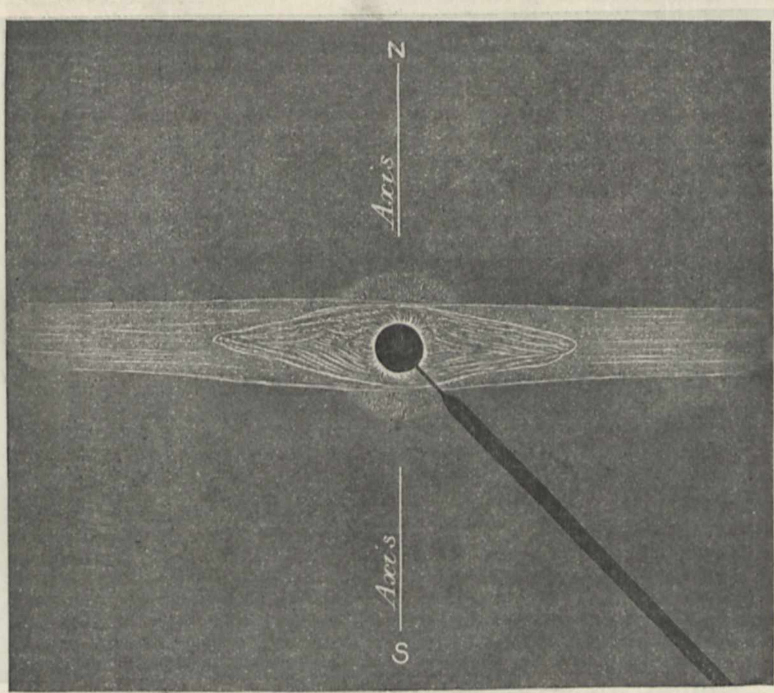


FIG. 2.—Minimum. Tracing of Newcomb's observation of 1878, the brighter portion of corona being hidden by a screen. Shows the equatorial extension and concentric atmospheres.

These currents, as they exist in the higher regions of the atmosphere, carry and gather the condensing and condensed materials till at last they meet over the equator.

There is evidence to show that they probably extend as solar meteoric masses far beyond the limits of the true atmosphere, and form a ring, the section of which widens towards the sun, and the base of which lies well within the boundary of the atmosphere (Fig. 2).

If we assume such a ring under absolutely stable conditions, there will be no disturbance, no fall of material, therefore there will be no spots, and therefore again there will be no prominences. Such was the state of things on the southern surface of the ring from December 1877 to April 1879, during which period there was not a single spot observed the umbra of which was over 15-millionths of the sun's visible hemisphere.

Assume a disturbance. This may arise from collisions, and these collisions would be most likely to happen among the particles where the surface of the ring meets the current from the poles. These particles will fall towards the sun, thereby disturbing and arresting the motion of other particles nearer the photosphere, and finally they will descend with a crash on to the photosphere, from that point where the surface of the ring enters the atmosphere some distance further down.

The American photographs in 1878 supply us with ample evidence that this will be somewhere about lat. 30°, and here alone will the first spots be formed for two reasons.

(1) In the central plane of the ring over the equator, the particles will be more numerous ; a rapid descent, therefore, in this central plane will be impossible, for the reason that the condensed matter has to fall perhaps a million of miles through strata of increasing temperature ; there will, therefore, be no spots ; and practically speaking, as is known, there are no spots at the equator, though there are many small spots without umbræ between latitudes 3° and 6° N. and S.

Above lat. 30°, as a rule, we have no spots, because there is no ring, and further the atmosphere is of lower elevation, so that there is not sufficient height of fall to give the velocities require to bring down the material in the solid form.

The lower corona, where the corona is high, and it is highest over the equator, acts as a shield or buffer ; volatilisation and

[1] The density referred to water = 1·444 and to the earth 0·255, according to Newcomb.

dissociation take place at higher levels. Where this occurs, spots are replaced by a gentle rain of fine particles slowly descending, instead of the fall of mighty masses and large quantities of solid and liquid material.

Volatilisation will take place gradually during the descent, and at the utmost only a veiled spot will be produced.

We know that when the solar forces are weak, such a descent is taking place all over the sun, because at that time the spectrum of the corona, instead of being chiefly that of hydrogen, is one of a most complex nature—so complex that before 1882 it was regarded by everybody as a pure continuous spectrum, such as is given by the limelight.

The moment the fall of spot material begins we get the return current in the shape of active metallic prominences, and the production of cones and horns which probably represent the highest states of incandescence over large areas and extending to great heights; and, besides these, the production of streamers (see Fig. 4).

