

THE DEEP-SEA DREDGING EXPEDITION
IN H.M.S. "PORCUPINE"

NATURAL HISTORY (continued)

THIS being a preliminary report, I will make only a few remarks as to the Mollusca obtained in the expedition, and with respect to that part of the sea-bed which I investigated:—

1. *The Mollusca are mostly Arctic or Northern.*—This I have shown in my narrative as regards the western coasts of Ireland, which have hitherto been supposed to belong zoologically to what Professor Edward Forbes called the "Lusitanian" province; and the present remark applies not only to deep water, but to shallow water, and even the bays. In Prof. Wyville Thomson's cruise to the south-west of Ireland occurred two species, which I was quite unprepared to see. These were *Solarium Siculum*, and an unmistakable fragment of *Cassidaria Tyrrhena*. The former inhabits the Mediterranean, Madeira, Canaries, and the coast of Portugal; and the latter has not been noticed north of Brittany. Such exceptions, as well as *Ostrea cochlear*, *Murex imbricatus*, and *Platydia anomioides*, it is difficult to account for; but as all these species are said to inhabit deep water, the Equatorial current may have carried them northwards in an embryonic state; or it is possible that they may be likewise Northern species, and have not yet been discovered in high latitudes. We are nearly ignorant of the Arctic Mollusca, owing to the difficulty of exploration; and those who assume that the marine fauna of the circumpolar seas is poor or wants variety, ought to see the vast collection made by Prof. Torell at Spitzbergen. The greatest depth at which he dredged there was 280 fathoms. The soundings taken in 1868 by the last Swedish Expedition reached 2,600 fathoms, when a *Cuma* and a fragment of an *Astarte* came up in the *Bulldog* machine. Soundings, however, are very insufficient for zoological purposes. Judging by the results of our own expedition this year, which have increased to such a wonderful extent our list of the British marine fauna living beyond the ordinary line of soundings, it may fairly be taken for granted that the Arctic marine fauna is much less known than ours. I have not the slightest doubt that by another expedition to Spitzbergen, provided with improved machinery, and under the charge of the Professor at Lund or some other able zoologist, the species obtained would be double the present number. It is evident that the majority, if not the whole of our submarine (as contradistinguished from littoral or phytophagous) Mollusca originated in the North, whence they have in the course of time been transported southwards by the great Arctic current. Many of them appear to have found their way into the Mediterranean, or to have left their remains in the tertiary and quaternary formations of the south of Italy; some have even migrated into the Gulf of Mexico, as I will presently mention.

I cannot see much (if any) difference between the Mollusca from the warm and cold areas of Dr. Carpenter. The number of species from the cold area, which also occurred in the warm area, is forty-four. Other species from the cold area, and not from the warm area, are eleven. Of these last, five are undescribed, and one is apparently sub-fossil and may be a relic of the glacial epoch; so that there remain five only which are Arctic and North-American, but which were not found in the warm area.

2. *Additions to the British Mollusca.*—Although I am aware that the discovery of what are called "new" species does not rank high as a scientific fact, it is still interesting to all zoologists as well as collectors; and it must not be forgotten that the important subject of zoö-geographical distribution depends in a great measure on such discoveries, and especially on the relation of any local fauna to other faunæ. The number of species new to our seas and procured in this expedition is no less than 117. Of these, fifty-six are new to science, and eight

were supposed to be extinct as tertiary fossils. Sixteen genera are new to the British seas, including five which are undescribed. Some of the species and genera, however, are represented by single specimens, and a few by fragments. These whet one's appetite instead of satisfying it. The total number of species of our marine Mollusca, inclusive of littoral species but exclusive of the Nudibranchs (none of which latter were met with except in the bays), is 451, according to the latest work on the subject, 'British Conchology:' so that more than one-fourth has been added in the course of a few months. All that I could do by continual dredgings in comparatively shallow water during the last sixteen years was to add about eighty species to the number described by Forbes and Hanley. I regard the present (although a large) addition as merely an earnest of future acquisitions. Almost every square mile of the sea-bed yields different species, some being apparently local or restricted in their distribution. In fact the treasury of the deep is inexhaustible.

