THE "LOST ATLANTIS" AND THE "CHALLENGER" SOUNDINGS[1]

IT may perhaps not be at first apparent what is the connection between those tubes and masses of metal and other apparatus on the right and these fossil leaves in the cases on the left. Those are some of the sounding apparatus used on board the *Challenger* in her four years' voyage. They have been brought from the galleries of the Loan Collection of Scientific Apparatus, where they are deposited by the Admiralty, into this theatre, in order to illustrate the method by which deep-sea soundings and temperatures are ascertained. It is the results obtained from soundings in the Atlantic Ocean alone that we shall consider this evening. While the working out of these results, as shown in the diagram, has been accomplished by the staff of the *Challenger*, there are some few other ships to which passing allusion will have to be made. These fossil leaves, deposited by Mr. J. Starkie Gardner, F.G.S., are also brought in from the Loan Collection. It is not these particular leaves we have to consider; these are all English: but we shall have to consider the teachings of collections of leaves similar as regards their manner of preservation, obtained from different parts of Europe and America. There are no specimens at present in the collection besides these, though until recently there was the small typical collection of the Baron von Ettingshausen. These English specimens will, however, serve our purpose very well as illustrations to convey an idea of what Tertiary fossil leaves look like.

The connection between these two subjects is here. We are going to consider certain past vegetations which are made known to us by their fossil remains. The study of some of them led Prof. Unger by a process of reasoning that will be presently indicated, to the belief that there existed in Tertiary times land between Europe and America by which the ancestors of the plants gradually travelled from America to Europe. It is now seventeen years ago that Prof. Unger proposed to call this hypothetical land the Island of Atlantis;—the sunken island or lost island of Atlantis. It was, no doubt, what our American cousins would call "a big thing" for a botanist to do, to "create" a former land in mid-ocean simply because he wanted it to account for the migration of the ancestors of fossil plants he had studied, and to do so without a particle of physical evidence. It was the first time in the history of geological science that so bold a step had been taken. The arguments by which Unger arrived at his conclusions were criticised at the time and another route for migration by the Pacific was suggested.[2] Whatever may be opinions as to the value of the evidence on which Prof. Unger based his "lost *Atlantis*," we now know from the *Challenger* working out of soundings that not only a "sunken island," but a ridge does lie in mid-Atlantic between the Old and New World.

Our subject groups itself into three divisions:—(1) Tertiary fossil plants; (2) Deep-sea soundings; (3) the "Atlantis ridge."

[The lecturer then turned to the fossil leaves, and described their manner of preservation and the conditions under which they are met with, and referring to diagrams and tables explained the meaning of the word Tertiary.]

No one now doubts these are really the remains of plants that grew and are not *lapides sui generis*. In comparing them with living plants and determining their affinities there are many difficulties to be encountered. The remains themselves are often fragmentary. Even when they are tolerably perfect the comparisons have to be made for the most part with specimens in herbaria, and the variations seen in the few leaves of a specimen often suggest that variations from different parts of the tree may be considerable. With fruits and with ferns preserving the fructification, the determination is safer, but with leaves alone, while in some well-marked cases there can be hardly a doubt, in a large proportion of cases the doubt is great. When the lecturer first paid attention to the Lower Bagshot flora, fourteen years ago, he thought, as many unacquainted with the subject might think, that with such herbaria as at Kew and the British Museum the work of comparison would be simple. The riches of these places will soon show, however, that a wide experience and a trained eye are needed to refer to all the species, frequently of orders and genera widely separated in the natural classification, whose leaves resemble a fossil leaf under consideration. Those who may try the work will more readily understand how it was that a few years ago not a single English botanist of note was willing to attach any importance to the determinations based on fossil leaves alone.