Two results follow:—

(1) In consequence of the increased temperature of the lower regions, the velocity of the lower currents towards the poles, and therefore of the upper currents from the poles, is enormously increased. The disturbance of the ring will therefore be increased.

(2) Violent uprushes of the heated photospheric gases, mounting with an initial velocity of a million miles an hour, can also disturb the ring directly.

In this way the sudden rise to maximum in the sunspot curve, and the lowering of the latitude of the spots, follow as a matter of course. And the part of the ring nearest the sun, its base, so to speak, is, it would appear, thrown out of all shape, and we get falls over broad belts of latitude N. and S.

Does this hypothesis explain, then, the slow descent to minimum and the still decreasing latitude? It does more, it demands it. For now the atmosphere over those regions where the spots have hitherto been formed is so highly heated and its height is so increased, that any disturbed material descending through it will be volatilised before it can reach the photosphere.

The best chance that descending particles have now to form spots is if they fall from points in lower latitudes. The final period, therefore, of the sunspot curve must be restricted to a very large extent to latitudes very near the equator, and this is the fact also, as is well known.

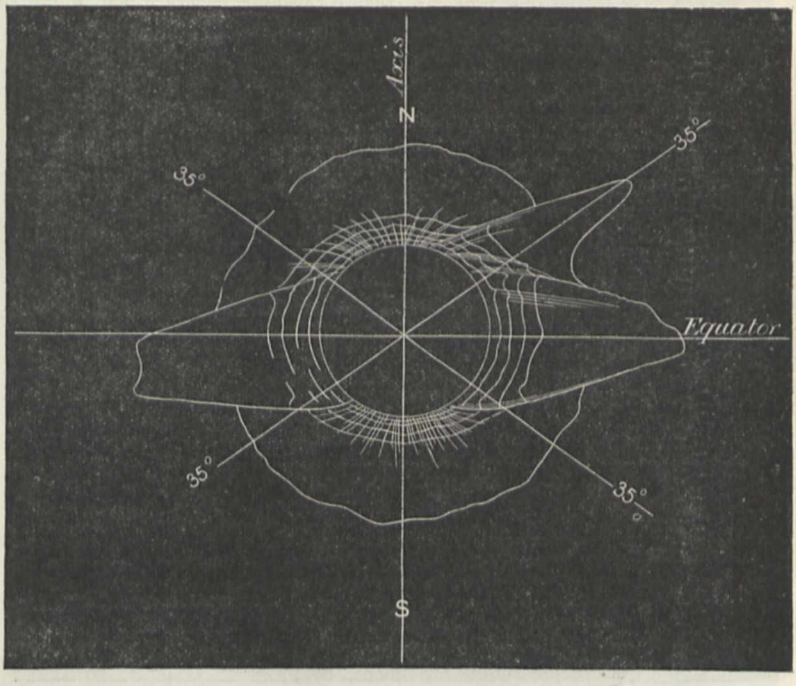


FIG. 3.—Minimum. Tracing of the results obtained by the cameras in 1878, showing inner portion of equatorial extension, and how the surfaces of it cut the concentric atmosphere in lat. 35° N. and S., or thereabouts.

It will be seen that on this view, as the brightness, and therefore the temperature, of the atmosphere, as we know, increases very considerably from minimum to maximum, the masses which can survive this temperature must fall from gradually increasing heights.

It may be pointed out how perfectly this hypothesis explains the chemical facts observed and associates them with those gathered in other fields of inquiry.

At the minimum the ring is nearest the sun, the subjacent atmosphere is low and relatively cool.

Particles falling from the ring, therefore, although they fall in smaller quantity because the disturbance is small, have the best chance of reaching the photosphere in the same condition as they leave the ring, hence at this time the widening in many familiar lines of iron, nickel, titanium, &c.

The gradual disappearance of these lines from the period of minimum to that of maximum is simply and sufficiently explained by the view that the spot-forming materials fall through gradually increasing depths of an atmosphere which at the same time is having its temperature as gradually increased by the result of the action I have before indicated, until finally, when the maximum is reached, if we assume dissociation to take place at a higher level at the maximum, dissociation will take place before the vapours reach the photosphere, and the lines which we know in our laboratories will cease to be visible.

This is exactly what takes place, and this result can be connected, as I have stated elsewhere, with another of a different kind. This hypothetical increasing height of fall demanded by the chemistry of the spots is accompanied by a known acceleration of spot movement over the sun's disk, as we lower the latitude—which can only be explained, so far as I can see, by a gradually increasing height of fall as the equator is approached.

