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THE THREE CRUISES OF THE "BLAKE."

The Three Cruises of the "Blake." Two Vols. By Alexander Agassiz. *Bulletin of the Museum of Comparative Zoology at Harvard College*, Vols. XIV. and XV., Cambridge, Mass. (Boston and New York: Houghton, Mifflin, and Co., 1888.)

IN these profusely illustrated volumes there is presented to the general reading public the best and most comprehensive account of recent oceanographical investigations and speculations that has as yet been attempted. These volumes have, moreover, a special value for all who interest themselves in deep-sea researches, from the descriptions that are given of the work carried on with so much ability and industry by Mr. Agassiz and his fellow-countrymen on the eastern and southern sea-boards of the United States and in the West Indian seas. The volumes abound with novel and ingenious views bearing on nearly all the physical and biological phenomena of the ocean; and, whether we agree with the writer or not, his opinions are none the less welcome and suggestive, coming as they do from one who has for many years taken a large part in the practical work connected with the observations which he here undertakes to describe and discuss. It does not seem possible to over-estimate the credit due to the Government and the men who initiated and have carried through this excellent and extensive hydrographical survey of the deeper waters surrounding the eastern shores of North America, nor to value too highly the resulting additions to human knowledge. These positive additions to our knowledge of the ocean will be fully acknowledged and appreciated by all who desire to trace the causes that have led to the development of the surface features of the earth and the existing conditions of life on our globe.

After an attentive reading of the twenty-three chapters into which this publication is divided, it is possible to point out some errors; but slips cannot be avoided in a work dealing with such a wide range of subjects. It is difficult to follow the author in all his speculations, or to agree with him in all the deductions drawn from his excellent and extensive observations, but such agreement was in no way to be expected in these wide fields of research. Almost all the writings and opinions of previous and contemporaneous workers are in some way noticed, and discussed in an appreciative spirit. Mr. Agassiz is in every respect to be congratulated on the completion of this praiseworthy contribution to the growing science of oceanography. So many subjects are presented for discussion and remark that the reviewer is at a loss to know which may with most advantage be touched upon within the limits of a short notice. An attempt may at all events be made to point out the arrangement of the work, and the nature of the varied investigations treated of in the several chapters.

An introduction gives a brief sketch of the cruises of the *Blake*, the extent of the work undertaken, and indicates the localities in which these were conducted. Acknowledgment is duly recorded for the assistance obtained from naturalists in all parts of the world in working out the

results of the dredgings. By arrangement the specimens were as far as possible sent to the same specialists as were engaged in describing the *Challenger* collections.

The first chapter deals with the equipment of the ship, which has already been made known through Captain Sigsbee's publication. Mr. Agassiz, from his engineering training in the copper mines of the West, was able to render very valuable assistance in modifying the apparatus for deep-sea work. To him we owe the introduction of wire dredging rope, improvements in the trawl, tow-net, and other apparatus. The use of tangles on rocky ground was very successful, as it was when used in similar places by the *Challenger*. The tow-net for intermediate depths is ingenious, but the experiments with it are in no way sufficient to prove that no living animals are to be found at intermediate depths, as is sometimes asserted. The *Challenger* experiments clearly showed that when tow-nets were dragged for considerable distances at depths of 1000 and 500 fathoms, they always contained animals (*Challengeridæ* and other Radiolarians and fishes, &c.) never taken in the nets dragged down to 100 fathoms from the surface. While the great development of life in the ocean is in the surface and sub-surface waters, where *Algæ* abound, and at and near the bottom, where the organic matters are settling on the mud or ooze, yet it appears to me that the *Challenger* has also shown that there is no intermediate lifeless region.

A short chapter gives a fair and impartial historical sketch of deep-sea work, with special reference to the work off the American coast; and a longer chapter gives a very complete account of the origin, development, and present condition of the Florida reefs—the most thorough account of a series of coral reefs to be found in the literature of the subject. Mr. Agassiz successfully explains the phenomena without calling in subsidence, indeed, he found Mr. Darwin's theory quite inapplicable. He rightly places stress on the vigorous growth of the reefs in all situations where they are bathed by currents coming directly from the ocean, and traces this vigorous growth to the abundant pelagic food brought to the reef-forming corals by these oceanic currents. He also dwells on the formation of submarine banks by the dead shells of these pelagic and other marine organisms. Speaking of the Pacific, he says: "It is difficult to account for the great depth of some of the lagoons—40 fathoms—on any other theory than that of subsidence." It appears to me that these depths are only found in very extensive atolls and barrier reefs, and that marine animals, other than the ordinary reef-building species, can build up submerged banks from much greater depths than 40 fathoms. Buchanan, on such a bank in the Atlantic, found *Lophohelia prolifera* growing in large quantities, together with Polyzoa, Crinoids, and other lime-secreting organisms. Besides, in the central parts of the lagoon of completely formed atolls, like Collo-mandu or Suadiva atolls, the solution of lime by the sea-water probably exceeds in quantity that secreted by organisms, and this process would of itself result in a deepening of the lagoon.

