Monday, 15th May 1882.

PROFESSOR BALFOUR, Vice-President, in the Chair.

The following Communications were read:—

1. Exploration of the Faroe Channel, during the Summer of 1880, in H.M.'s hired ship "Knight Errant."* By Staff-Commander Tizard, R.N., and John Murray; with Subsidiary Reports on the—

<i>Echinoidea</i>	by	Professor Alex. Agassiz.
<i>Foraminifera</i>	,,	Mr. H. B. Brady.
<i>Copepoda</i>	,,	Dr. George S. Brady.
<i>Polyzoa</i>	,,	Dr. Geo. Busk.
<i>Fishes</i>	,,	Dr. A. Günther.
<i>Radiolaria</i>	,,	Professor Ernst Haeckel.
<i>Pycnogonida</i>	,,	Dr. P. P. C. Hoek.
<i>Mollusca</i>	,,	Mr. Gwyn Jeffreys.
<i>Ophiuroidea</i>	,,	Professor Theodore Lyman.
<i>Annelida</i>	,,	Dr. W. C. M'Intosh.
<i>Crustacea</i>	,,	Rev. A. M. Norman.
<i>Diatomaceæ</i>	,,	Dr. James Rae, R.N.
<i>Deposits</i>	{	Mr. John Murray.
	" {	Professor A. Renard.
<i>Asteroida</i>	,,	Mr. W. Percy Sladen.
<i>Holothurioidea</i>	,,	Dr. Hjalmar Théel.
<i>Sponges</i>	,,	Professor F. E. Schulze.
<i>Sea-water</i>	,,	Professor W. Dittmar.
<i>Rocks of N. Rona</i>	{	Mr. John Murray.
	" {	Professor A. Renard.

Communicated by Mr. Murray. (Plate VI.)

I. INTRODUCTION.

The region known as the Faroe Channel is that portion of the Atlantic Ocean to the north of the mainland of Scotland, which is bounded on the N.W. by the Faroe Islands, with their south-west-

* A short preliminary note on the cruise of the "Knight Errant," by the late Sir C. Wyville Thomson, will be found in *Nature* for September 1880.

Most of the materials for the present communication were prepared in December 1880, and handed to the late Sir Wyville Thomson. It was Sir Wyville's intention to describe the Echinoderms, write a general introduction, and arrange the whole for publication. The feeble state of his health, and the pressure of other work, prevented this intention from being carried out.

ward extending fishing-banks, and on the S.E. and S. by the Shetland and Orkney Islands, the shores of Caithness and Sutherland, and the Hebrides.

The Faroe Islands are composed of basaltic rocks, while the north of Scotland, and the Scottish Islands, are chiefly made up of Laurentian gneiss, Silurian, and Devonian rocks.

The average width of the Faroe Channel, throughout its more defined and restricted portion, that is to say, between the 100 fathom line of soundings off the coast of Scotland and the Scottish Islands, and that of the Faroe plateau, is between 80 and 90 miles, and the maximum depth rather more than 700 fathoms.

At the south-westerly end the depth increases gradually to the mean depth of the “Cable Plateau” of the North Atlantic, and towards its north-easterly extension it deepens gradually to the lowest bed of the Arctic Ocean.

Up to the time of the recent investigations the bottom was regarded as irregular, as the soundings seemed to indicate one or two dome-like elevations, rising towards the centre of the trough, to within 200 fathoms of the surface.

The Faroe Channel has acquired special interest, because, so far as England is concerned, it is the region where systematic deep-sea investigations were first carried on.

One of the most interesting results of the investigations of the “Lightning” and “Porcupine” expeditions under Dr. Carpenter, Professor Wyville Thomson, and Mr. Gwyn Jeffreys in 1868–69, was the discovery in the deeper water of the Faroe Channel of contiguous areas, having widely different temperature conditions.

This phenomenon is thus described by Dr. Carpenter :—“Among the most important results of the ‘Lightning’ expedition was the discovery of the fact that two very different submarine climates exist in the deep channel (from 500 to 600 fathoms) lying E.N.E. and W.S.W. between the north of Scotland and the Faroe banks; a minimum temperature of 32° being registered in some parts of this channel, whilst in other parts of it, at the same depths, and with the same surface temperature (never varying much from 52°) the minimum temperature registered was never lower than 46°, thus showing a difference of at least 14°” (*Proc. Roy. Soc.*, 1869, p. 453).