There are two other points. (1) The sunspot curve teaches us that the slowing down of the solar activities at the maximum is very gradual. We should expect, therefore, the chemical conditions at the maximum to be maintained for some time afterwards. As a matter of fact, they have been maintained till March of the present year, and only now is a change taking place which shows us chemically that we are leaving the maximum conditions behind. (2) The disappearance of the lines of the metallic elements at maximum is so intimately connected with an enormous increase in the indications of the presence of hydrogen that there is little doubt that we are in the presence of cause and effect. The hydrogen, I am now prepared to believe, is a direct consequence of the dissociation of the metallic elements.

It will be convenient to refer here to the facts which have been recorded during those eclipses which have been observed at the sunspot minimum and maximum.

At the minimum the corona is dim; observations made during the minimum of 1878 showed that it was only one-seventh as bright as the corona at the preceding maximum. There are no bright lines in its spectrum, and both photographic and eye-observations proved it to consist mainly of a ring round the equator, gradually tapering towards its outer edge, which some observations placed at a distance of twelve diameters of the sun from the sun's centre.

The same extension was observed in the previous minimum in 1867, and the polar phenomena were observed to be identical in both eclipses. At the poles there is an exquisite tracery curved in opposite directions, consisting of plumes or *panaches*, which bend gently and symmetrically from the axis, getting more and more inclined to it, so that those in latitudes 80° to 70° start nearly at right angles to the axis, and their upper portions droop gracefully, and curve over into lower latitudes.

Although indications of the existence of this ring have not been recorded during eclipses which have happened at the period of maximum, there was distinct evidence both in the eclipses in 1871 and 1875 of the existence of what I regard as the indications of outward upper polar currents observed at minimum.

The fact that the solar poles were closed at the maximum of 1882, while they were open in 1871, is one of the arguments which may be urged that at times the whole spot-zones are surmounted by streamers, with their bases lying in all longitudes along the zones.

It was probably the considerable extension of these streamers earthwards, in 1882, which hid the finer special details at the poles, while in 1871 the part of the sun turned towards the earth was not rich in streamers of sufficient extension.

Touching these streamers, it is an important fact to be borne in mind, that no spots ever form on the poleward side of them.

It is obvious, therefore, that spots are not produced by the condensation of materials on their upper surfaces, for in that case the spots would be produced indifferently on either side of them, and the width of the spot-zones would be inordinately increased.

Although in the foregoing I have laid stress upon the indications afforded by the observations of 1878 of the existence of a ring, it should be remarked that, so far, the eclipse appearances on which the idea rests have not been observed at maximum. This, however, is not a fatal objection, because precautions for shielding the eye were necessary even in 1878 when the corona was dim; and if it is composed merely of cooled material it would not readily be photographed.

In may be urged by some that the phenomena observed in 1878 may only after all have been equatorial streamers.

It is obvious, therefore, that this point deserves the closest attention during future eclipses, until it is settled one way or the other.

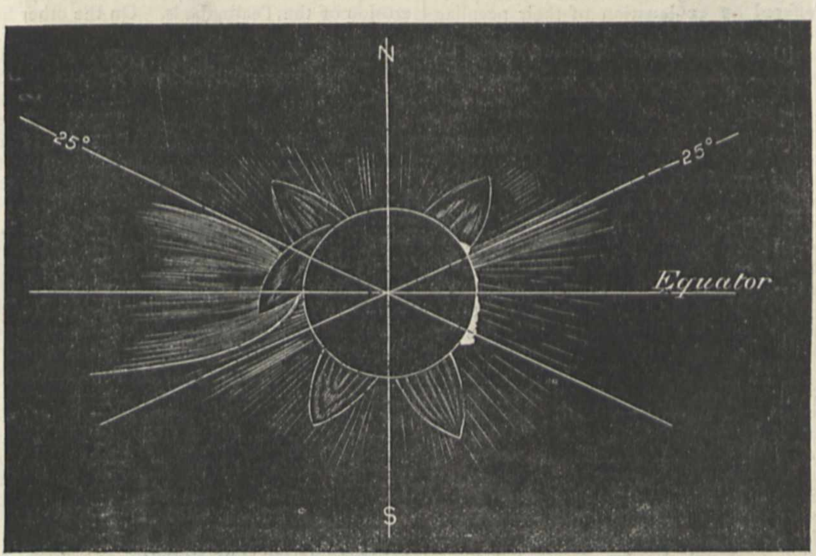


FIG. 4.—1½ years from maximum, 1858. Tracing of drawing by Liais, showing "cones."