3. *Relation to North-American Mollusca.*—The late Dr. Gould, in his 'Report on the Invertebrata of Massachusetts' (1841), gave 176 species of marine Mollusca as inhabiting that coast. Mr. Mighels, Prof. Stimpson, and others have since described a few more species, making the total number about 200. I attribute less to the discovery of these as British, a dozen being from the present expedition. The size of North-American specimens is, so far as I have observed, smaller than that of our specimens of the same species, perhaps showing that their common origin was in the Arctic seas of Europe and not of America.

4. *Relation to Mediterranean Mollusca.*—In my last Report on Shetland dredgings, published a short time ago by the British Association, I discussed this subject so fully that it is needless to go further into it, except by calling the attention of the Society and all scientific men, particularly geologists, to the importance of ascertaining what has caused or is still causing the remarkable concordance which is observable between the marine Mollusca in the deeper parts of the North-Atlantic and Mediterranean. I cannot help now thinking that this concordance may be explained by the existence of an undercurrent into the Mediterranean through the Straits of Gibraltar, being probably a branch of the great Arctic current. Dredging researches ought to be carried on in the lower part of the Bay of Biscay, and off the coasts of Portugal and Spain into the Straits for the purpose of determining this vexed and highly interesting question. Dr. Carpenter's last cruise to the west of Shetland, at a depth of 290 fathoms added a remarkable species to our Mollusca in *Platydia anomioides*, a rare Mediterranean Brachiopod. The specimen is twice the size of those from the Mediterranean. *Octopus Cocco* of Verany is another remarkable discovery, and was dredged in 345 and 632 fathoms between latitudes 60° and 62° N. It was only known as Mediterranean, where it is stated by Verany to inhabit a depth of 100 mètres or nearly 55 fathoms. The dimensions of our largest specimen of this Cephalopod considerably exceed those given by Verany. I may here mention that my friend Captain Spratt, who co-operated with Prof. Edward Forbes in his Ægean exploration, has most obligingly placed at my disposal a very small quantity of material which he dredged in 1846, forty miles east of Malta, at a carefully ascertained depth of 310 fathoms. It contains among others the following remarkable species of Mollusca, all of which were found in the Porcupine expedition, and may be considered northern forms:—*Leda pellucida* (Phil.), *Leda acuminata* (Jeffr. M.S.), *Dentalium agile* (Sars), *Hela tenella* (Jeffr.), *Eulima stenostoma* (Jeffr.), *Trophon Barvicensis* (Johnst.), *Pleurotoma carinata* (Biv.), and *Philine quadrata* (S. Wood). This shows how imperfect is our knowledge of the Mediterranean fauna.

5. *Relation to Mollusca of the Gulf of Mexico.*—I hope soon, through the kindness of Professor Agassiz, to have an opportunity of examining and comparing the Mollusca dredged during the last three summers by Count Pourtales in the United States expeditions. The only species which I have yet seen from the Gulf of Florida are *Waldheimia Floridana* and *Terebratula Cubensis*. The former appears to be that variety of *Terebratula septata* (a Norwegian and now British species), which Professor Seggenza has described and figured under the name of *Waldheimia Peloritana*, from tertiary beds in Sicily; and the latter is closely allied to *Terebratula vitrea* (Mediterranean), and is perhaps a variety of that polymorphous species. Not only the external characters, but also the skeletons or internal processes of these American species correspond exactly with those of their European relatives. I must repeat that I am no believer in the doctrine or idea of species being "represented" in a geographical point of view. Species may be identical or allied, but not "representative."

6. *Gulf Stream.*—The northern character of the marine fauna observed during the Porcupine expedition is certainly at variance with the general notion that this "river in the ocean," or any branch of it, flows directly to our coasts; and I have elsewhere* endeavoured to show that the occurrence in northern latitudes of tropical shells, seeds, and timber may be accounted for by the surface-drift arising from the prevalence of westerly winds. But there is unquestionably a marine as well as an aerial circulation, Equatorial and Arctic currents as well as Trade winds.

