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

I.—NATURAL HISTORY

MY part of the expedition in H. M. S. *Porcupine* commenced on the 18th of May, and ended on the 13th of July last. It comprised the Atlantic coast of Ireland, from the Skelligs to Rockall (a distance of about 6½ degrees, or 400 miles), Loughs Swilly and Foyle on the north coast, and the North Channel on the way to Belfast. I took with me as assistant Mr. B. S. Dodd (who had accompanied me in former dredging expeditions); and as dredger Mr. W. Laughrin, of Polperro, an old coast-guardman, and an Associate of the Linnean Society. Both did their share of the work carefully and zealously.

The first dredging was on the 24th of May, about 40 miles off Valentia, in 110 fathoms; bottom sandy with a little mud. The fauna was mostly northern, and the following are the more remarkable species there procured: Mollusca—*Ostrea cochlear*, *Neæra rostrata*, *Verticordia abyssicola*, *Dentalium abyssorum*, *Aporrhaïs Serresianus*, *Buccinum Humphreysianum*, *Murex imbricatus*, *Pleurotoma carinata*, and *Cavolina trispinosa*; Echinodermata—*Echinus elegans*, *Cidaris papillata*, and *Spatangus Raschi*; Actinozoa—*Caryophyllia Smithii*, var. *borealis*. Of these, *Ostrea cochlear*, *Aporrhaïs Serresianus*, and *Murex imbricatus* are Mediterranean species; and *Trochus granulatus* also imparted somewhat of a southern character, although that species was afterwards found living in the Shetland district. *Ostrea cochlear* is a small Mediterranean species of oyster; and it is one of the shells which Milne-Edwards noticed as adhering to the telegraph-cable between Sardinia and Algiers from a depth of about 1,100 fathoms. Although considered peculiar to deep water, I found it attached to the columns of the temple of Jupiter Serapis at Pozzuoli, which are reputed not to have been submerged to any depth. The above-mentioned results of this dredging will give a fair idea of the fauna inhabiting the 100-fathom line on the west of Ireland.

After coaling at Galway we steamed south; and (the weather being very coarse and unpromising) we dredged in Dingle Bay, at a depth of from 30 to 40 fathoms; bottom rocky and muddy. As before, in comparatively shallow water, we had two dredges out, one at the bow, and the other at the stern; this was what I always did in my own yacht, when dredging in from 20 to 200 fathoms. In Dingle Bay the dredges several times caught in rocks or large stones, but were saved by the usual yarn-stops, and by the extraordinary strength of the two-inch Chatham rope which was used. On one occasion, when the dredge was fast, the steamer, which was nearly of 400 tons burden, was pulled round, and swung by the rope as firmly as if she were at anchor and moored by a chain cable. Here, again, the Mollusca were mostly northern. *Siphonodentalium Lofotense*, *Chiton Hanleyi*, *Tectura fulva*, *Odostomia clavula*, *Trophon truncatus*, and *Cylichna nitidula* fall within this category; and *Eulima subulata*, *Trophon muricatus*, *Pleurotoma attenuata*, and *Philine catena* may be reckoned southern species. But the most remarkable shell obtained in this dredging was *Montacuta Dawsoni*, which I had described and figured from specimens found by Mr. Robert Dawson in the Moray firth. I subsequently detected in the Royal Museum at Copenhagen specimens of the same species in the collection of Greenland shells, made by the late Dr. H. P. C. Möller. The species was briefly described or noticed by him in the addenda to his 'Index Molluscorum Groenlandiæ,' as "*Testa bivalvis*"; but he did not give it any other name. The size of the Greenland specimens is considerably greater than that of British specimens, thus adding another to the numerous cases of a similar kind which I have from time to time adduced in illustration of the fact, that with regard to those species of Mollusca which are common to northern and southern latitudes, and which inhabit the same bathymetrical zone, northern are usually larger than southern specimens. It may, perhaps, be a not unfair inference, that the origin of such species is northern, and that they dwindle or become depauperated, in proportion to the distance to which they have migrated, or been transported from their ancestral homes.