Geological Society, June 23.—Prof. J. W. Judd, F.R.S., President, in the chair.—The President announced that he had received from Prof. Barrois an intimation that the Geological Society of France would hold a special country meeting in the district of Finistère from the 19th to the 28th of August next, during which a variety of interesting excursions would be made under the guidance of MM. Barrois, Davy, and Lebesconte. Prof. Barrois, in writing, expressed the pleasure which it would give the members of the Geological Society of France if they were joined by some of their English *confrères*, but at the same time stated that as the accommodation for travellers was limited in the district, he would be glad to have timely notice from any one intending to take part in the meeting. Particulars were to be obtained from the Assistant Secretary, who would also communicate with Prof. Barrois.—The following communications were read:—On some perched blocks and associated phenomena, by Prof. T. McKenny Hughes, M.A., F.G.S. The author described certain groups of boulders which occurred on pedestals of limestone rising from 3 to 18 inches above the level of the surrounding rock. The surfaces of these pedestals were striated in the direction of the main ice-flow of the district, while the surrounding lower rock in no case bore traces of glaciation, but showed what is known as a weathered surface. He inferred that the pedestals were portions of the rock protected by the overhanging boulder from the down-pouring rain, which had removed the surrounding exposed parts of the surface. When the pedestals attained a certain height relatively to the surrounding rock the rain would beat in under the boulder, and thus there was a natural limit to their possible height. He referred to the action of vegetation in assisting the decomposition of the limestone, and considered that there were so many causes of different rates of waste and so many sources of error, that he distrusted any numerical estimate of the time during which the surrounding limestone had been exposed to denudation. Considering the mode of transport of the boulders, he thought that they could not have been carried by marine currents and coast-ice, as they had all travelled, in the direction of the furrows on the rock below them, from the parent rock on the north. Moreover, marine currents would have destroyed the glaciation of the rock and filled the hollows with debris. Furthermore, the boulders and striæ are found in the same district at such very different levels and in such positions as to preclude the possibility of their being due to icebergs. Nor could the boulders represent the remainder of a mass of drift which had been removed by denudation, for the following reasons: (1) they were all composed of one rock, and that invariably a rock to be found in place close by; (2) any denudation which could have removed the clay and smaller stones of the drift would have obliterated the traces of glaciation on the surface of the rock; (3) the boulder which had protected the fine glacial markings below it from the action of the rains would certainly in some cases have preserved a portion of the stiff boulder-clay; (4) the margin of the boulder-clay along the flanks of Ingleborough was generally marked by lines of swallow-holes, into which the water ran off the boulder-clay; and when the impervious beds overlying the limestone had been cut back by denudation, a number of lines of swallow-holes marked the successive stages in the process; but there was not such evidence of the former extension of the drift up to the Norber boulders; (5) the boulders themselves were not rounded and glaciated in the same way as the masses of the same rock in the drift, but resembled the pieces now seen broken out by weathering along the outcrop of the rock close by. Having thus shown the improbability of these boulders having been let down out of a mass of drift the finer part of which had been removed by denudation, or of their having been masses floated to their present position on shore-ice, he offered an explanation of their peculiar position, which he thought was not inconsistent with the view that they belong to some part of the age of land-ice. That they were to be referred to some exceptional local circumstances seemed clear from the rarity of such glaciated pedestals, while boulders and other traces of glaciation were universal over that part of the country. He therefore pointed out, in explanation, that they occurred always where there was a great obstacle in the path of the ice: at Cunswick the mass of Kendal Fell curving round at the south and across the path of the ice; at Farleton the great limestone escarpment rising abruptly from Crooklands; at Norber the constriction of the Crummack valley near Wharfe, and the great mass of Austwich grit running obliquely across its mouth. In all these cases the ice had to force its way up hill; and there would be a time when it would just surmount the obstacle after a season of greater snow-fall, and fall back after warm seasons, until it fell back altogether from that part. During the season of recession, boulders would be detached below the ice-foot; during the