THE GUATTARI ATMOSPHERIC TELEGRAPH

THIS new invention is stated to consist of certain arrangements and combinations of apparatus whereby ordinary air compressed and passed through a tube, is utilised as a means of communicating intelligence from one given point to another, effecting the same object as the electric telegraph.

The principal portion of the apparatus consists of a reservoir or air-vessel which is charged or filled with air compressed to any desired degree according to the initial velocity or force which it is requisite the movements of the air employed should possess. A double action compression pump, or any other suitable mechanism, may be employed to charge the reservoir or air-vessel, and to sustain the pressure to the required degree. The reservoir or air-vessel is connected by means of a tube or pipe with a writing apparatus of any suitable description, and such as are well known and understood, especially in connection with electro-telegraphy; the tube or pipe being provided with a cock by which more or less force may be given to the current of air whereby the writing mechanism is actuated. In order to regulate the signals, a governor or piston, actuated by hand, is employed, by which pulsations or movements of the air in the tube or pipe are transmitted through a valve which is arranged therein, the currents actuating a lever connected with the writing apparatus. For the purpose of giving or receiving signals, the before-mentioned tube or pipe is connected with a conducting tube or pipe constructed of any suitable material, and which is so arranged that communication can be established between the air reservoir, or vessel, and the writing engine which is placed at the receiving station, or *vice versa*, by means of stop-cocks which are worked by hand. An indicator is employed to show the force of the current of air passing through the transmitting tube or pipe. Similar arrangements are, of course, placed and employed at each end of communication. By means of this invention it is stated that intelligence and signals can be transmitted to any distance; any of the known receiving and recording instruments capable of being used in connection therewith being employed. It is obvious that any number of conducting tubes may be employed, the requisite currents or pulsations of air therein being produced as before mentioned. The Guattari system claims to be more simple than the electric system, both in point of construction and continuous use, for whereas in the latter case it is necessary to use the electric battery and all its accessories, by the former ordinary atmospheric air compressed will perform similar functions. It is also claimed for it that it is free from atmospheric influences, which it is well known materially disturb the electric telegraph on the occasion of storms; and that the tubes employed as the medium for conducting the air would not be subjected to accidents like the ordinary wires, and would therefore necessarily last longer, and thus prove much more economical. We understand also that it is so simple that any person may learn in a few hours how to use and work it with the greatest ease, as compared with the electric system; it is calculated that the machinery necessary to work this system could be produced at about one-half the producing and annual working cost of the electric system.

The Royal Scientific Institute of Naples has already awarded to Signor Guattari a gold medal in recognition of what they consider an important invention, adding a graceful tribute on its presentation to the effect that it was the only gold medal which the Institute had ever awarded. The following experiments were made on Monday, 11th July, 1870:—

1. Transmission by atmospheric compression by means of the large machine, obtaining answers by impulsion and repulsion, Signor Guattari having at present but one machine.

2. System of impulsion and repulsion by a naval apparatus, which may be used with five different derivations or branches.