Dr. Carpenter calls the regions indicated above the “cold” and

“warm” areas respectively, but during these early investigations, there seems to have been no suspicion that these two areas might be separated by a submarine barrier. Two bodies of water, differing from one another by 14° Fahr., were, at this early stage of deep-sea investigations, even regarded as abutting against one another without any intervening barrier. Professor Wyville Thomson says:—
 “In the Faroe Channel the warm water forms a surface layer, and the cold water underlies it, commencing at a depth of 200 fathoms,—567 fathoms above the level of the bottom of the warm water off the Butt of the Lews. The cold water abuts against the warm—there is no barrier between them. Part of the warm water flows over the cold indraught, and forms the upper layer in the Faroe Channel. What prevents the cold water from slipping, by virtue of its greater weight, under the warm water off the Butt of the Lews? It is quite evident that there must be some force at work keeping the warm water in that particular position, or, if it be moving, compelling it to follow that particular course” (*Depths of the Sea*, p. 395).

II. ORIGIN AND OBJECTS OF THE “KNIGHT ERRANT” INVESTIGATIONS.

How these early trips of the “Lightning” and “Porcupine” in 1868–69 led to the equipment of the “Challenger” for a circumnavigating cruise is now a matter of history. One or two general considerations with regard to the movements of ocean water, which were established by the “Challenger” observations, may be here referred to, as having led to a reinvestigation of the Faroe Channel.

The waters of the ocean are everywhere in a state of movement,—not a mere state of oscillation by the tides, not a surface movement by shifting winds,—but a steady massive movement, affecting the ocean throughout its whole extent and depth.

The deeper currents are in general so slow that it is impossible to detect their movement directly by the current drag, or any other instrument which has yet been constructed. By means of the thermometer, however, these deep currents can be traced to their source, and their depth and direction determined.

Conduction takes place in masses of water with such extreme slowness, that, when a large mass of water has acquired a given temperature, it may retain it for an almost indefinite period, and move over a vast area without losing much of its heat.

The massive movement of the waters of the ocean is, broadly speaking, from the equator to the poles on the surface, and from poles to equator at the bottom—the cause of this movement being difference of density arising from varying temperature and saltness, and the direction being due to the greater specific gravity of cold than warm salt water.*

The normal distribution of temperature in the great oceans, as found by the “Challenger” may briefly be described as follows :—Towards the surface the warmest water is found, the surface layers being greatly heated by solar radiation; the water cools rapidly downwards for the first 200 fathoms, slowly down to 500 or 600 fathoms, then very slowly to the bottom, where the minimum temperature is reached. This normal vertical distribution of temperature in the ocean is, however, by no means universal.

It is frequently found that the minimum temperature is reached at several hundred or thousand fathoms above the bottom, as, for instance, in the eastern basin of the Atlantic extending along the coasts of Europe and Africa, where the temperature sinks steadily to 36·5° Fahr. at a depth of 2000 fathoms, and then this temperature extends to the bottom at 3150 fathoms. One or two remarkable instances of this abnormal distribution of temperature may be mentioned.

In the Celebes Sea, which attains a depth of 2600 fathoms, the minimum temperature (38·6° Fahr.) is reached at 800 fathoms; the Banda Sea, with a depth of 2800 fathoms, reaches its minimum temperature of 38° Fahr. at 900 fathoms; and the Sulu Sea, which is at least 2550 fathoms deep, has a uniform temperature of 50·5° Fahr. from a depth of 400 fathoms to the bottom. World wide examples of the same phenomenon were found during the “Challenger” investigations. Two neighbouring stations frequently gave water

* See papers by Prof. Tait (May 16, 1881, *Proc. Roy. Soc. Edin.*, vol. xi. p. 217), and by Profs. Marshall and Smith and Mr. Omond (read before Roy. Soc. Edin., July 3, 1882), on the effect of pressure on the maximum density point of water.

at the same depth, at temperatures differing often by many degrees.