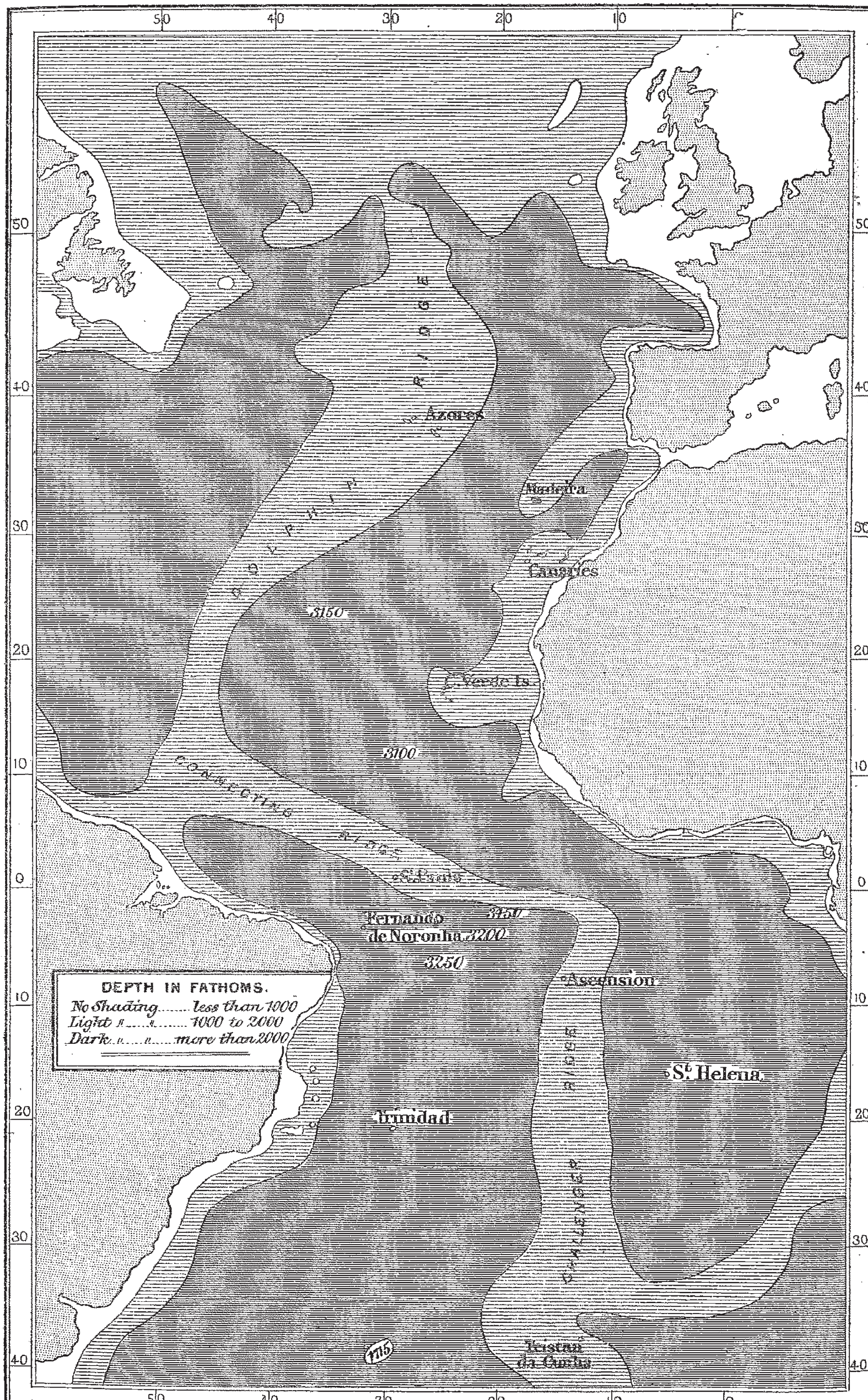
Matters are looking more hopeful now, partly because more perfect and well-marked specimens are being frequently added to museums and private collections, and partly because the writers of monographs on any living order are now beginning to adopt the plan of adding what is known about its fossil forms. There can hardly be a doubt that the solid reliable progress in the determination of fossil leaves is to be made alone by botanists who select a particular group of plants for exhaustive study, and include such fossil forms as they find no hesitation in admitting. General botanists of even great experience may make good guesses, but nothing short of the determination of a specialist can be regarded as absolutely safe, even if that may be considered so.

While the feeling of English botanists a few years ago was as described, there were on the Continent some few whose hesitation with regard to fossil leaves did not prevent them from trying what could and what could not be done in the way of identification. [The lecturer then referred to the work of continental botanists, especially of Heer and Unger, and alluded to the confirmatory evidence which in some cases had occurred of fruits being found subsequently from the same locality as leaves, whose determination had been attempted.] Unger compared the Tertiary flora of America with that of Europe, and in 1860, in a lecture called "Die versunkene Insel Atlantis," made a comparison between the two, and detailed the steps by which, after twenty years' study, he had been led to the conclusion that the European Tertiary flora had a North American character. There have been two theories respecting the origin of plants in particular areas. One is that the plants of that area have been created there as fully developed as met with; another is that they have been partly the result of evolution in the same district, and partly or entirely the result of immigration from other districts. [Starting with familiar illustrations of the effects of climate on plants, the lecturer proceeded to show how plants retreated before climatal conditions that were hostile to them and spread where the conditions were favourable, in some cases changing the elevation at which they grew, in others changing their area.] It was the consideration of the migration of the plants that led Prof. Unger to believe that a high proportion of the European Tertiary forms had come from North America.