seasons of advance they would be pushed forward; and in those exceptional localities of isolated hills from which the drainage from higher ground was cut off, the boulders were left on a clean furrowed surface of limestone, which was then acted upon by rain-water and the vegetation, except where protected by the boulders. The author said that the reason why he objected to any numerical estimate of the time which had elapsed since the boulders were left on the glaciated surface was that we did know that the rate of weathering in the limestone was most unequal. He gave cases from Devonshire and the Lake District of extensive weathering in a few years. He had called attention to the great acceleration of decomposition where the vegetation encroached on the limestone, and he maintained that we had no constant measure to apply.—On some derived fragments in the Longmynd and newer Archæan rocks of Shropshire, by Dr. Charles Callaway, F.G.S. Further evidence was added to that given in the author's previous paper (*Q.J.G.S.*, 1879, p. 661) to show that the Longmynd rocks of Shropshire were chiefly composed of materials derived from the Uriconian series, and that the Uriconian series itself (Newer Archæan) was partly formed from the waste of pre-existing rocks. This evidence consisted of (1) the presence, throughout the greatly developed Longmynd conglomerates and grits, of purple rhyolite fragments, recognised by microscopical characters as identical with the Uriconian rhyolites of the Wrekin, and the occurrence of grains, probably derived from the same rhyolites, in the typical green slates of the Longmynd; and (2) the existence of conglomerate beds containing rounded fragments of granitoid rock in the core of the Wrekin itself, whilst the Uriconian beds of other localities, and especially those of Charlton Hill, contained water-worn pebbles, chiefly metamorphic. These pebbles appeared to have been derived from metamorphic rocks of three distinct types. The views put forward were founded on microscopical evidence, of which some details were given in the paper, and were supported by the views of Prof. Bonney, who had furnished notes on the microscopical characters of the rocks.—Notes on the relations of the Lincolnshire carstone, by Mr. A. Strahan, M.A., F.G.S. The Lincolnshire carstone has hitherto been supposed to be correlative with the upper part of the Speeton series, and to be quite unconformably overlain by the red chalk (*Quart. Journ. Geol. Soc.*, vol. xxvi. pp. 326–47). But the overlap of the carstone by the red chalk, which seemed to favour this view, is due to the northerly attenuation, which is shared by nearly all the Secondary rocks of Lincolnshire. Moreover, the carstone rests on different members of the Tealby group, and presents a strong contrast to them in lithological character, and in being, except for the derived fauna, entirely unfossiliferous. It is composed of such materials as would result from the "washing" of the Tealby beds. In general it is a reddish-brown grit, made up of small quartz-grains, flakes and spherical grains of iron-oxide, with rolled phosphatic nodules. Towards the south, where it is thick, the nodules are small and sporadic. Northwards, as the carstone loses in thickness, they increase in size and abundance, so as to form a "coprolite-bed," and have yielded specimens of *Ammonites speetonensis*, *A. plicomphalus*, *Lucina*, &c. When the carstone finally thins out, the conglomeratic character invades the red chalk, similar nodules being then found in this rock. The presence of these nodules, with Neocomian species, taken in connection with the character of the materials of the carstone, points to considerable erosion of the Tealby beds. On the other hand, there is a passage from the carstone up into the red chalk. It would seem, then, that the carstone should be regarded as a "basement-bed" of the Upper Cretaceous rocks. The Lincolnshire carstone is probably equivalent to the whole of the Hunstanton Neocomian, the impersistent clay of the latter being a very improbable representative of the Tealby clay. It therefore follows that the whole Speeton series is absent in Norfolk, and also in Bedfordshire. The unconformity at the base of the carstone becomes greater southwards, and the nodules have been derived from older rocks. Similarly north of Lincolnshire, where the Speeton series is overlapped, the nodules in the red chalk, marking the horizon of the carstone, have been derived from oolitic rocks. In the south of England it would seem that equivalents of the Speeton series reappear. The Atherfield clay contains an indigenous Upper Speeton fauna, while a pebble-bed near the base of the Folkestone beds is described by Mr. Meyer as containing derived oolitic pebbles, and being probably the representative of the Upware deposit, and presumably, therefore, also of the Lincolnshire carstone.—The geology of Cape Breton Island, Nova Scotia, by Edwin Gilpin, Jun., F.R.S.C., Inspector H.M. Mines. After referring to previously published descriptions of Cape Breton geology, the author stated that the various formations found in the island had been thus classified by the officers of the Geological Survey:—

