stations, with the mean temperatures for 1877, being, Curepipe (1800 feet) 68°·3, Bonne Veine (1500 feet) 69°·5, and Midlands (1400 feet) 73°·2. The difference in height (400 feet) of the first and last of these, and the difference of their mean annual temperatures, 4°·9, call for inquiry, and in connection therewith it may be suggested that a small map showing the physical features of Mauritius and the positions of the various stations would usefully illustrate these reports. As regards thunderstorms, which are carefully recorded, none occurred from May to October during 1876 and 1877, and the daily maximum is from 1 to 4 p.m., with a tendency to a secondary maximum about sunset, and the daily minimum from 10 p.m. to a little after sunrise.

In a supplement to No. 366 of the *Bulletin International* of the Paris Observatory M. Mascart gives an interesting and rapid sketch of the meteorology of Europe for December last, illustrated with two maps showing the storm-tracks over the Continent during the month. During the first half of the month the storm-tracks were all to northward of the British Isles and Denmark, and fine weather prevailed particularly in Scotland, Denmark, and Germany. In France high barometers ruled with light winds, and temperatures high for the season. The contrast afforded with the weather in France during December, 1879, is is most striking; thus on December 10 of both years barometers were unusually high in France, but in 1880 the mean temperature was 50°·5, whereas on December 10, 1879, the mean temperature was −14°·1. The bearings of the geographical positions of anticyclones, with their high pressures, on the temperature of the regions covered by them is a point well worthy of examination. The influence of a high-pressure area resting over the Atlantic and extending on its eastern side over Western Europe, has doubtless a very different influence on the temperature of that part of the Continent than an area of high pressure covering the Continent and terminated on its west side by France and Spain, even though the barometer be equally high over the west of Europe. During the second half of December the storm-tracks took a much more southerly course, several being as far south as the Channel and the north shores of Germany. The result was an extension south of the cold, so that in Orkney and the Hebrides temperatures were nearly 3°·0 below the normal, on the Tweed about the normal, rising farther south to 1°·1 above the normal in North Wales, 5°·0 in the Channel Isles, and 6°·7 in Paris. During December, 1879, temperature in Paris was 21°·2 below the normal, the mean for that month being 17°·6, or 27°·9 colder than that of last December.