7. *Nature of the sea-bed.*—In that part of my Report which contains a narrative of the expedition, so far as I was engaged in it, I have given some particulars which it is unnecessary to recapitulate. Some of the pebbles and gravel from my deepest dredgings (1,215 to 1,476 fathoms) have been examined by Mr. David Forbes, the eminent mineralogist; and he has kindly furnished me with the detailed report which I append to this communication. Among the pebbles and gravel were several fragments of true volcanic lava, which throw a considerable light on the course of the Arctic current along the western coasts of Ireland. He is of opinion that these volcanic minerals came from Iceland or Jan Mayen. Mr. Forbes has also, at my request, carefully and completely analysed a portion of the Atlantic mud from 1,443 fathoms, the pebbles and gravel having been previously removed from it by sifting; and the result shows that its chemical composition differs greatly from that of ordinary chalk. The sifted mud contains out of 100 parts 50·12 only of carbonate of lime, and no less than 26·77 of fine insoluble gritty sand or (rock débris); while chalk consists almost entirely of carbonate of lime, and seldom contains more than from 2 to 4 per cent. of clay, silica, and other foreign material. But I do not say that this single analysis is conclusive. Mr. Forbes's further report on that head, as well as on a specimen of Rockall (for which I am indebted to Staff-Commander Inskip, who procured it in the Porcupine surveying expedition of 1862), also accompany this communication. I may observe that stony ground did not occur during the present expedition beyond about 550 fathoms, the sea-bed at greater depths being covered by mud or what is technically called "ooze." This superstratum appears to consist chiefly of decomposed animal matter mixed with the shells of Pteropods and *Globigerina*, which must have dropped from the surface of the sea. I have myself seen living *Globigerina* in great abundance taken with *Spiriales* in the towing net; and Major Owen's papers in the Journal of the Linnean Society for 1865 and 1866 leave no doubt not only that *Globigerina* and other free Foraminifera live on the surface of the mid-ocean, but that they have the power, by protruding their pseudopodia, of descending a few inches and rising again to the

surface. Sessile or fixed Foraminifera, of course, cannot do this; but I have found some of these living on the surface and attached to floating sea-weed (*Fucus serratus*) at a considerable distance from land. The fresh appearance of the sarcode in Foraminifera taken from great depths does not of itself prove that they live there, when we consider the comparatively antiseptic or preservative property of sea-water as well as the extremely minute size of the aperture in each cell which contains the sarcode. Some Foraminifera, however, inhabit only the bottom of the sea.

8. *Bathymetrical conditions.*—So much has been said of late years (by myself among others) as to the depths of the sea being not merely inhabited but replete with life of a highly organised nature, and as to there being apparently no bathymetrical limit of habitability, I will content myself with noticing the Mollusca which were dredged in 2,435 fathoms. They were—(1) *Pecten fenestratus*, a Mediterranean species; (2) *Dacrydium vitreum*, Arctic; (3) *Scrobicularia nitida*, Finmark to Sicily; (4) *Neara*, an undescribed species, Norwegian; and (5) *Dentalium*, a fine species, also undescribed. The first of these species was known to inhabit depths varying from 40 to 60 fathoms, the second 50 to 300 fathoms, the third 3 to 300 fathoms, and the fourth 50 to 60 fathoms. The *Dentalium* is an inch and a half long; and in 1,207 fathoms was taken a new species of *Fusus*, living and two inches in length. This last species, being one of a zoophagous tribe, must have had for its food prey of a suitable kind and perhaps of dimensions at least equal to its own. Abyssal life is not represented merely by microscopic organisms; and I suspect that there is no difference in size between the animals that live in shallow water and the greatest depths. Nor do I believe that such abysses are dark or devoid of light. Colour is assuredly not wanting, nor the usual organs of sight in the Mollusca and Crustacea. Living specimens of the *Dacrydium* from 2,435 fathoms are reddish-brown; and a fine live specimen of *Trophon latericeus* from 440 fathoms is bright rose-colour. *Dacrydium vitreum* makes a nest (like that of *Modiolaria discors* and *Lima hians*) consisting of a narrow tubular case twice as long as itself. This case is lined with a delicate membrane, and covered with small Foraminifera, particles of sponge, and coccospheres, which are firmly agglutinated. The *Dacrydium* inhabits the broader half, its front or ventral margin lying in the direction of the opening of the case. From 2,090 fathoms came a new species of *Pleurotoma*, alive, and having a pair of prominent eyes on short stalks; and the *Fusus* from 1,207 fathoms was similarly provided. In both these genera the eyes are perfect and not rudimentary. The eyes of the *Oncopus* from 632 fathoms are remarkably large and more highly organised than those of many fishes. The animals of this genus crawl with their arms, head downwards; and the common species (*O. vulgaris*) buries itself in sand and gravel. Instances to prove that colour and visual organs are possessed by animals at very great depths are innumerable; and they would lead us to infer that light (of what nature I cannot suggest) penetrates the sea to its profoundest base. None of the deep-sea animals appeared to be phosphorescent. Perhaps in the next expedition some photometric apparatus may be devised in order to solve this problem.