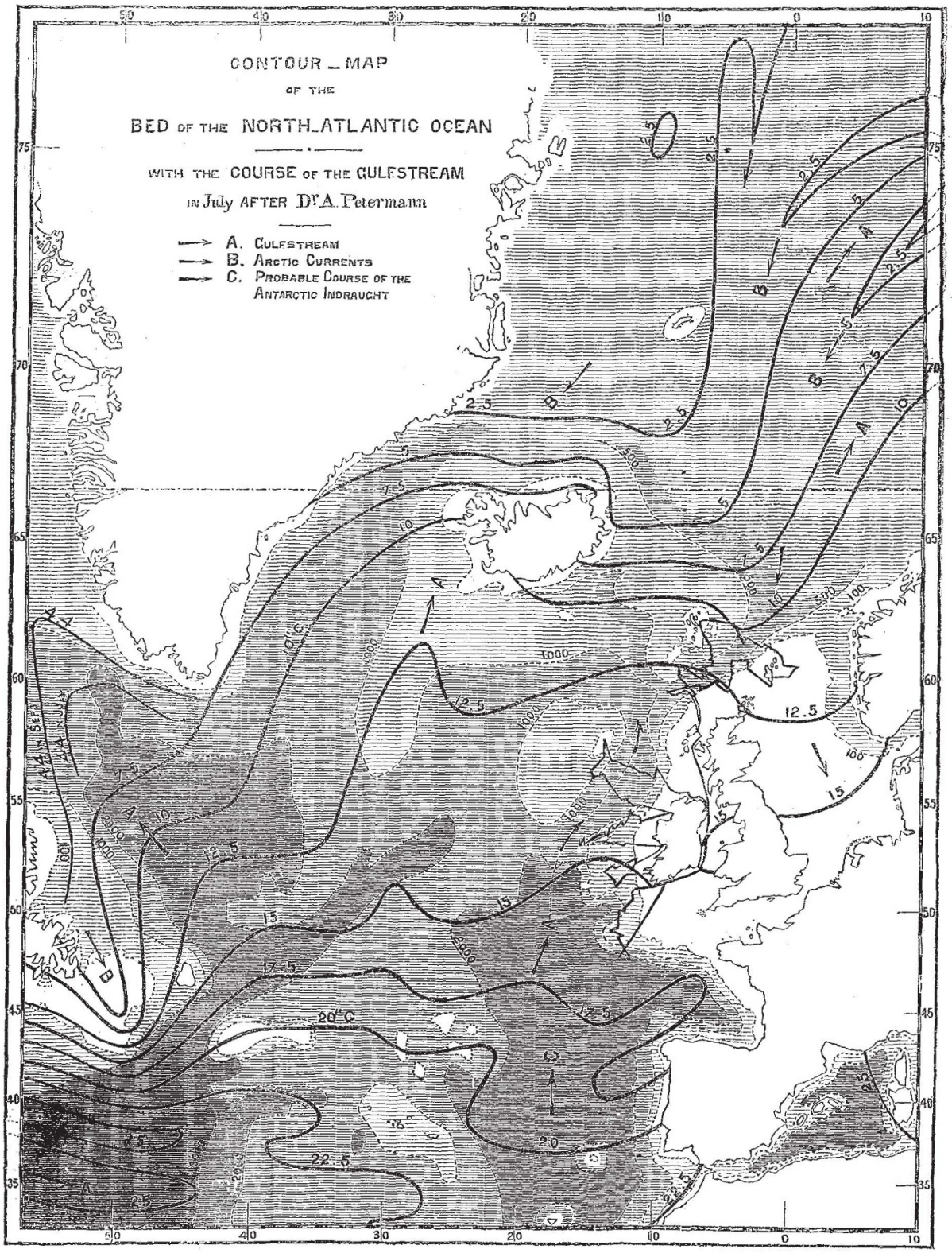
3. Universal telegraphy, namely, despatching telegrams to one or more stations at the same time without the aid of the transmitting machine or the necessity of the sender remaining fixed to any one point.

ON DEEP-SEA CLIMATES*

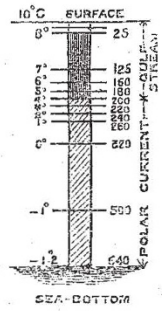
RECENT investigations have certainly tended to confirm the view originally advocated by my colleague, Dr. Carpenter, and myself, that a large portion of the bottom of the present sea has been under water and continuously accumulating sediment, at all events since the commencement of the "Cretaceous period," and possibly much earlier. The marked parallelism which, setting aside all local dislocations and denudations, evidently exists between the Jurassic, the Cretaceous, the Tertiary formations, and the present sea-board, and the evident relation of that parallelism to the older rock axes, would seem indeed to indicate that the main features of the present physical geography may date from a period even anterior to the deposition of the older Mesozoic rocks. With many minor and temporary oscillations, of which we have ample geological evidence, the borders of the Oolitic, the Cretaceous, and the Tertiary seas, have apparently been successively and permanently raised, and the ocean over an area, the long axis of which may probably correspond with that of the Atlantic, proportionally contracted. The question simply is, whether, since the elevation of the Jurassic beds, any oscillation has at any time raised into dry land the whole of the trough of the Atlantic, so as to arrest the deposit of sediment abruptly over the area, and to extinguish all animal life, thus defining what seems to be popularly understood as the close of a geological period, and requiring the complete repeopling of the succeeding sea by immigration, or, according to another view, by the creation of an entirely new fauna. It seemed to us on the whole more probable that the successive elevations of the borders of the Mesozoic sea were accompanied by compensating depression and deepening of the centre of the trough, which may thus have been inhabited throughout by a continuous succession of animal forms; at all events, the onus of proof appeared to rest with those who maintained any breach of continuity.