GEOGRAPHICAL NOTES

On Tuesday night, at the Royal Institution, Mr. Edward Wymper described his ascents of Chimborazo and Cotopaxi to a distinguished audience. While purely athletic mountaineers had his sympathy in the practice of mountaineering as a sport, Mr. Whymper confessed that his sympathies were much more with those who employed their brains as well as their muscles. His journey to the Andes was to be one of work, and all its arrangements were devised so as to economise time to the uttermost. In observations for altitudes and position, in studying the manners and customs of the country, in photography and sketching, in the collection of objects of interest, from beeties on the summits of mountains to antiquities buried in the ground, he found quite sufficient to occupy his time. From Bodegas the party was composed of two Swiss mountaineers, the cousins Carrel of Val Tournanche, Mr. Perring, some muleteers, and their teams. When they reached the summit of Chimborazo, on the 3rd of January, after a most arduous climb, they found the wind blowing at the rate of 50 miles an hour, from the north-east, and driving the snow before it. With extreme difficulty, a reading of the mercurial barometer was effected. The mercury fell to 14·1 inches with a temperature of 21 deg. Fahr. This being worked out, in comparison with a nearly simultaneous observation at Guayaquil, gave 20,545 feet for the height of Chimborazo. They began the descent at 20 minutes past 5, with scarcely an hour and a quarter of daylight, and reached their camp (about 17,400 feet above the sea-level) about 9 p.m., having been out nearly sixteen hours, and on foot the whole time. Passing from an extinct to an active volcano, Mr. Wymper next gave an account of his journey to the crater of Cotopaxi. Observing with the telescope, during an enforced stay at Machachi, that much less smoke or vapour was given off at night than by day, he resolved, if possible, to pass a night on the summit. On the 18th of February the party got to the edge of the crater, having passed almost the whole way from their camp at a height of 15,000 feet to the foot of the final cone over snow, and then over ash mixed with ice. The final cone was the steepest part of the ascent, and on their side presented an angle of 36 deg. When they reached the crater vast quantities of smoke and vapour were boiling up, and they could only see portions of the opposite side at intervals, and the bottom not at all. Their tent was pitched 250 feet from the edge of the crater, and during a violent squall the india-rubber floor of the tent was found to be on the point of melting, a *maximum* thermometer showing a temperature of 110 deg. on one side of the tent and of but 50 deg. on the other; in the middle it was 72·5 deg. Outside it was intensely cold, and a thermometer on the tent cord showed a *minimum* of 13 deg. At night they had a fine view of the crater, which has a diameter from north to south of 2000 feet, and from east to west of about 1500 feet. In the interior the walls descend to the bottom in a series of steps of precipice, and slope a good thousand feet, and at the bottom there was a nearly circular spot of glowing fire, 200 feet in diameter. On the sides of the interior higher up, fissures, from which flickering flames were leaping, showed that the lava was red hot a very short distance below the surface. The height he found to be 19,600 feet. The party remained at the top for twenty-six consecutive hours, sleeping about 130 feet below the loftiest point. At first they had felt the effects of the low pressure of the atmosphere, and again, as at Chimborazo, took chlorate of potash with good effect. All signs of mountain sickness had passed away before they commenced the descent, and did not recur during the journey. Nearly five months later Mr. Whymper returned to Chimborazo, and from a second reading of the barometer at 14·028 inches, with a temperature of 15 deg. Fahrenheit, he made the height 20,489 feet, the mean of the two readings giving 20,517 feet. While on the side of Chimborazo he witnessed a magnificent eruption of Cotopaxi, ashes rising in a column 20,000 feet above the rim of the crater and then spreading over an area of many miles. Prof. Bonney had submitted the ash to microscopic examination, and found that the fineness varied from 4000 to 25,000 particles to the grain in weight, and from observation of the area over which the ash fell Mr. Whymper calculated that at least two million tons must have been ejected in this one eruption.

A telegram was read at a recent meeting of the French Academy of Sciences from M. de Brazza, who has been conducting an exploration in the region of the Ogowé and Congo, West Africa. Quite recently a French station has been founded in the upper course of the former river in connection with the International African Association. In July last, M. de Brazza informs the Academy, he reached the Congo from this station on the Ogowé, between the river Inpaka Mpania and the river "Lawson Afrisi." Gaining the favour of King Makoko he pacified the tribes on the right bank of the Congo, and peacefully descended the river in a canoe. On October 3 he founded the station of Ntamo Ncoma on land ceded by King Makoko on the right bank of the Congo. M. de Brazza surveyed the route between the Ogowé and Congo; it is twelve marches in length, over a plateau of an average height of 800 metres. The country is healthy, and the population dense and peaceful. In November last M. de Brazza arrived at Mdambi Mbongo, the advanced post of Mr. Stanley, whom he met, and with whom he reached the latter's headquarters at Vivi on November 12. If the new station can be maintained and victualled, it is no doubt well chosen as a starting-point for further discovery, for both north and south of it there are large regions of which he knew nothing.

At the meeting of the Geographical Society on Monday last, Mr. E. Delmar Morgan gave some account of his journey last year to Semiretchia and the town of Kulja. Being unable to make use of the more southern line of communications, Mr. Morgan travelled by the northern post-road from Orenburg to Troitsk and Petropaulofsk, and thence to Omsk and Semipalatinsk. He then struck southwards to Sergiopol, where he was detained three weeks owing to the southern road being blocked by snow. He afterwards went to Kulja for a short time, and he also made some excursions to Issyk-kul and other places of interest. In the course of the discussion which followed the paper, Mr. Ashton Dilke, the only other Englishman

who has visited Kulja, gave an interesting account of his experiences in that region a few years back.