Pre-Cambrian (Laurentian)
  including { The Felsite series. / The Crystalline Limestone series.
Lower Silurian.
Devonian.
Carboniferous, including
  Lower Coal-formation.
  { Gypsiferous series.
  { Limestones, &c.
  Millstone-Grit.
  Middle Coal-formation.

He then proceeded to give an account of each system and its subdivisions in order, commencing with the most ancient, and adding a few detailed sections of the rocks belonging to some of the principal series. He described the distribution and relations of the several divisions. The paper concluded with a few notes on the superficial geology of the island. There is a general absence of moraines and of the fossiliferous Post-Pliocene marine clays of the Lower St. Lawrence. The older beds are generally exposed, but deeper soils and deposits with erratic boulders are found overlying the Carboniferous beds. Marks of recent ice-action are found on the shores of some of the lakes, and are due to the ice being driven by the wind.—On the Decapod Crustaceans of the Oxford Clay, by James Carter, F.G.S. The author commented on the paucity of these fossils as indicated in British lists, only three or four species having hitherto been recorded. The discovery of considerable numbers of Decapod Crustaceans in the Oxford Clay of St. Ives has enabled the author to increase the list materially. Many have been collected by Mr. George, of Northampton. These fossils occur in the clay immediately beneath the St. Ives rock, and therefore presumably in the uppermost zone of the Oxford Clay. Many of the specimens are more or less mutilated, but some fifteen or sixteen distinct species have been made out. None of these have been recorded as British except *Eryma Babeaui*, mentioned by Mr. Etheridge as having been found in the Kimmeridge Clay. Seven species are identified as foreign forms, and seven are new to science. They are distributed as follows:—

Eryon	1	species.
Eryma	5 or 6	,,
Glyphea	2	,,
Magila	2 or 3	,,
Mecochirus	2	,,
Goniochorus	1	,,
Undetermined	3	,,

Nearly all the forms being to the type of the Macrura, the Brachyura being doubtfully, if at all, represented.—Some well-sections in Middlesex, by W. Whitaker, B.A. Lond., F.G.S. Accounts of many well-sections and borings having been received since the publication of vol. vi. of the Geological Survey *Memoirs*, the author now gave more or less detailed descriptions of fifty-six of these, all in the Metropolitan county, and all either unfinished or, in a few cases, with further information as to published sections. The depths range from 59 to 700 feet, more than half being 300 feet or more deep. Nearly all pass through the Tertiary beds into the Chalk, and most have been carried some way into the latter. Papers descriptive of like sections in Essex, Herts, and Surrey have been sent to Societies in those counties.—On some Cupriferous Shales in the Province of Houpeh, China, by H. M. Becher, F.G.S. This communication contained some geological observations made during a visit to a locality on the Yangtse River, near I-chang, about 1000 miles from the sea, for the purpose of examining a spot whence copper ore (impure oxide with some carbonate and sulphide) had been procured. The principal formations in the neighbourhood of I-chang were said to be Palæozoic (probably Carboniferous) limestones of great thickness, overlain by brecciated calcareous conglomerate and reddish sandstones, which form low hills in the immediate vicinity of the city. About fifty miles further west the limestones pass under a great shale-series with beds of coal, the relations of which to the sandstones are not clearly ascertained. The copper ore examined by the writer came from the shales, which contained films and specks of malachite and chrysocolla, and in places a siliceous band containing cuprite, besides the oxidised minerals, was interstratified in the beds. Occasionally larger masses of pure copper ore are found embedded in the strata. The ground had not been sufficiently explored for the value of the deposits to be ascertained.—The Cascade Anthracite Coal-field of the Rocky Mountains, Canada, by W. Hamilton Merritt, F.G.S. The coal-field named occurs in the most eastern valley of the Rocky Mountains, that of the Bow River, and, like other coal-fields of the country, consists of Cretaceous rocks, which lie in a synclinal trough at an elevation of about 4300 feet above the sea. The underlying beds, of Lower Carboniferous, or possibly Devonian, age, rise into ranges 3000 feet higher. Further to the eastward the Jurassic and Cretaceous coal contains a large percentage of hygroscopic water and volatile combustible matter, and has the mineral composition of lignite. The average composition is:—

	Per cent.
Fixed carbon...	42
Volatile combustible matter ...	34
Hygroscopic water	16
Ash	8
	100

As the mountains are approached, the amount of hygroscopic water is found to diminish by about 1 per cent. for every 10 miles, and 15 miles from the range the percentage is about 5. In the foot-hills the lignites pass into a true coal, with 1·63 to 6·12 per cent. of hygroscopic water, and 50 to 63 per cent. of fixed carbon. In the Cascade River coal-field the average character of the coal is that of a semi-anthracite, with the following composition;—

	Per cent.
Fixed carbon	80·93
Volatile combustible matter ...	10·79
Hygroscopic water	·71
Ash	7·57
	100·00

The coal-seams have been subjected to great pressure, and the change in the quality of the coal appears to be due to metamorphic influence.—On a new Emydine Chelonian from the Pliocene of India, by Mr. R. Lydekker, B.A., F.G.S. The author described the shell of an Emydine tortoise from the Siwaliks of Perim Island, Gulf of Cambay, which he regarded as decidedly distinct from any of the previously described Siwalik species, and proposed to refer to the genus *Clemmys*, with the name of *C. watsoni*, in compliment to the donor of the specimen.—On certain Eocene formations of Western Servia, by Dr. A. B. Griffiths, F.R.S.E., F.C.S. Communicated by the President. A great thickness of paper-shales containing paraffin occurs near the River Golabara; these extend over 30 square miles of country. Small beds of clay with rock-salt are also found: the whole is said to resemble the paraffin and salt districts of Galicia. The paraffin shale is free from bituminous impurities. It contains:—