The following week was occupied in sounding and dredging off Valentia, and on the way to Galway, at depths varying from 85 to 808 fathoms. The fauna throughout was northern. Several interesting acquisitions were made in all departments of the Invertebrata. Among the Mollusca I may mention—*Nucula pumila* (Norway), *Leda frigida* (Spitzbergen and Finmark), *Verticordia abyssicola* (Finmark), *Siphonodentalium quinquangulare* (Norway and Mediterranean), and an undescribed species of *Fusus* allied to *F. Sabini*; Echinodermata—*Brisinga endecacnemos*; Actinozoa—*Ulocyathus* (or *Phyllodesmia*) *arcticus*. That fine sponge *Phakellia ventilabrum* was also met with so far south, in 90 fathoms. The 808 fathoms' dredging was then a novelty, being the greatest depth ever explored in that way. The length of rope paid out was 1,100 fathoms, and the time occupied in hauling in was 55 minutes. The same proportional time was observed in other dredgings during my part of the expedition, viz. 5 minutes for every 100 fathoms of rope. The dredge contained about 2 cwt. of soft and sticky mud, in appearance resembling "China clay." The animals brought up on this occasion were quite lively; and I examined more than one specimen of a small Gastropod (described and figured by me as *Lacuna tenella*), which had very conspicuous eyes: there was also an active little stalk-eyed crab.

The next cruise was for ten days, and comprised the examination of the sea-bed between Galway and the Porcupine Bank, as well as beyond the Bank, at depths varying from 85 to 1,230 fathoms. All the Mollusca were northern, except *Aporrhaïs Serresianus*; and even that I am now inclined to consider identical with *A. Macandreæ*, which inhabits the coasts of Norway and Shetland; the latter appears to be a dwarf variety or form. The more remarkable species were, *Limopsis aurita* (a well-known tertiary fossil), *Arca glacialis*, *Verticordia abyssicola*, *Dentalium abyssorum*, *Trochus cinereus*, *Fusus despectus*, *F. Islandicus*, *F. fenestratus*, and *Columbella haliæeti*, (a tertiary fossil), among the Mollusca; *Cidaris papillata* and *Echinus Norvegicus* among the Echinoderms, and the beautiful branching coral, *Lophohelia prolifera*. In the deepest dredging made in this cruise (1,230 fathoms), occurred several new species and two new genera of the *Arca* family, *Trochus minutissimus* of Mighels (a North American species) having two conspicuous eyes, a species of *Ampelisca* (Crustacea) with the usual number of four eyes, comparatively gigantic Foraminifera, and other animals belonging to undescribed species and genera. An enormous fish (*Mola nasus*), which is not uncommon on the coasts of upper Norway, was slowly swimming or floating on the surface of the sea; but we did not succeed in capturing it for want of a harpoon.

We then put into Killybegs, county Donegal, and coaled there for our Rockall cruise. In anticipation of this cruise taking a clear fortnight, coals were stacked on the deck, in addition to the usual stowage in the bunkers, so as to provide a sufficient supply. Some delay was caused by the non-arrival of a proper galvanometer to work Siemens' electro-thermometrical apparatus, which we were anxious again to try. We left Donegal Bay on the 27th of June, and returned to the mainland on the 9th of July, after experiencing severe weather. The vessel sustained some injury from the heavy cross seas which struck her on her homeward passage. During this cruise we dredged seven days at depths exceeding 1,200 fathoms, and on four other days at less depths; the greatest depth was 1,476 fathoms. In this last-mentioned dredging we