The deep-sea dredgings on both sides of the Atlantic have brought to light a very large number of hitherto unknown animal forms, and undoubtedly the assemblage bears a decided resemblance to the fauna of the chalk—a resemblance which increases as the investigation proceeds. Probably the most striking point is the apparent identity of the material of the chalk with the chalk-mud of the Atlantic; the globigerinæ and coccoliths by whose accumulation the beds have been, and are now, being produced, seem to be the same; though, of course, it is difficult to determine with certainty the specific identity of such simple and variable forms. Sponges are abundant in both, and the recent chalk-mud has yielded a large number of the examples of the group *porifera vitrea*, which find their nearest representatives among the ventriculites of the white chalk. From Prof. Martin Duncan's report it would appear that the corals, which are chiefly confined to water of moderate depth, are most nearly allied to those of the later Tertiaries. The echinoderm fauna of the deeper parts of the Atlantic basin is very characteristic, and yields an assemblage of forms which represents in a remarkable degree the corresponding group in the white chalk. Species of the genus *Cidaris* are numerous; some remarkable flexible forms of the Diademidæ seem to approach *Echinothuria*. M.

* The substance of a Lecture delivered to the Natural Science Class in Queen's College, Belfast, at the close of the summer session, July 15, 1870.

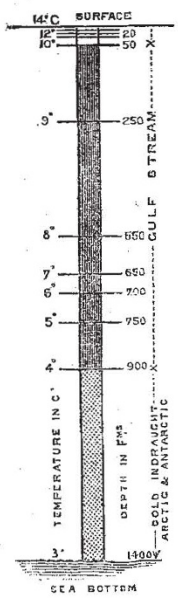


de Pourtales dredging in the Gulf Stream in the Strait of Florida has found a true *Salenia*, several representatives of the chalk forms of *Cassidulidæ*; and M. de Pourtales on the American side, and we off the west coast of Ireland and off the Shetlands, have dredged a remarkable form, appropriately named by Lyman *Pourtalesia miranda*, which is most nearly related to the Jurassic and Cretaceous genus, *Dysaster*.



Between the Faröe and Shetland Islands. 61° 21′ N. Lat., 3° 44′ W.L., Gr.

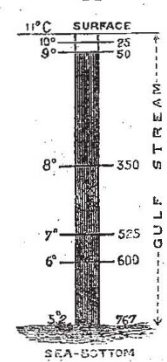
The Crustaceans of the chalk are, as yet, very imperfectly known, so that little can be founded upon them. The Mollusca have not yet been worked up, but the large number of smooth terebratulæ, and of species of the genera *Aporrhais*, *Dentalium*, *Pecten*, *Lima*, &c., from the deeper water, are highly suggestive of older times. Mollusca are, of course, most abundant in comparatively shallow water, and we were prepared to hear from Mr. Gwyn Jeffreys that out of about 120 species new to the British area, dredged in the *Porcupine* expedition, a large number date back to the newer Tertiaries.



Between Rockall & N.W. Coast of Ireland.

With these facts before us, it can scarcely be a matter of surprise that the point of view of those who are carrying on these investigations is insensibly changing, and that when the dredge comes up from a depth of one or two thousand fathoms the number of new species which it may contain is not now so much the question as the relation which these new forms may bear to their ancestors of an earlier epoch, and the light which they may be expected to throw upon types hitherto supposed to be entirely extinct.