	Per cent.
Paraffin wax	1·75
Water of combination	3·02
Ammonia	1·18

The mineral constituents of the shale are:—

	Per cent.
Alumina	32·86
Iron oxide...	5·20
Magnesia	1·26
Lime	1·21
Potash	2·17
Soda	0·41
Silica	56·85
Loss	0·04
	100·00

The brown coal of the neighbourhood, whose natural distillation has most probably yielded the hydrocarbon in the shales, contains:—

	Per cent.
Carbon	49·2
Hydrogen	1·1
Water, combined	30·2
Water, hygroscopic	19·5
	100·00

The beds containing these coals have been invaded by eruptive porphyry and trachytic rocks, of which the former contains 75½ and the latter 61 per cent. of silica. The clays from which the shales were originally formed contain abundance of marine Diatomaceæ and Foraminifera (chiefly Nummulites), as also species of *Ostrea*, *Cyrena*, *Cerithium*, *Voluta*, and *Nautilus*, together with the remains of Placoid and Teleostean fishes.

Paris

Academy of Sciences, July 5.—M. Jurien de la Gravière, President, in the chair.—Memoir on the life and works of Louis-François-Clement Bréguet, Member of the Academy of Sciences, born at Paris on December 22, 1804, died October 27, 1883, by M. de Jonquières.—Obituary notice of M. H. Abich, Corresponding Member of the Section for Mineralogy, who died at Vienna on July 1, 1886, by M. Daubrée.—Preliminary note on the principles and method employed in a study on the movement of the hydro-extractor, about to be presented to the Academy, by M. de Jonquières.—Experiments on a new apparent paradox in hydraulics, by M. A. de Caligny.—Final objections to M. de Bussy's formulas on the roll of vessels, by M. A. Ledieu. It is pointed out that M. de Bussy's theorising is of a purely speculative character, of very little practical utility. After the protracted studies of Froude and Rankine in England, published in the *Transactions* of the Institution of Naval Architects (1861–64), and of MM. Bertin and Bénazé in France, the subject may be regarded as exhausted.—On the real position to be assigned to the fossil flora of Aix, in Provence, by M. G. de Saporta. It is argued against the views of M. Fontannes on stratigraphic grounds that the whole series of varied and numerous deposits giving birth to the flora of Aix, cannot be reduced to the gypsum alone, or to the section of this gypsum contiguous to the beds at Cyrènes. In a further paper it will be shown that the palæontological indications are equally opposed to M. Fontanne's opinion. —Note and photographs of the thunderstorm of May 12, 1886: spiral form of lightning, by M. Ch. Moussette. The photographs taken at Auteuil on this occasion seem to indicate a general law that the electrical discharges between the clouds and the earth assume the normal form of irregular spirals.—Observations of the new planet 259 made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—On the development in series of the potential of a homogeneous revolving body, by M. O. Callandreau. In this paper the author verifies the two formulas of Legendre and Laplace relative to the exterior and interior points of a spheroid usually defined by the equation $r = a(1 + \alpha y)$. —Memoir on the rowing-vessels of antiquity, by M. Corazzini. The author attempts to solve the difficult problems associated with the construction of the *naves longæ*, and reconstructs the Roman polyremes in a manner which seems to harmonise best with the monuments and the descriptions of classic writers.—On the refraction of carbonic acid and of cyanogen, by MM. J. Chappuis and Ch. Rivière. The results of the authors' researches on the refraction of carbonic acid at 21° and up to 19 atm. are resumed in the formula—