got several living Mollusca and other animals, a stalk-eyed crustacean with two prominent and unusually large eyes, and an Echinoderm of the Holothuria family, of a blue colour. The bottom, at the greatest depths, consisted of a fine clayey mud, which varied in colour (in some dredgings being brownish, in others yellow, creamcolour, or drab, and occasionally greyish), and invariably having a greater or less admixture of pebbles, gravel, and sand. The upper layer formed a flocculent mass, which appeared to be animal matter in a state of partial decomposition. This was in all probability derived from the countless multitude of *Salpæ*, oceanic *Hydrozoa*, Pteropods, and other gelatinous animals, which literally covered the surface of the sea, and filled our towing net directly it was dipped overboard. Their remains must fall to the bottom after death. Such organisms doubtless afford a vast store of nutriment to the inhabitants of the deep. It must be borne in mind that it is extremely difficult to dredge in very deep water. The dredge must be unusually heavy to counterbalance the tendency of the necessary bulk of rope to buoy it up under the descending pressure; and when it reaches the bottom, it sinks by its own weight, like an anchor, into the mud. This would give only the same result as the cuplead or any sounding machine, but on a larger scale; and it would tell us very little about the fauna. Further, if by the drift-way of the vessel, or by a few turns of the engine now and then, we are enabled to scrape the surface of the sea-bed, the dredge gets choked up with the flocculent mass above described. The fertile ingenuity of our experienced and excellent commander devised a method which was a great improvement in deep-sea dredging, and which enabled us to obtain at least a sample of the substratum. This was to attach two iron weights, each of 100 lbs., to the rope, at a distance of 300 or 400 fathoms from the dredge (when the depth exceeded 1,200 fathoms), so as to dredge from the weights instead of from the ship, the angle thus made causing the blade of the dredge to lie in its proper position: in fact it reduced the depth by the distance of these weights from the vessel to the easy and manageable limit of 300 or 400 fathoms. Another method was to fasten the bag to the dredge in such a way that, when it was hauled in it could be unlaced, emptied, and afterwards washed quite clean. I was thus assured that the specimens really came from the place where each dredging was made, and the risk of intermixture with previous dredgings was avoided. My sieves were also framed with a similar object, every sieve having a beading round the inside rim, to prevent specimens remaining inside the edges when the sieves were washed after every dredging. Two other kinds of sieve I also found useful. One was spherical, with its lid fastened inside by bolts; its frame consisted of a strong network of copper ribs, which was lined with very fine gauze-wire of the same metal; and it had a ring through which a rope would pass. Its use was to sift and wash away in the sea the impalpable mud got in such quantities at great depths, so as to leave only for examination all organisms exceeding in size $\frac{1}{32}$ of an inch, this being the greatest diameter of the wire-mesh in the lining. Some of the residuum or strained mud was likewise preserved after sifting the material in the usual way. This apparatus, which we called the "globe-sieve," saved a great deal of the time and useless labour required for washing that sort of dredged material through the ordinary sieves in a tub of sea-water, which would immediately become so turbid that, unless the tub were continually emptied and refilled, it was extremely difficult (if not impossible) to detect any specimens. Another kind of sieve had a similar framework; but the body was semi-globose, with a funnel-shaped neck. It was fastened to a long pole, and served for catching Pteropods, *Salpæ*, and other animals on the surface of the sea. This went among us by the name of the "vase-sieve." We tried on this and other occasions a contrivance of Mr. Easton, the celebrated engineer, consisting of gutta percha valves, which closed inwards in a wedge-like form, and were fitted to the mouth of the dredge. The object was to retain the contents of the dredge while it was being hauled in, as I had found by frequent and disappointing experience that a large portion of the contents generally escaped through the mouth during this part of the operation. The contrivance, although admirable in a theoretical point of view, was found impracticable; perhaps it may yet succeed after more trials, and with some alterations. In their present form the valves close the mouth of the dredge, so that it has no contents to be retained. The deep-sea dredgings in this cruise yielded no end of novelties and interesting results in every department of the Invertebrata. They were enough to take one's breath away. Among the Mollusca were valves of an imperforate Brachiopod with a septum in the lower valve, which I propose to name *Cryptopora gnomon*. Some shells were of a tolerable size; and the fry of *Isocardia cor* (*Kelliella abyssicola* of Sars) were not uncommon. Many Crustacea (Amphipoda) were scarlet, and others bright red with feathered processes of a golden colour at the tail. A magnificent Annelid was pinkish, with purplish-brown spots on the line of segmentation. A *Holothuria*, from 1,443 fathoms, was 5 inches long and $2\frac{1}{4}$ in circumference. None of the animals, especially the Mollusca, were living when they were brought on board and examined; this was perhaps owing to the great change of temperature (sometimes as much as 20°) between that of the sea-bed and that of the atmosphere.