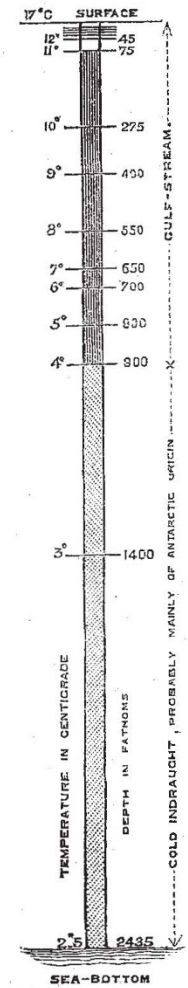
Although there is so striking a resemblance in general character between the fauna of the European chalk and that of the deeper portion of the bed of the Atlantic, especially of a band extending from a depth of 400 fathoms to 900 fathoms in the Gulf Stream area, none of the animals, with the possible exception of some of the Foraminifera, are absolutely identical. The species of *Sympagella*, *Holtenia*, and *Farrea* approach the siphonias and ventriculites very nearly, but they form a distinct subsection of the order. *Rhizocrinus* and its allies resemble *Bourgetticrinus*, and undoubtedly represent it, but there are important differences. The Saleniæ, the Cassidulidæ, and the Dysasters, &c., of the chalk mud approach their Cretaceous antetypes more closely than they do any known living forms, but they are generally dwarfed, and otherwise diverge so far as to require in most cases the establishment of new genera for their accommodation. Now, if we admit the continuous accumulation of sediment of the same character, and the persistence of the same general conditions over a large portion of the area of the present ocean from Mesozoic times, it seems at first sight more difficult to account for this great amount of modification than for the perpetual recurrence in deep dredgings of forms suggestive of close relationship to, and lineal descent from, extinct species.



South-West of the Faröe Islands. 59° 35′ N. Lat., 9° 11′ W. L., Gr.

At the bottom of the ocean, where other conditions are comparatively uniform, we may probably regard successive changes of temperature as the main cause of successive alterations in the fauna of a region, by the modification, extinction, emigration, and immigration of species. It is my object, in the present lecture, to show that in the vertical oscillations which are known to have occurred since the close of the Mesozoic period, we have a *vera causa* of alternations of temperature fully adequate to the entire result.

In order to understand this point thoroughly it will be necessary, in the first place, to pass in review the present conditions of distribution of temperature in the North Atlantic.*



Bay of Biscay. 47° 38′ N Lat., 12° 8′ W. L., Gr.

There seems to be little room for reasonable doubt that the present temperature of the basin of the North Atlantic depends, it may be said, *entirely*—for other modifying causes, such as the drift of the variable winds and the surface-heating and consequent expansion of equatorial water, are comparatively trifling—upon the Gulf Stream and the general indraught of cold water from the Arctic and Antarctic basins to supply the place of the constant warm current streaming north-eastwards from the Strait of Florida. Means of summer temperature which indicate roughly, not quite exactly, for higher temperatures, the mean amount of heat derived from the sun by direct radiation: the heat derived from all other sources, have been reduced from many thousands of isolated observations, and their results incorporated in an admirable and careful paper by Dr. A. Petermann (Geographische Mittheilungen, 1870).

The curves on the accompanying map, copied from Petermann, explain at a glance the distribution of abnormal temperature along the coasts of Western Europe, and indicate unmistakeably the source and direction of the warm current. One point only remained in doubt, namely, the depth to which the temperature of the ocean is affected by the Gulf Stream water. Now that there has been time to correlate and compare the large series of invaluable observations made with consummate skill and care by Captain Calver, R.N., during the *Porcupine* Expedition, this question may be considered solved over a considerable area, and the depth of the Gulf Stream off the west coast of Great Britain and France determined at about 800 fathoms (4,800 feet). This is so very im-

* My colleague, Dr. Carpenter, in many interesting communications on the temperature results of the *Porcupine* expedition (NATURE, Vol. i., p. 490, &c., &c.), denies that the Gulf Stream exercises any influence upon the temperature of the basin of the North Atlantic, and doubts whether it reaches the coast of Europe at all. He attributes the differences of temperature between different zones of depth to "a great general movement of equatorial water towards the polar area, of which movement the Gulf Stream contributes a peculiar case, modified by local conditions." And if I understand him aright, he supposes that this general movement is produced by some cause analogous to that which produces the general circulation in the atmosphere. I am sorry to be obliged to dissent so completely from his view on this point.

portant a matter in connection with the distribution of animal life and the other conditions of the problem at present more especially before us, and there are still so many wide differences of opinion with regard to it, even among competent authorities, that, at the risk of repeating a good deal that you know already, I will explain to you as simply as I can what appears to me to be the present state of knowledge with regard to it. This must be considered, however, merely an outline sketch, and when a phenomenon is represented as a sole cause or a sole result, I mean simply to convey that it is a cause or result so paramount as to reduce all accessories to insignificance.