$$n - 1 = 0{\cdot}000540p(1 + 0{\cdot}0076p + 0{\cdot}0000050p^3),$$

in which n denotes the index for the ray D, and p the pressure in metres of mercury. The refraction of cyanogen has also been studied at different temperatures between the pressures of 1m. and 2m. or 3m. of mercury, the series of experiments relative to a determined temperature being resumed in a formula of the form $n - 1 = ap(1 + bp)$.—On the electrical conductivity of the mixtures of neutral salts, by M. E. Bouty.—On the decomposition of the perchloride of iron by water, by M. G. Foussereau. The author had already employed the measure of electric resistance to determine the nature and proportion of foreign substances contained in water and alcohol, and the conditions under which these fluids acquire the greatest degree of purity. He now applies the same method to the study of the progressive alterations of fluids, and especially of saline solutions under the influence of the dissolvent. The present paper deals specially with the perchloride of iron.—Note on a transmitting dynamometer with a system of optical measurement, by M. P. Curie. This apparatus consists of a horizontal arbor supported by two bearings. Two pulleys at the extremities of the arbor serve to transmit the motion from the motor to the receiver, and the work done is measured during the motion by the torsion of the arbor between the two pulleys.—Temperature of the deep waters in the Lake of Geneva, by M. F. A. Forel. Observations taken during the years 1879–86 show that at great depths the temperature never falls below 4°, and varies normally between 4°·6 and 5°·6. From his experiments the author also infers that the heat penetrates to the lower layers mainly through the mechanical intermingling of the upper with the deep waters under the action of the winds. The same explanation, he argues, should be applicable to all lakes and to all seas confined by bars, notably the Mediterranean, whose deep waters have a mean temperature of 13°.—Absorption-spectra of the alkaline chromates and of chromic acid, by M. P. Sabatier.—On the heat of transformation for vitreous selenium to metallic selenium, by M. Ch. Fabre. Vitreous is transformed to metallic selenium by heating it to 96° or 97°, the transformation being accompanied by a considerable development of heat, which is here directly determined by means of M. Berthelot's calorimeter.—Action of vanadic acid on the alkaline haloid salts, by M. A. Ditte.—On the fluorides of the metalloids, by M. Guntz. By practical tests the author has verified his hypothesis that the fluoride of lead is decomposable by all the chlorides of the metalloids. With the oxychloride of phosphorus the reaction is so regular that it gives a convenient process for preparing the oxyfluoride of phosphorus. —On the hydrate of baryta, BaO,H_2O_2, by M. de Forcrand.—A contribution to the study of the alkaloids, by M. Œchsner de Coninck.—Isomery of the camphols and of the camphors, by M. Alb. Haller.—Researches on the chemical composition of the grease of sheep's wool, by M. A. Buisine. The grease of Australian wool yielded for 100 of dry residuum 7·1 of acetic acid, 4 of propionic acid, 2·6 of benzoic acid, 2·59 of lactic acid, 1 of capric acid.—Acidimetric analysis of sulphurous acid, by M. Ch. Blarez.—Researches on the development of beetroot; study of the leaf, by M. Aimé Girard.—Comparative studies on the influence of the two orders of vaso-motor nerves, on the circulation of the lymph, on their mode of action, and on the mechanism of lymphatic production, by M. S. Lewachew.—On a process of indirect division by threes of the cellules in tumours, by M. V. Cornil.—The house-bug and the seat of its fetid secretion: the dorsal abdominal glands of the larva and nymph; the sternal thoracic glands of the adult, by M. J. Künckel.—On the influence of certain Rhizocephalous parasites on the exterior sexual characters of their host, by M. A. Giard. —On the circulatory system of the Echinidæ, by M. R. Kœhler. —On the seeds of Bonduc, and their active principle as a febrifuge, by MM. Ed. Heckel and Fr. Schlagdenhauffen. These seeds are supplied by two closely allied exotics: *Guilandina Bonducella*, *L.* (*Cæsalpinia Bonducella*, Tlem.) and *Cæsalpinia Bonduc*, Roxb. Their therapeutic properties are shown to reside in the bitter principle, which acts against intermittent fevers as efficaciously as the salts of quinine.—On the Triassic system of the Eastern Pyrenees, in connection with M. Jacquot's recent communication, by M. A. F. Noguès.—Invertebrate fauna of the Mentone grottoes, Italy, by M. Emile Rivière. In these caves the author has discovered 171 species of invertebrates, comprising 20 fossil, 125 living marine, and 26 land species. Amongst the living marine species 50 are at once Mediterranean and oceanic, 62 exclusively Mediterranean, and 6 oceanic.

BOOKS AND PAMPHLETS RECEIVED

"A Word for Ireland," by T. M. Healy (Gill, Dublin).—"Inorganic Chemistry," by Ira Remsen (Macmillan)—"British Fungi, Lichens, &c.," by Holmes and Gray (Sonnenschein).—"Journal of the Mathematical Society of St. Petersburg," vol. vi.—"Outlines of the History of Ethics," by H. Sidgwick (Macmillan).—"Proceedings of the Academy of Natural Sciences of Philadelphia," part 1 (Philadelphia).—"The Handy Guide to Emigration to the British Colonies," new edition, by W. B. Paton (S.P.C.K.).—"Notes from the Leyden Museum," vol. viii., No. 3, July (Brill, Leyden).

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