FEARS had been entertained by many that the expedition sent out by the Russian merchant M. Alexander Sibiriakoff to discover the North Passage by means of the steamer *Oscar Dickson*, on board of which M. Sibiriakoff was himself, had been lost, and M. Konstantin Sibiriakoff, his brother, had already equipped another expedition to find and assist the *Oscar Dickson*. In the meantime the welcome news has arrived that Alexander Sibiriakoff reached Tobolsk at the end of December. The *Oscar Dickson* and another ship, the *Nordland*, had met fresh ice near Mate-Ssale, and had retired into the Gydan Bay on the coast of Siberia, in order to winter there.

M. TARRY, a member of the French Commission for Trans-Saharan Communications, is stated to have discovered in the south of Wargla the ruins of a large city called Cedrada, which had been entombed by sands of the desert. This city is placed in the Valley of Wed Mya, and in the vicinity of a number of sources which in former centuries watered thousands of palm-trees. Orders have been sent to procure a set of sounding apparatus, and it is expected a large quantity of pure water will be extracted from the earth. M. Tarry published an appeal to the local papers in order to obtain from the Government the foundation of a colony in this remote region.

DEEP-SEA EXPLORATION[1]

II.

4. *FOOD.*—The late Prof. Sars, in his remarks on the distribution of animals in the depths of the sea, asks "Whence do animals that live at depths far below the limits of vegetation obtain their food?" Bronn, Wallich, Wyville Thomson, and others have endeavoured to answer this question; but I do not think the problem has yet been satisfactorily solved. A considerable quantity of vegetable food is undoubtedly supplied from the Sargasso Sea and a similar area in the Pacific Ocean, as well as by the sea-weeds which fringe every coast. But this supply is not sufficient for the indirect support of the countless host of animals that inhabit the depths of the ocean, all of which are necessarily zoophagous or subsist on other animals. Plant life, except perhaps one of a peculiar kind, which will be presently noticed, appears to be absent in depths exceeding 150 fathoms.

In all probability the chief supply of vegetable food is derived from the countless diatoms, coccoliths, rhabdoliths, and oscillatoriæ, which are plants of a low degree of organisation, and swarm on the surface of the sea; these are swallowed by pelagic animals (such as *Salpæ* and Pteropods, or "sea-butterflies"), and the latter fall to the bottom after death, and form that flocculent or glairy mass which I have described in the Report of the *Porcupine* Expedition of 1869 as covering the bed of the North Atlantic at great depths.[2] The preservative effect of sea-water on animal tissues would stay decomposition for a long while; and Mr. Moseley ascertained by a curious experiment that it would take only about four days for a *Salpa* to reach the bottom at a depth of 2000 fathoms, and that the *Salpa* was not greatly decomposed after having remained in sea-water for a month in the tropics.

When we say that vegetable life does not exist at any considerable depth, we must not forget that some kind is said to occur in great abundance even in the benthal or deepest zone. The word "benthal" is applied to depths exceeding 1000 fathoms (see my Address, which is referred to hereafter in this lecture). Shells, corals, and other organisms, are everywhere permeated by what are considered to be minute plants allied to fungi or confervæ, which form branching canals, like those of the *Cliona* or perforating sponge; and such canals have been also detected in all fossiliferous strata of a marine nature, from the Silurian to the present epoch. These plants, or Thallophytes, have been called "parasitic"; but they do not live on any other living thing. They can hardly serve as food for deep-sea animals, because they are never exposed. Whether they may not be a link to connect the animal and vegetable kingdoms may be a matter for further investigation.

Food is of course a very important factor as regards the size of all animals. I have noticed, in my work on "British Conchology," that Mollusca from moderate depths are generally larger than those of the same species from shallow water; but this does not seem to be the case with a species of coral obtained in the *Challenger* Expedition, which ranged from a depth of 30 to one of 2900 fathoms, and was very variable in size.

5. *Light.*—Milton tells us of the

> "world of waters dark and deep."