Viewing these temperature observations with the indications given by the soundings, we arrived at the generalisation—that contiguous areas with widely different bottom temperatures were separated by submarine barriers, and that *the depth at which the minimum temperature was found in one of the areas, indicated the height of the barrier.*

The following diagram (fig. 1) will illustrate:—

Fig. 1.

The water which is cooled down in the Polar seas, and has thus acquired a high specific gravity, flows along the bottom into the deepest part of the ocean to which it can find access, as shown by the arrows. The surface of the earth below, as well as above the level of the sea is irregular, and the result of this irregularity is that masses of water meet with barriers, over which they must pass, like that represented in the diagram (A).

A barrier like this surrounding a depression, cuts off the lower and colder layers of water, and the basin beyond is filled with water at a uniform temperature by an overflow, the temperature being the same as the water at the height of the ridge, as shown in the diagram.

In any region, then, where we have different bottom temperatures in contiguous areas, and where the minimum temperature in one of the areas is reached at some distance above the bottom, we thought we had reason to believe that the point at which the minimum temperature is found indicates the height of the submarine ridge which cuts off the underflow.

This generalisation induced Captain Tizard to predict the existence

of a ridge rising to within 200 or 250 fathoms from the surface between the warm and cold areas of the Faroe Channel.

This opinion was founded upon the following considerations :—

1. If an imaginary line be drawn from North Rona to the southern end of the Faroe fishing bank, all the bottom temperatures obtained in the cold area were situated to the N.E. of this line, whilst those obtained in the warm area were to the S.W. of it.

2. The warm and cold areas had actually been traced across the channel on either side of this imaginary line with the exception of about thirty miles towards the Faroe fishing-banks.

3. That the serial temperatures in the two areas were nearly similar to the depth of 200 fathoms, but at greater depths showed a marked difference.

The whole direction of the “Challenger’s” inquiries was new, and the methods and appliances were hitherto untried ; nevertheless, a very fair general idea of many leading phenomena was acquired, and an intelligible basis was laid down for a novel section of the science of Physiography.

Our observations, however, extended over the widest areas, and were restricted to sketching in the merest outline—no single locality was exhaustively examined, no single phenomenon was thoroughly studied.

We had no opportunity of ascertaining by actual soundings the existence and continuity of any one of the ridges, the existence of which we inferred from our temperature observations.

The Faroe Channel afforded an accessible and limited area, with abnormal temperature conditions which might in a comparatively short time be examined in detail, with the probable result of a satisfactory solution of not a few questions of frequent occurrence, of great complexity and of very great interest for science.

These circumstances were set forth in a letter addressed to Sir Frederick Evans, K.C.B., hydrographer to the Admiralty, by the late Sir Wyville Thomson, dated June 16, 1880. (See *Nature*, 2nd Sept. 1880.)

Sir Frederick, whose great interest in deep-sea investigations is well known, had no difficulty, especially as soundings for the general purposes of navigation were required in this region, in recommending this matter to the favourable consideration of the Lords

Commissioners of the Admiralty, with the result that the “Knight Errant”—a hired surveying vessel employed on the west coast of Britain—was instructed to carry out this service.

The object of this cruise was (*a*) to ascertain by actual soundings (over the space between the positions, where warm and cold bottom temperatures had been obtained in the “Lightning” and “Porcupine”) whether a submarine ridge existed, (*b*) to extend our researches to those portions of the Faroe Channel hitherto unexplored, and (*c*) to obtain a few serial temperature observations and trawlings in each area.

The plan we proposed to follow in searching for this ridge, was to run sectional lines of soundings at given intervals across the channel N.E. of the warm bottom temperatures previously obtained, and southward of those in the cold area.

In this way the bottom temperature would be ascertained at each depth, and we should then gradually narrow the locality to be sounded over in looking for the ridge itself.

If we obtained a sectional line in which the bottom temperatures were all warm, we should be, according to our theory, S.W. of the ridge, but if the bottom temperatures were cold, N.E. of it.

Thus we hoped to draw the sectional lines nearer and nearer, until, either we proved the existence of the ridge, or ascertained, what appeared to us to be most improbable, that a bank of cold water was in contact with water of a much higher temperature. Having ascertained whether the ridge existed or not we proposed to devote the rest of the time to taking some serial temperature observations, dredgings, and trawlings, both in the warm and cold areas.