9. *Oceanic currents.*—The Arctic or Northern current probably runs with greater rapidity and force in some places than in others, where the flow seems to be very slow and feeble. Everywhere (as I pointed out in my Shetland Report for 1863) the motion must be extremely gentle or imperceptible at the bottom in deep water, as we find the most fragile and delicate corallines from stony ground quite uninjured.

10. *Geological considerations.*—Not the least interesting fact derived from this expedition was the discovery, in a living or recent state, of species hitherto supposed to be

* "British Conchology," vol. i. Intr. pp. xcvi. and xcix., and Report of British Association, 1868, p. 236.

long exclusively to the tertiary formation and hitherto considered extinct. Such are *Leda excisa* of Philippi, and an undescribed species of the same genus (Calabrian and Sicilian fossils), *Scalaria corrugata* of Brocchi (Subapennine), *Kellia pumila*, *Neera jugosa*, and *Cerithium granosum*, all of S. Wood (Coralline Crag), and an undescribed species of *Fusus*, which I propose to name *Sarsi*, lately found in the Red Crag. Mr. Wood is inclined to refer this last species to *F. Spitzbergensis* of Reeve; I regret that I cannot agree with him in such determination. Our Coralline and Red Crag beds notoriously contain a large proportion of northern species; and I was not far wrong in regarding the former as the "cradle" of the British Mollusca. I may here remark that, as in Shetland, valves and fragments of *Pecten Islandicus*, *Tellina calcaria*, and *Mya truncata* var. *Uddevallensis* (all Arctic species) were dredged in rather deep water, on the western coasts of Ireland; and a perfect specimen of *Leda arctica* was found in Loch Torridon. These shells are apparently in a semi-fossil condition; but it is impossible to say whether they are quaternary or recent.

As regards marine zoology, this expedition has produced results more important than those which have ever been obtained in any previous expedition of the kind by the enterprise of our own or any other nation; and I cannot help expressing a fervent wish that it may be renewed next year. The United States, France, Sweden, and Norway are prosecuting with great success this line of scientific research; and I feel confident that Great Britain, with her vast wealth, naval resources, intelligence, energy, and perseverance, will keep the lead which she has now taken.

As one of the naturalists who were privileged to assist in the late expedition I shall be happy again to place my humble services at the disposal of the Royal Society in continuation of the work, especially in conjunction with Dr. Carpenter and Prof. Wyville Thomson.