It would occupy too much time and would fulfil no useful purpose in a popular lecture like this, to give in detail the data on which he based his conclusions. A *résumé* of them in a form convenient for reference may be found in a translation of his lecture in the *Journal of Botany* of January, 1865. Believing the evidence was sufficiently strong that the Tertiary plants he studied had come from North America, he proposed a hypothetical land between the two as the route by which they had travelled.

[1] Abstract of a lecture given in connection with the Loan Collection of Scientific Apparatus at South Kensington, March 31, 1877, by W. Stephen Mitchell, M.A., LL.B.

[2] Prof. Oliver, *Nat. Hist. Rev. Ap.*, 1862, Prof. Asa Gray, *Mem. Am. Acad.*, N. S., vol. vi. p. 377.


DEPTH IN FATHOMS.
No Shading....... less than 1000
Light .... 1000 to 2000
Dark .... more than 2000
DOLPHIN RIDGE
Azores
Madeira
Canaries
Verde Is.
3150
3100
CONNECTING RIDGE
St. Paul's
Fernando de Noronha
3150
3200
3250
Ascension
St. Helena
Trinidad
CHALLENGER RIDGE
Tristan da Cunha

He took the name of his hypothetical land from a legend met with in the "Timæus" of Plato. In a conversation between a priest of Saïs and Solon, when in Egypt, mention is made of a great island of Atlantis, situated beyond the pillars of Hercules, where lived a powerful nation that ruled over Libya as far as Egypt, and over Europe as far as Tyrrhenia. They tried to subjugate the Hellenes, but that heroic people defeated them. At a later period, during severe earthquakes and great floods, the island of Atlantis sank into the ocean. Such in brief outline is the legend. [The lecturer, alluding to the translations of Jowett and Whewell, referred to the puzzle this passage had been to students to know where an Egyptian priest could have known such a legend, or why (possibly) Plato had invented it, and alluded to one explanation that it was probably an exaggeration of some local phenomenon. In the *Journal of Botany* for January, 1865, a list of the literature of the subject is given.] This is as much as time will allow to be said to indicate the nature of the reasoning by which Unger, on the evidence of plant remains in Europe and America, conjectured former intervening land between the two, and why that hypothetical land was called "the sunken" or "the lost island of Atlantis."

We now turn to the *Challenger* soundings, and with these must be mentioned those of the United States ship *Dolphin*, the German frigate *Gazelle*, and the British ships *Hydra* and *Porcupine*. The generalisations of the soundings taken by these vessels, with inferences drawn from bottom temperatures, have been worked out by the staff of the *Challenger*, and a contour map has been prepared, of which the features which bear on our subject are reproduced in the diagram. Some of the most important soundings were taken from the *Challenger* herself, and as the working out of the whole results have been performed by the staff of that ship it is not unfair, at any rate in a short title for a popular lecture to mention only "*Challenger* soundings." That there was no feeling of international jealousy on the part of the *Challenger* staff is fully evidenced by the fact that the northern portion of the ridge has been named after the *Dolphin*.

Before referring to the results it may be of interest, as we have some of the *Challenger* apparatus here, to speak of the method of deep-sea soundings.

[The lecturer then briefly sketched the history of deep-sea soundings, alluded to the impulse given by the laying of cables, and mentioned how the improvement in mechanical appliances made possible now what was impossible a few years ago.]

The line used is about one inch in diameter ; on this the twenty-five and seventy-five fathom distances are marked with white thread, interwoven, the fifty by red, and the 100 fathoms in blue. By this means the amount of line paid out can be easily ascertained. The weights to sink the line are so arranged, that when they touch the bottom they release themselves. There are several modifications of this apparatus, but the principle of those used on board the *Challenger* is that round flat weights with holes through them are placed one above another with a rod or tube running through them, the number of weights depending on the expected depth. To the bottom of the lowermost weight a wire ring is fastened, and a wire passes up and is fastened to a spring at the top of the tube. The tube is then attached to the line. So long as the strain of the weights is on this spring it remains closed. Directly the weights rest on the bottom the strain is removed, the spring opens, the wire is released, and when the line is hauled in it brings up the tube only, leaving the weights below. For taking temperatures a cup lead is generally used to sink the line, to which self-registering thermometers specially arranged to withstand great pressures are attached at every 100, and sometimes at every ten fathoms. It is not necessary here to speak of dredging, nor of the means for bringing up water or samples of mud from the sea bottom. We have now only to speak of soundings and taking temperatures. In both operations the line is passed through a pulley-block, which is attached to a group of elastic "accumulators," the object of this being to break the shock of the roll of the ship.