III. NARRATIVE OF THE CRUISE.

The “Knight Errant” arrived at Stornoway on the 24th of July 1880, and left that port again for the south on the 20th of August. During this period she made four trips to the Faroe Channel.

The original intention was to confine our attention to sounding operations. We did not, however, like to allow the opportunity to pass of taking a few dredgings and trawlings—consequently Sir Wyville supplied the ship with dredging rope, trawls, and dredges at his own expense, and Messrs. D. & W. Henderson, Engineers,

Glasgow, kindly placed one of their steam winches at Mr. Murray's disposal, and fitted it on board. Sir Wyville remained at Stornoway while some of the investigations were being carried on.

First Trip.

We left Stornoway on Monday the 26th of July, and proceeded out towards Rona Island. On Tuesday the 27th we commenced running a sectional line of soundings towards the S.W. of the Faroe Islands, and obtained on that day eight casts of the lead. The bottom temperatures were similar to those obtained by the "Porcupine" in the warm area.

At 8 P.M. the dredge was put over in 305 fathoms, the wind and sea were moderate, and the weather bright enough to allow the position of the ship to be fixed accurately by astronomical observations.

Several hauls of the tow-net were taken at intervals when sounding. Early on Wednesday the 28th July, the dredge was hauled in and found to contain stones, sponges, polyzoa, &c.

The sectional soundings were resumed, and six casts were obtained before striking the edge of the Faroe fishing-bank, the temperatures continued similar to those obtained by the "Porcupine," in the warm area.

We then proceeded to the north-eastward, and commenced running another sectional line parallel to the first and about eight miles N.E. from it. During the afternoon we obtained three soundings, two of which were in the cold area; the dredge was put over at 8 P.M. in 375 fathoms.

The day was fine but cloudy, slight swell from the eastward; the sun appeared at intervals and allowed us to determine our position with accuracy.

The dredge was hove up at 4 A.M. on the 29th July, and contained a few stones covered with serpulæ and gravel; some of the stones had on their upper surfaces a coating of peroxide of manganese, there were also a few sponges, ophiuroids, cephalopods, and gasteropods.

The sectional soundings were then continued, and three casts were taken in depths varying from 375 to 210 fathoms.

At 10 A.M. the weather, which had not been very favourable since the night before, changed for the worse, the barometer fell, and a fresh N.E. gale sprung up, which raised a high sea, and a portion

of our bulwarks was carried away. It was deemed expedient to bear up for Stornoway, and we arrived at that port on Friday afternoon, after having spent a very unpleasant four and twenty hours.

Second Trip.

The weather having settled, the "Knight Errant" left Stornoway on the 3rd of August, and on the same day carried a line of soundings from the Butt of Lewis to Sulisker Island.

While off the Butt of Lewis, we stopped to shoot some of the sea-birds and to obtain some hauls of the tow-net in the locality where the birds were feeding, in order to ascertain, if possible, the nature of their food.

During the night we dredged in 53 fathoms. The day was very fine and bright, but towards evening a dark bank of clouds rose in the S.W., and the barometer began to fall. At 10 P.M. a drizzling rain commenced and lasted throughout the night.

On Wednesday the 4th August, we commenced running a sectional line of soundings N.N.W. from Rona Islands towards the last sounding obtained on the 29th July. We took nine casts of the lead, which, with one exception, were under 300 fathoms. At 6 P.M. we had completed the second sectional line. As the barometer was steadily falling, and the weather thick, with a long westerly swell, we proceeded towards Stornoway.

Third Trip.

The "Knight Errant" left Stornoway again on the 9th of August, with a rising barometer.

A line of soundings was carried out from the Butt of Lewis towards the "Holtenia ground" of Dr. Carpenter to the north-westward. During the night of the 9th we had a S.W. gale, which necessitated our "laying to."

On the 10th we sounded and trawled in 555 fathoms. There were many animals in the trawl. We had again to lay to in the evening on account of a moderate S.W. gale and thick weather.