One of the most interesting problems relating to the subject of this lecture is whether the above is a poetical idea or based on fact, as regards the absence of light in the abysses of the ocean.

We do not know to what extent the sun's rays penetrate the sea, nor whether the bottom at all depths is absolutely devoid of light. An ingenious apparatus, which was contrived by Dr. Siemens for ascertaining the presence of light at different depths by means of highly sensitive photographic paper, has never yet been properly tried. An experiment of this kind made by Prof. Forel proved that in the Lake of Geneva, even at a depth of only thirty fathoms, the paper was entirely unaffected after protracted exposure. But the water of that lake is peculiar; it is said to be rendered less transparent by suspended and floating particles of mica brought from glacier streams, and to have thus acquired its deep blue colour. I cannot believe that the only abyssal light, if there be any, is phosphorescent.

At all events we are certain that, as regards the sea, many animals at very great depths have eyes, and that there is no absence of colour.

Cuttlefishes, which have eyes not less highly organised than our own, have frequently been obtained from depths of many hundred fathoms; they do not eat phosphorescent polypes and such small deer. Nor are the deep-sea Mollusca blind. During the *Porcupine* Expedition of 1869 an undescribed species of *Pleurotroma* from 2090 fathoms had a pair of well-developed eyes on short footstalks; and a *Fusus* from 1207 fathoms had its eyes at the base of the tentacles. The last-named mollusks chiefly prey on bivalves. I have taken at moderate depths, living on the same ground, closely-allied species of univalve mollusks, some of which were eyeless or blind, and others were provided with the usual organs of vision. Numerous instances have been given by the *Challenger* naturalists of apparently seeing as well as of apparently sightless animals taken at great depths. Prof. Semper, of Würzburg, says, in "The Natural Conditions of Existence as they Affect Animal Life" (1881), "Many creatures furnished with well-constructed eyes live associated with the actually blind species, and which have been partly enumerated above." He mentions among the former five species of fish (one of a new genus) discovered in the *Challenger* Expedition at depths of from 675 to 2040 fathoms, besides several Mollusca and Crustacea.

Some land-slugs and mollusks (e.g. *Geomalacus maculosus* and *Achatina acicula*) are also blind. On the sea-shore and in shallow water most bivalves, as well as all the species of *Chiton*, are eyeless.

Some deep-sea animals are brightly and deeply-coloured. In the *Challenger* Expedition shrimps "of an intense bright scarlet colour" were obtained in very great abundance; and many Holothurians or Sea-cucumbers were of a "deep purple" hue. The same observation occurred to me in the *Porcupine* and *Travailleur* Expeditions.

6. *Temperature.*—The highest temperature of the sea-bottom observed in the *Challenger* voyage at depths over 1000 fathoms was 50°·5 Fahr., in 2550 fathoms; the lowest was 32°·1 only, in 1950 fathoms. The average bottom-temperature at great depths does not much exceed the freezing-point; but life does not appear to be affected by that circumstance. In the Arctic Expedition of 1875 I found an abundance and variety of animals in icy cold water.

7. *Depth.*—The average depth of the ocean between latitudes 60° N. and 60° S. is nearly three miles, or 2500 fathoms. The greatest depth which has been ascertained by sounding is five miles and a quarter, or 4620 fathoms, and occurs in the North-west Pacific Ocean; it is nearly equal to the height of Mount Everest, the highest known mountain, in the proportion of 27,720 to 29,000 feet.

8. *Inequalities of the Sea-bottom.*—The operations of the Telegraph Construction and Maintenance Company have materially added to our knowledge of the shape and contour of the floor of the ocean. They have shown us that the bed of the sea is quite as uneven as the surface of the land, and that it represents the same mountains, hills, gorges, and valleys, equally

[1] A Lecture by J. Gwyn Jeffreys, LL.D., F.R.S. Given at Swansea, Llanelly, and Barrow-in-Furness, in December 1880 and January 1881. Continued from p. 302.

[2] See *Proc.* Roy. Soc. 1870, p. 420.