Dr. Spry, writing about the *Challenger* voyage, has said :—

"It has been found that in all deep soundings it is necessary to use steam power. No trustworthy results can be obtained from a ship under sail, as even in the calmest weather the heave of the sea or the surface current is sufficient to drift the ship in a very short time a considerable distance from the place where the lead was originally let go. . . . The first thing therefore to be done is to shorten and furl all sail and bring the ship head to wind, regulating the speed in such a manner as to avoid forcing her through the water."

The soundings and temperatures obtained by the *Challenger* have been from time to time issued in special reports, of which there have been seven. In the seventh is given a map on which the soundings have been marked, together with those of the other ships already mentioned. On this map the ridges and deep basins have been contoured, and where soundings have been wanting the bottom temperatures have been taken as a guide of the probable position of the separating ridges. For the *Challenger* ridge there are plenty of soundings and nearly as many for the *Dolphin* ridge. The connecting ridge is, however, assumed from bottom temperatures.

It is on this map our diagram is based.

Having now obtained approximately the contour of this ridge, which throughout the greater part of its range is known as a FACT from actual soundings, there are some few speculations concerning it which naturally present themselves for consideration. In the first place it will be noticed that along the ridge itself there are four places where it rises to dry land, at the Azores, at St. Paul's rocks, at Ascension, and at Tristan d'Acunha. In the deeper basins there is land rising above the sea-level at Fernando de Noronha, at Trinidad, and at St. Helena. In the deeper basins too there are five soundings which show a depth of more than 3,000 fathoms. These are given on our diagram. The greatest depth recorded is 3,450 fathoms. A glance at the *Challenger* map on which the soundings are marked in figures is sufficient to show that if the contour lines were drawn at every 250 fathoms the Atlantic would be found to be diversified by hills and valleys. Geologists are familiarised with invoking former rises and falls in land to account for some of the facts they study. Indeed in some cases it seems almost as if it were believed that the axis of the earth may be shifted and its ice-caps, its soil-caps, and its continents moved about with impunity to suit any particular theory. At any rate it would not be received as a startling idea that the whole area of what is now the Atlantic has been dry land. True we know that deposits are now being formed on the floor of the ocean, and at different rates, and consequently producing different thicknesses ; rivers carry material which is spread out according to conditions over large or small areas, and so produce variations in the thickness of their deposits ; and perhaps allowance must also be made for currents. These circumstances may to some extent modify the relative levels of parts of the ocean bottom. But they could hardly account for such extent of variations in the hills and valleys as are met with. Some of the ridges may be the result of submarine elevation analogous to that which has raised high mountain ridges elsewhere, and in this case has never brought the ridge above the sea except in a few peaks. It must too be remarked that if we admit the ridge through its whole length to have been dry land, it does not necessarily follow it was so all at the same time. There is not, however, any readily apparent argument against the theory that it has been all dry land and at one and the same time. Let us for a while assume that it was, and let us then see what facts about climate we may infer with regard to it.

There are no doubt many other places besides those already known where the depth exceeds 3,000 fathoms. Let us, however, take the group of the known three which run in a line north-east and south-west, and are respectively 3,450, 3,200, 3,250, and we may assume that they represent a valley line. Let us suppose that the area is raised till this valley is dry land; what then will be the height of our ridge, and what will be the highest peaks of the country? To the north-west of the valley, distant about as far as from here to the Grampians, would tower the peaks, now the islands of St. Paul's Rocks, and Fernando de Noronha, rising some 30,000 feet; and to the south-east would rise Ascension to a similar height. The "ridge" itself would be about 15,000 feet. There is no reason whatever for supposing that the ridge is a table land. On the contrary, it seems more probable, judging from the variations in the soundings, that it was diversified with hills and valleys. Now a ridge of this elevation would, in all probability, have a snow capping even at the equator. Astronomers tell us that in "former" times the earth's atmosphere was higher and its pressure greater than now, but that was in a very remote past, and we may fairly assume that at the time of this ridge being land the atmospheric conditions were much as now. We should thus have a mountain ridge with hot valleys and every variation in temperature according to height; so that so far as temperature is concerned botanists would have no difficulty in accounting for the migration across the equator of plants that would be killed by great heat. With regard to the part of the ridge between Europe and America, answering to Unger's "Atlantis," the soundings are more numerous. The undulations seem to have been many, and the general elevation was probably not more than 9,000 feet, unless the original depths are masked considerably by a deposit of globigerina-ooze. Some peaks—now the Azores—still remain above water. When the ridge sank is a question on which we have at present no evidence. The whole subject is still young, and we have much yet to learn.