But to return from the bottom to the surface. At a distance of from 130 to 140 miles from the nearest part of the Irish coast I observed quantities of floating seaweed (mostly *Fucus serratus*) and feathers of sea-fowl, covered with *Lepas fascicularis*, and occasionally *L. sulcata;* and on the seaweed were also two kinds of sessile-eyed Crustacea. The wind having been previously easterly, it is difficult to say what share the wind or tide had in the drift; but it did not appear to have been caused by any circulation from the equator. The fauna nowhere showed the least trace of that wonderful and apparently restricted current known as the Gulf Stream. The beautiful Pteropod, *Clio pyramidata*, flitted about in considerable numbers; a delicate cuttle-fish (*Leachia ellipsoptera*), which is supposed to prey on *Salpæ*, was caught in the vase-sieve, as well as several specimens of a small and very slender pipe-fish or *Syngnathus*. One peculiar feature of this cruise was Rockall, an isolated and conical excrescence of the Atlantic, 70 feet high, and situate at least 200 miles from the nearest land. We lay to within a quarter of a mile of it on the evening of Saturday the 3rd of July, when fishing parties were formed, and continued their sport till midnight. The supply of fresh fish thus procured was very acceptable. The rock was inhabited by a multitude of sea-fowl; and a huge gannet perched on the highest pinnacle, looking like a sentinel, or the president of the feathered republic. On our return to Ireland, we dredged in Lough Swilly, Lough Foyle, and the North Channel, on the way to Belfast, where we arrived on the 13th of July. Here I parted with my shipmates and excellent companions, and enjoyed the hospitality and sympathy of my friends Professor Wyville Thomson and Mr. Waller.

After my part of the expedition was concluded, I went for the second time to Scandinavia, and compared notes with Dr. Koren at Bergen, Prof. Sars (now, alas! no more) at Christiania, Prof. Lovén at Stockholm, Prof. Lilljeborg at Upsala, Prof. Torell at Lund, Prof. Steenstrup and Dr. Mörch at Copenhagen, and with Prof. Möbius and Dr. Meyer at Kiel. All these zoologists had investigated the Mollusca in the Arctic and North-European seas; and the result of my interviews with them, and of examining the extensive collections in the public museums at the above places, was extremely useful in connection with the subject of the present report.

Prof. Wyville Thomson succeeded me on the 19th of July, and made a short but very successful cruise to the northern part of the Bay of Biscay, where he dredged at the extraordinary depth of 2,435 fathoms, or 14,610 feet. Some particulars of this dredging I have already given. Dr. Carpenter replaced Prof. Wyville Thomson on the 12th of August, and explored the sea-bed lying between the north of Scotland and the Faröe Isles. The depths there dredged did not exceed 650 fathoms; but the results are most interesting and important in a biological as well as physical point of view. Prof. Wyville Thomson accompanied Dr. Carpenter in the last part of the expedition. It terminated on the 7th of September.

J. GWYN JEFFREYS

(*To be continued.*)

UTILISATION OF SEWAGE

WE have been requested by the Secretary of the Committee* of the British Association on the Treatment and Utilisation of Sewage, to print the following letter, which has been sent to the Municipal Authorities throughout the country :—

22, Whitehall Place, London, S.W.
November 18th, 1869.

SIR,—I have the honour to inform you that, last year, at the meeting of the British Association at Norwich, a Committee was appointed to report on the Treatment and Utilisation of Sewage. In the first instance, a grant of £10 was placed at the disposal of the Committee, with which to defray the cost of printing and postage incidental to the collection of preliminary statistical information. Through the kindness of Her Majesty's Government, the Committee was enabled to obtain Reports respecting the methods of dealing with town refuse practised in most civilised countries, and that information has now been collected in a more complete form than hitherto existed in any country.

This preliminary work being completed, the Committee was re-appointed at the meeting of the British Association this year at Exeter, and the inquiry was considered to present such important features of social and scientific interest, that the sum of £50 was voted towards enabling the Committee to enter more fully and practically upon the investigation of this subject. The British Association being a purely scientific body, has not at its disposal funds which would be adequate or applicable for the full prosecution of this very large and pressingly-important inquiry. The Committee nevertheless desires to take advantage of the opportunity created by the British Association, to investigate the entire subject in all its bearings—whether chemical, physiological, or engineering, sanitary, municipal, or agricultural—and in a manner worthy of the body they represent.

It is unnecessary to point out the enormous importance, especially at the present time, of a full and complete investigation of this question by the light of the knowledge and experience now gained in the several departments above alluded to; but properly to carry out such an inquiry with a practical end, numerous observations, gaugings, and experiments, aided by simultaneous analyses, are essential; and these cannot be accomplished, especially the analyses, without the continued aid of efficient and therefore highly-paid assistants. Moreover, from time to time it may be necessary for the Committee to purchase extensive apparatus, and to subject various inventions and processes to a thorough and complete test; for it is the desire of the Committee, not only to ascertain, as far as possible, the causes of the sanitary inefficiency of existing works, but also to inquire into every suggestion which affords promise of practical utility, in order that this investigation may be searching, the report practical, and any recommendations that may be made authoritative.