J. GWYN JEFFREYS

. At the Meeting of the Royal Society at which the observations described in the above paper were communicated, Professor Alexander Agassiz gave an account of the principal results arrived at by the American Dredging Expedition. The ground explored was limited to a length of about 120 miles by 60 to 90 miles in width between the Florida Keys and the Northern Coast of Cuba, and although the depth reached was by no means as great as that attained by the last British expedition, not being much more than one-third of it, about 820 fathoms, yet the results were fully as striking, and agree in the main points with the conclusions arrived at by the English explorers. Commencing with the sponges, which contained a great number of siliceous forms, he gave as the results of the examination of Dr. Oscar Schmidt, of Graatz, the specific identity of the majority of the species with Mediterranean, Azoric, and Atlantic species, showing a geographical range quite unprecedented, and extending the Atlantic fauna from the Gulf of Mexico to the Bermudas, the Azores, the Mediterranean, the Western Coasts of Europe, and extending far north to the boreal regions of Norway, Iceland, and Greenland. These same results would apply, as far as the collections have been examined, to the Echinoderms, Mollusca, and Crustacea, though the number of identical species in these branches over this extensive Atlantic area is much smaller. Among the Echinoderms, the *Echini* specially showed several new and interesting forms, recalling types characteristic of the cretaceous period; one genus especially, the genus *Salenia*, is represented in our seas by a most interesting species. Another cretaceous type, a new genus of *Spatangida* (Pourtalesia) was found in deep water in Florida, and like the Crinoid genus *Rhizocrinus*, was also dredged by the Porcupine expedition. Several other species of Echinoderms were also shown to be identical on both sides of the Atlantic.

Prof. A. Agassiz gave besides an instance of one of these so-called cretaceous generic types, which was only the young stage of a well-known genus represented from the time of the chalk through the tertiaries, and which is now found living in the tropical seas, showing how careful we ought to be in our generalisations when drawn from a class where the transformations from the young stages to the adult are as great as they are in Echinoderms. He gave as an example of this the case of two species of *Echini*, one of which is known under one generic name (*Stolonoclypeus*), as the adult, in Florida, while the young is known under a different generic name (*Echinocyamus*) in Europe, and endeavoured to explain by the action of the currents the migration of the pelagic embryos, many of which remain in a helpless condition for several months, and thus to show how changes of currents, brought about by the elevation or subsidence of portions of continents, would fully account for the present limitation of marine fauna. The presence of corals at great depths will also materially alter the views generally received of the depth at which reef-builders may work, and modify to a certain extent Darwin's theory of the reefs, and their mode of growth. Prof. A. Agassiz alluded to the probable continuation of the exploration of the Gulf Stream by Prof. Pierce, the superintendent of the W. S. Coast Survey, who was carrying out the plans laid out by his predecessor, Professor Bache; and trusted that the Coast Survey would carry on the investigations so successfully inaugurated, thanks to the enlightened views of Professor Pierce, and the executive ability of the assistant in charge, Count Pourtales. This exploration would consist of a series of normals to the coast of the United States, extending from Georgia to New York, completely across the Gulf Stream, thus extending sufficiently far north to meet upon a common ground the English expedition, which the British Government could not fail to send in consequence of the brilliant results of the two previous years.

SCHOLARSHIPS AND EXHIBITIONS FOR NATURAL SCIENCE IN CAMBRIDGE

THE following is a list of the scholarships and exhibitions for proficiency in natural science, which are likely to be offered in Cambridge during the ensuing year.

Trinity College.—One of the value of about £80 per annum. The examination (in chemistry, physics, physical geology, including meteorology and the elements of mineralogy) will be in Easter week, and will be open to all undergraduates of Cambridge and Oxford. Further information may be obtained from the Rev. E. Blore, tutor of Trinity College.

St. John's College.—One of the value of £50 per annum. The examination (in chemistry, physics and physiology, with geology, anatomy, and botany) will be on 29th and 30th of April, and will be open to all persons who are not entered at the University, as well as to all who have entered and have not completed one term of residence. In this College, moreover, natural science now is made one of the subjects of the regular college examination of its students at the end of the academical year (in May); and exhibitions and foundation scholarships will in consequence be awarded to students who show an amount of knowledge equivalent to that which in classics or mathematics usually gains an exhibition scholarship in the College. In short, natural science is on the same footing as classics and mathematics, both as regards teaching and rewards.

Christ's College.—One to four, and in value from 30*l.* to 70*l.*, according to the number and merits of the candidates, tenable for three and a half years, and three years longer by those who reside during that period at the College. The examination will be in April, 1870, and will be open to the undergraduates of Christ's College; to non-