In conclusion the lecturer said: I hope I have given sufficient prominence to the distinction that must be drawn between fact and inferences from those facts.

I should be very sorry for anyone to go away from this place and say that they heard a lecture at South Kensington in which they were told that there formerly was a continent running down the middle of the Atlantic, and that there was a lofty mountain ridge along it, capped with snow even at the equator.

I wish carefully to point out to you I have made no statement of the kind. I have simply told you the fact that a ridge less than 1,000 fathoms beneath the ocean runs down mid Atlantic in a sinuous course, whose contour is roughly indicated by the diagram. That on each side of it are ocean depths, twice and in some cases thrice the distance it is below the sea-level. That *if* these depths were once land valleys, as geologists have no difficulty in believing possible, then there would be a ridge running north and south along the area of what is now the deep Atlantic, ranging from 9,000 to 15,000 feet above the sea-level, and that *if* the atmospheric conditions were the same then as now, judging from what we know of the Andes under the equator at the present time, there was probably a snow-capping.

Such a land-connection between Europe and America, if it existed as late as Tertiary times, would meet the requirements of Unger's hypothesis, varying in height as it sank, and the whole ridge would afford a solution of any difficulty botanists may have on the score of temperature in accounting for the migration of cold-loving and heat-shunning plants across the torrid zone.

The remarks at the conclusion of the lecture, in reference to its being the last of the series, we have already reported at p. 490.

REMARKS ON THE INVESTIGATION OF CLIMATES

TO Prof. Balfour Stewart we are indebted for the separation of meteorology into its two great divisions of *physical* and *climatic*. The latter I have proposed to separate into two sub-divisions, viz., *normal* and *abnormal*. The first of these subordinate branches includes the investigation of the usual states of the atmosphere in different parts of the earth's surface, as ascertained by periodic data derived from the averages of observations continued for a series of years. The second subordinate branch has for its object the investigation of unusual temporary disturbances of the equilibrium of the atmosphere—such, for example, as storms of wind, by means of the comparison of individual observations, extending over only a few hours or a few days.

We need hardly wonder at the disfavour with which meteorology is regarded by some men of the highest standing in physical science, from whom valuable assistance might have been expected; for we know that there is a great want of agreement among meteorologists themselves as to the means of determining even the most important fundamental data. For example, it will hardly, one would think, be disputed that the essential condition in all meteorological inquiries is *uniformity in instrumental observation*. But towards the establishment of a uniform international system no progress has as yet been made. Points of subordinate importance may have been adjusted at the Congress meetings at Leipzic and Vienna, but this all-important question remains just where it was. To Mr. Glaisher is due the adoption among his observers of the uniform height of 4 feet above the ground for thermometers, and one invariable form of screen for protecting them. The Scottish Meteorological Society, when establishing their stations in 1855, followed the example of Mr. Glaisher by adopting the 4-feet standard height, and they ultimately selected the form of double-louvre boarded protecting box, which I proposed in 1864. The Meteorological Society of England have also adopted the same uniform system as that in Scotland of boxes, and their exposure, and hours of observation. But other observers follow different methods, and on the Continent it is believed there is still less approximation to uniformity than among ourselves. The very first matter which should be taken up by home and foreign meteorologists is the settlement once for all of the questions how, when, and with what position and exposure of instruments are observations to be made. Until this is done it is impossible to arrive at useful results, because the observations which are now being obtained at different stations are not comparable the one with the other. Unless there be some such general Council as that lately proposed in NATURE by Prof. Balfour Stewart for carrying out this and other important objects, I shall certainly despair of the future of this new science.

But let us now see in what way the mode of instrumental observation bears on the subject of climate. Climates may be defined as states of the atmosphere due to the joint operation of geographical, geological, and other conditions more or less local, and they are judged of by their effects on animal and vegetable life. They do not, therefore, depend simply on the geographical position on the earth's surface of the district where the observations are made, but are largely affected by various conditions, such as the distribution of land and water, the nature of the soil and its covering, and the elevation or depression and character of the land at, and