It is the wish of the several members of the Committee to devote, to the utmost of their ability, their personal attention to the work thus sketched out; but the expenses absolutely necessary to enable them to conduct so extended an inquiry cannot but be very heavy, and, unless they are able to secure an adequate fund, they must abandon the attempt to investigate the subject in this broad and comprehensive manner. However, since there is no subject of greater practical and social importance to the public generally, and thus to the various municipal authorities and other governing bodies throughout the country, it is believed that many will share the opinion expressed at the recent meeting of the British Association at Exeter, that the existence of this Committee affords a specially favourable opportunity for such a wide inquiry, and for that reason its members confidently appeal to those authorities who are officially interested in the subject to supply the funds necessary for the investigation.

I am therefore desired to request that you will kindly submit this letter to the body you represent, and I venture to hope you will give the Committee the benefit of your good offices in procuring a subscription proportionate to the population of your town or district.

It is suggested that the subscriptions of towns of different populations might be graduated somewhat in the following proportions :—

Where the population does not exceed 10,000 .	£5	5	0
Between 10,000 and 25,000	10	10	0
Between 25,000 and 50,000	21	0	0
Between 50,000 and 75,000	30	0	0
Between 75,000 and 100,000	50	0	0
Above 100,000	100	0	0

I beg to call your attention to the accompanying list of members of the Committee, and to inform you that all public bodies subscribing not less than 5*l.* 5*s.* 0*d.* will have the benefit of the information from time to time, as the results of the inquiry partake of a conclusive character, and will receive a copy of the report of the Committee when published.

I have the honour to be, &c.,

GEORGE F. BARNES,
Honorary Secretary pro tem.

* The following are the names of the Committee:—Richard B. Grantham, Esq., M. Inst. C.E., F.G.S., Chairman; J. Bailey Denton, Esq., M. Inst. C.E., F.G.S.; J. Thornhill Harrison, Esq., M. Inst. C.E.; Benjamin H. Paul, Esq., Ph.D., F.C.S.; Professs Wanklyn, F.C.S.; William Hope, Esq. V.C.; Professor Williamson, Ph.D., F.R.S; Professor Marshall, F.R.S., F.R.C.S.; Professor Corfield, M.A., M.D.; M.C. Cooke, Esq.; and Sir John Lubbock, Bart., F.R.S., Treasurer. Subscriptions should be paid to the credit of Sir John Lubbock, on behalf of the Committee, at Messrs. Robarts, Lubbock, and Co.'s, 15, Lombard Street, London, E.C.

TELEGRAPHIC COMMUNICATION WITH FRANCE

LAST Tuesday, November 30, the S.S. *William Cory* left Greenhithe with a heavy submarine cable, to be laid between Salcombe in Great Britain and Cape Finisterre in France. This cable, 105 miles long, has just been made by the Telegraph Construction and Maintenance Company, at their works at North Woolwich, and its special object is to establish direct telegraphic communication between London and Brest, so as to expedite the transmission of messages between Great Britain and America by the French Atlantic Cable.

The new cable is very strong and heavy. The shore ends weigh 20 tons to the mile, and the deep-sea portion weighs very nearly 10 tons to the mile. It contains one conductor only, consisting of a strand composed of seven copper wires, and weighing, when twisted together, 107 pounds to the mile. The insulating medium is gutta-percha, and weighs 166 pounds to the mile. The contractors undertook that the electrical resistance of the conducting strand should not exceed 12·25 ohms per mile, and that the insulation resistance should not be less than 200 megohms (million ohms), at the standard temperature of 24 degrees centigrade. So well have the contractors done their work, that the quality of the cable is better than agreed upon, the conductivity resistance being only 11·8 ohms, and the insulation resistance nearly 400 instead of only 200 megohms per knot. The inductive capacity of this cable is as nearly as possible ·333 Farad. per mile.

The *William Cory*, since 1858, has laid many submarine cables; she carried and laid portions of the French Atlantic cables last summer, and is now employed solely in this new branch of industry. Captain Donaldson has been in charge of her throughout the whole of this period, and he took her out again last Tuesday, on which day she left Greenhithe for Salcombe. For the above details relating to the conductivity, insulation, and capacity of the cable, we are indebted to Mr. C. F. Varley, C.E., engineer to the French Atlantic Telegraph Company, who accompanies the expedition. The apparatus used in testing the cable