The ultimate source of the Gulf Stream is undoubtedly, as has been specially insisted upon by Sir John Herschel, the equatorial current of the Atlantic, the drift of the trade winds. The path of that portion which trends north-eastwards is determined by the great initial velocity of the equatorial water which escapes from the Strait of Florida. The glory of the Gulf Stream, as it issues from the Strait, has been the theme of every physical geographer; and Mr. James Croll, in a valuable paper in the February number of the *Philosophical Magazine* on Ocean Currents, has entered into a careful examination of the actual amount of heat conveyed by the Gulf Stream from the Tropics into Temperate and Arctic regions. Mr. Croll calculates the Gulf Stream as equal to a stream of water fifty miles broad and 1,000 feet deep flowing at a rate of four miles an hour, consequently conveying 5,575,680,000,000 cubic feet of water per hour, or 133,816,320,000,000 cubic feet per day.

This mass of water has a mean temperature of 18° C. as it passes out of the Gulf, and on its northern journey it is cooled down to 4·5°, thus losing heat to the amount of 13·5° C. The total quantity of heat, therefore, transferred from the equatorial regions per day amounts to something like 154,959,300,000,000,000,000 foot-pounds.

This is nearly equal to the whole of the heat received from the sun by the Arctic regions, and reduced by a half to avoid all possibility of exaggeration, it is still equal to one-fifth of the whole amount of heat received from the sun by the entire area of the North Atlantic.

The basin of the North Atlantic forms a kind of *cul-de-sac*, and while a large portion of the Gulf Stream water, finding no free outlet towards the north-east, turns southwards at the Azores, the remainder, instead of thinning off, has rather a tendency to accumulate in the northern portions of the trough. We accordingly find that it has a depth off the west coast of Ireland of at least 4,800 feet, with an unknown lateral extension. There are no data as yet to determine the rate of the branch of the Gulf Stream which sweeps round the coast of Western Europe and into the Arctic Sea, but it must be very slow, for even so far south as at lat. 42° N. it has lost all effect upon navigation, its character as a constant current being entirely masked on the surface by the drift of the anti-trades, which has nearly the same direction.

The Gulf Stream is thus a constant "river" of hot water, forced into a particular direction by the rotation of the earth, by the constant winds, and by the configuration of the land; and accumulated and modelled by the confined basin of the North Atlantic and Arctic Sea. The cold water which replaces it is supplied under very different conditions.

Sea water increases steadily in density as the temperature falls till it reaches its freezing point, about 3° C.; the coldest water, therefore, lies at the bottom, and if over any region warm water be removed by any cause from the surface, as for instance in the case of the equatorial current and the Gulf Stream, its place will be supplied by a general indraught beneath of water from the coldest and heaviest, and consequently usually from the deepest sources from which it can be brought in by gravitation. The cold water is, however, merely drawing in to supply a vacancy, and there is no special reason why it should follow one ingress rather than another. From the low initial velocity of polar water it will tend to flow westwards in passing into lower latitudes, but that tendency will probably be entirely subordinate to specific weight in determining the course of the cold influx and the distribution of layers of water of different temperatures.

As cold water can gravitate into the deeper parts of the ocean from all directions, it is only under peculiar circumstances that any movement having the character of a current will be induced; these circumstances occur, however, in the confined and contracted communication between the North Atlantic and the Arctic Sea. Between Cape Farewell and North Cape there are only two channels of any considerable depth, one very narrow along the east coast of Iceland, and the other along the east coast of Greenland. The shallow part of the sea is entirely occupied, at all events during summer, by the warm water of the Gulf Stream, except at one point, where a rapid current of cold water, very restricted and very shallow, sweeps round the south of Spitzbergen and then dips under the Gulf Stream water at the northern entrance of the German Ocean.

This cold flow, at first a current, finally a mere indraught, affects greatly the temperature of the North Sea; but it is entirely lost, for the slight current which is again produced by the great contraction at the Straits of Dover has a summer temperature of 7·5° C. The path of this cold indraught from Spitzbergen may be readily traced on the map by the depression in the surface isothermal lines; and in dredging by the abundance of gigantic amphipodous and isopodous Crustaceans and other well-known Arctic animal forms. The other two Arctic currents along the coasts of Iceland and Greenland are likewise very apparent, taking a slightly western direction from their low initial velocity.