The topography of the Caribbean Sea, Gulf of Mexico, and eastern coasts of North America are illustrated by the admirable hydrographic charts of the Coast Survey. With a thorough knowledge of the various basins, their

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depths, currents, passages, and contour lines, Mr. Agassiz is well qualified to enter on a discussion of the relations of the American and West Indian fauna and flora, which he does in a most suggestive and instructive chapter. He says:—

“The deep soundings south of Cuba, between that island and Yucatan and Jamaica, do not lend much support to the theory of an Antillean continent as mapped out by Wallace, nor is it probable that this continent had a much greater extension in former times than now, judging from the depths found on both sides of the West Indian Islands. This would tend to prove the want of close connection between the West Indian Islands and the adjoining continent. It leads us to look for the origin of the fauna and flora of those islands to causes similar to those which have acted upon oceanic islands. The proximity of these islands to a great continent has, moreover, intensified the efficiency of these causes.”

Since the return of the *Challenger*, the existence of Tertiary continents in the Atlantic, Indian, and Pacific Oceans does not appear to have been seriously advocated. These views have been generally replaced by that which looks upon the continents and ocean basins as holding positions of great permanence on the surface of the earth. Mr. Agassiz adopts this latter view, and illustrates it by special reference to the geological structure of the American continent and its adjoining oceans. In discussing this matter, he expresses the opinion that the “Blake Plateau” was once within the 100-fathom line, and that it has been cut away to its present depth of 500 or 600 fathoms “by the action of the Gulf Stream acting upon the ‘Blake Plateau’ from a geological time which we can trace with a certain degree of accuracy.” This is a most important conclusion, but I cannot think it will be accepted till more evidence of the action of oceanic currents at these depths can be produced. The deposits I have examined from the bed of the Gulf Stream are principally composed of the shells of pelagic Foraminifera, Pteropods, and other organisms living in the present seas of the region, together with much glauconite and many phosphatic concretions. These would lead one to think that the bed of the Gulf Stream was now growing upwards by these accumulations, rather than being washed away.

All the new and valuable observations on the temperatures of the West Indian seas and on the Gulf Stream are presented to the reader with a wealth of illustration in the way of diagrams and maps that leaves little to be desired, and the chapters on these subjects give to the physical geographer many much-needed data.

Mr. Agassiz has long been known to the scientific world for his special researches on the pelagic animals of the eastern North American coasts, conducted chiefly at Newport since 1866. It was therefore to be expected that his observations in this direction would be attractive and important. Nearly all the principal organisms met with in the tow-nets are illustrated in the long chapter devoted to this subject, and the naturalist will here find much new matter and many novel views concerning the origin of this fauna. He says:—

“It seems most natural to look upon the pelagic fauna of to-day and that of former geological periods as made up of embryonic types removed from the influences necessary for their full development, even after a time reproducing themselves as other larval forms are now capable of doing. But to consider that the littoral forms

were developed from pelagic types, as has been suggested by Moseley, does not seem to be warranted by the embryological history of marine invertebrates.”

The chapters on marine formations, deep-sea deposits and deep-sea fauna contain the latest information and views as to their origin, and the first volume is concluded with a chapter on the physiology of deep sea life, dealing with the gases in sea-water, the effects of pressure and temperature, phosphorescence, effects of the absence of sunlight, colours of deep-sea animals, source of their food, and other kindred relations.

It is now recognized that the inhabitants of the abysmal regions differ more from the shore species than they do from one another. Perhaps the most striking characteristic of deep-sea species is that they live in a region where there is no plant-life, and that their food consists primarily of the dead remains that fall to the bottom from the surface. All these animals, therefore, either live by eating the mud or ooze of the bottom, or by devouring each other. It appears to me probable that these deep-sea animals are derived from the shore ones, some species descending into these deep regions and establishing a home there at each geological period, while the forms from which they were derived have died out in the shallower waters.

This and all similar questions Mr. Agassiz discusses in his second volume, where he deals specially with the West Indian fauna of the deep sea. He writes:—

“We may safely assume that but little will hereafter be added to our notions of the association of the sponges, polyps, corals, echinoderms, crustacea, and mollusks, comprising the West Indian deep-sea fauna, and making it in certain groups by far the richest in the world. The number of new forms from the West Indian region constitutes such a vast addition to our knowledge of the principal classes of invertebrates of that fauna as to revolutionize our ideas of geographical as well as of bathymetrical distribution. No other region of the ocean has yielded so abundant a harvest.”

I should think that in proportion to the number of dredgings, the regions in the Southern Ocean investigated by the *Challenger*, or off the north of Scotland worked over by the *Porcupine* and *Triton*, might be held to be quite as rich as those of the West Indian Islands. It is to be hoped that this will be shown before long by an expedition thoroughly equipped for examining the deep waters around Britain.

In a series of nine chapters in his second volume Mr. Agassiz attempts for the first time to give a general account of the deep-sea fauna in the areas explored by the *Blake*, commencing with the fishes, and ending with the Protozoa. In this he has been remarkably successful by the help of numerous illustrations. For details the reader must be referred to the volumes themselves, which will be widely consulted, and will well repay all who give them attentive study.

JOHN MURRAY.

KANT'S "KRITIK."

Kant's Critical Philosophy for English Readers. By J. P. Mahaffy and J. H. Bernard. (London: Macmillan and Co., 1889.)

THE abundance of Kantian literature within recent years shows no signs of abating. In Germany itself there is quite a school of students who have taken