But while the communication between the North Atlantic and the Arctic Sea itself, a second *cul-de-sac*, is so restricted, limiting the interchange of warm and cold water in the normal direction of the flow of the Gulf Stream, and causing the diversion of a large part of the stream to the southwards, the communication with the Antarctic basin is as open as the day, a continuous and wide valley of upwards of 2,000 fathoms in depth stretching northwards along the western coast of Africa and Europe.

That the southern cold water wells up into this valley there could be little doubt from the form of the ground, but here again we have curious corroborative evidence on the map in the remarkable reversal of the curves of the surface isotherms. The temperature of the bottom water at 1,230 fathoms off Rockall is 3·22° C., exactly the same as that of water at the same depth in the serial sounding, lat. 47° 38′ N., long. 12° 08′ W., in the Bay of Biscay, which affords a strong presumption that the water in both cases is derived from the same source; and the bottom water off Rockall is warmer than the bottom water in the Bay of Biscay (2° 5′ C), while a cordon of temperature soundings drawn from the north-west of Scotland to a point on the Iceland shallow, gives no temperature lower than 6·5° C. This entirely precludes the idea that the low temperature of the bottom water of the Bay of Biscay is due to any portion of the Spitzbergen current passing down the west coast of Scotland; and as the cold current of the east of Iceland passes southwards considerably farther to the westward, as indicated on the map by the successive depressions in the surface isotherms, the balance of probability seems to be in favour of the view that the conditions of temperature and the slow movement of this vast mass of moderately cold water, nearly two statute miles in depth, are to be referred to an Antarctic rather than to an Arctic origin.

The water of the North Atlantic thus consists first of a great sheet of warm water, the general northerly reflux of the equatorial current, the most marked portion of it

passing through the Strait of Florida, and the whole generally called the Gulf Stream, of varying depth, but attaining off the west coast of Ireland and Spain a depth of 800 to 900 fathoms. Secondly, of a general indraught of Antarctic water compensating at all events that part of the Gulf Stream which is deflected southwards; and thirdly, of a comparatively small quantity of Arctic water which, flowing through two or three narrow channels, replaces that portion of the Gulf Stream which makes its way into the Arctic Sea. As I have already said, the Gulf Stream loses an enormous amount of heat in its northern tour. At, say a point 200 miles west of Ushant, where the observations at the greatest depth were made on board the *Porcupine*, a section of the water of the Atlantic shows three surfaces, at which interchange of temperature is taking place. 1. The surface of the sea, that is to say, upper surface of the Gulf Stream layer, is losing heat rapidly, *a* by radiation, *b* by contact with a layer of air, which is in constant motion, and perpetually being cooled by convection; and *c* by the conversion of water into vapour. As the cooling of the Gulf Stream layer takes place principally at the surface, the temperature of the mass is kept pretty uniform by convection. 2. The band of contact of the lower surface of the Gulf Stream water with the upper surface of the water of the cold indraught. Here the interchange of temperature must be very slow, though that it does take place is shown by the slight depression of the surface isotherms over the principal paths of the indraught. The cold water being below, convection in the ordinary sense cannot occur, and interchange of temperature must depend upon conduction and diffusion, causes which in the case of masses of water of such depth must be almost secular in their action, and probably to a much greater extent upon mixture produced by local currents and by the tides. 3. The third surface is that of contact between the cold indraught and the bottom of the sea. The temperature of the surface of the earth is calculated at about 11°C., but it would be completely cooled down by anything like a movement and constant renewal of cold water; all we can say, therefore, is that contact with the bottom can never be a source of depression of temperature. As a general result, the Gulf Stream water is nearly uniform in temperature throughout the greater part of its depth; there is a marked zone of intermixture at the junction between the warm water and the cold, and the water of the cold indraught is regularly stratified by gravitation; so that in deep water the contour lines of the sea bottom are, speaking generally, lines of equal temperature. Keeping in view the enormous influence which ocean currents exercise in the distribution of climate at the present time, I think it is scarcely going too far to suppose that such currents, movement communicated to the water by constant winds, existed at all geological periods as the great means, I had almost said the sole means, of distributing heat in the ocean, and thus producing general oceanic circulation; they must have existed, in fact, wherever equatorial land interrupted the path of the drift of the trade winds. Wherever a warm current was deflected to north or south from the equatorial belt, a polar indraught crept in beneath to supply its place; and the ocean consequently consisted, as in the Atlantic and doubtless in the Pacific at the present day, of an upper warm stratum and a lower layer of cold water, becoming gradually colder with increasing depth. Wherever such conditions existed it is plain that mere vertical oscillations must have produced very decided changes of climate, through only a small number of degrees, but still very marked if the oscillation affected merely a portion of the cold underlying water, but enormous if it were sufficient to raise or depress the bottom of the sea, the principal theatre of animal life, so as to shift it from the cold layer into the warm, or from the warm layer into the cold.

One of the most striking phenomena connected with the distribution of heat in the North Atlantic is the case of the Shallow including the Hebrides, Orkney and Shetland Islands, and the Faroes, stretching westwards and northwards nearly to Iceland. The average depth is about 500 fathoms, and the Gulf Stream, which has a depth in these latitudes in summer of from 600 to 700 fathoms, occupies the whole of it, giving an abnormal temperature of something like 7° C. Owing to the peculiar conformation of the basin of the German Ocean, a tongue of cold water, with a bottom temperature of − 1° C. creeps into the valley between Scotland and Faroe, where it is overlaid by a stratum of Gulf Stream water, 150 fathoms thick. At the western mouth of the valley the cold water is banked in and retained by the water of the Gulf Stream, which is slowly passing the entrance of the gorge, giving a repetition, on a small scale, of the curious phenomenon described by Prof. Bache, off the coast of Massachusetts, as the "cold wall." My colleague, Dr. Carpenter, has conveniently called these two neighbouring districts, where the thermometer indicates 7° C. and − 1° C. respectively, the warm and cold areas. A depression, affecting that region of 250 fathoms equal to that which admitted of the accumulation of post-tertiary shells on Moel Tryfaen, would produce an extraordinary effect on its climate. In the first place, by mere subsidence, the Gulf Stream not reaching the bottom but flowing over a band of cold water, the temperature of the warm area would be reduced to, say, 3° C., and that of the cold, by an indraught of deeper water from the north, to − 2° C., but the Gulf Stream would no longer bank out the cold indraught from the north-east; which, in that case, passing down a deep open channel from the deep soundings to the west of the Loffotens, would spread along the bottom on the west coast of Scotland and Iceland, and greatly reduce its temperature, and probably entirely alter its fauna.

WYVILLE THOMSON

NOTES

WE have reason to believe that Professor Sir Wm. Thomson will be the next President of the British Association.

WE learn that the Royal Commission on Scientific Instruction and the Advancement of Science, which has met regularly two days a week, have now adjourned over the recess.

THE Royal Astronomical Society has issued a list of the members of the various learned Societies who propose to take part in the observations of the approaching total eclipse of the sun.

WE learn from the last number of the *Revue des Cours Scientifiques* which has reached us—that for the 24th inst.—that on Monday last week the Paris Academy of Sciences continued, in *comité secret*, the discussion of Mr. Darwin's nomination to fill the vacancy in the Zoological Section caused by the death of Purkinje. M. Milne-Edwards first spoke in his favour. While insisting on his own absolute opposition to evolutional doctrines, he rendered homage to the value of the special works of Mr. Darwin, especially the theory of the formation of coral islands. M. Elie de Beaumont also attested the value of this theory, and remarked that Mr. Darwin had done good work which he had spoiled by dangerous and unfounded speculations. He thought he should not be elected until he had renounced them. M. Emile Blanchard, who spoke for more than an hour, was very severe upon Mr. Darwin, styling him an "amateur intelligent," a remark capped by M. Elie de Beaumont (it is stated), who cried out, to the great indignation of M. de Quatrefages, "*C'est de la science mousseuse.*" M. de Quatrefages promised to answer M. Blanchard point by point on Monday last.

THE Archæological Congress is now in full swing at Leicester, one of the most interesting towns and localities which it is possible for such a Congress to visit. The proceedings commenced on Tuesday with an address presented by the Mayor and Corporation, followed by visits to some of the objects of interest in the