On the 11th we sounded and trawled in 515 fathoms. This trawl-

ing was a somewhat barren one. As our observations showed us to be ten miles from the “Holtenia ground,” we steamed to the northward, and trawled again in lat. $59^{\circ} 37'$ N., long. $7^{\circ} 19'$ W. The trawling here was rather more successful. We also obtained a serial temperature at every 50 fathoms down to 500 fathoms.

In the evening the dredge was put over for the night, the weather being fine.

On Tuesday the 12th, at 5 A.M., the dredge was hove up, and was found to be full of ooze, while to the tangles were attached numerous echini and starfishes. The ship's coal now running short we returned to Stornoway to replenish.

Fourth Trip.

We left Stornoway on Monday the 16th of August, and proceeded to Rona Island, carrying out a line of soundings. We stopped on the east side of Rona, and observing little break upon the shore, landed for a short time. The landing place is on the eastern side of the northern point of the island, where a narrow spur of moderate height projects from the higher land. It is at the entrance of a small cavern, faced by a series of natural steps, which were, in all probability, formerly used when Rona was inhabited.

The remains of a dwelling are visible in the immediate vicinity of the landing place.

The rock of Rona is composed of Laurentian gneiss, but here and there we gathered some fragments of Cambrian sandstone evidently washed up by the sea (see page 657). The power of the waves is here magnificently illustrated; all along the western side of this northern projecting point, at a height of over 50 feet above the level of the sea, is a line of stones, some of them of considerable size, which have evidently been forced up the face of the sloping cliffs during westerly gales.

The island is covered with rich turf, upon which were grazing a considerable number of sheep. There were numerous sea-birds on the cliffs, and several seals were seen near the shore.

On the western side of the projecting point on which we landed is a deep cavern, which extends to such a depth as to point to the probability of a breach being made in the not distant

future which will separate the northern spur from the rest of the island.

During our stay off the island, several casts of the lead, over an uneven rocky ground, were obtained from the ship in 7 to 8 fathoms, with the extremes of Rona S. 38° W. and N. 54° W. (mag.).

On leaving Rona we proceeded to the cold area of the Faroe Channel. At 5 A.M., on the 17th August, we sounded in 540 fathoms, and put the trawl over.

At 10 A.M. the trawl was hauled in and contained a splendid lot of animals, fishes, cephalopods, starfishes, crustacea, sponges, pycnogonids, molluscs, &c.

A tow-net attached to the trawl contained some ooze. A serial temperature sounding was afterwards obtained at every 50 fathoms to the bottom.

For the next two days the ship was engaged in running lines of soundings between Rona Island, the Nun Rock, and Cape Wrath, and left Stornoway on Friday the 20th of August for the south.

We were unfortunate in having bad weather during all these cruises. This circumstance, together with the fact that the "Knight Errant" could not carry a large supply of coal, prevented our doing so much work as was originally intended.

Some most important results were, however, obtained.

IV. RESULTS.

1. *Observing Stations, &c.*—The following (pp. 650–51) is a list of the observing stations during the cruise of the "Knight Errant," with the position, depth, nature of deposit, bottom temperatures, and meteorological observations, with serial temperatures in the warm and cold areas.

The accompanying map of the Faroe Channel shows the soundings obtained by the "Knight Errant," in block figures, thus (540), while those formerly obtained are in ordinary Roman figures. The "cold" area is coloured blue, the "warm" area pink.

2. *Wyville Thomson Ridge.*—The most important result of the "Knight Errant" investigations was the discovery of the ridge predicted from theoretical considerations.

We have named the ridge “Wyville Thomson Ridge” in honour of the late Sir Wyville Thomson.

Its position is shown on the map by the contour lines of 300 fathoms. The exact height and form of the ridge, however, has still to be determined by a series of soundings in cross sections, and this work we hope to undertake during the present season.*

If we trust to the indications given by the serial temperature soundings, we should say that the depth over the ridge cannot much exceed 200 fathoms.

The discovery of this ridge is an important fact in Physical Geography, and is in itself a sufficient justification, if justification were needed, for a thorough reinvestigation of so highly interesting a region in such close proximity to our own shores. The discovery confirms strongly the correctness of the theory that submarine ridges exist in all cases in the ocean, between adjoining areas, the bottom temperatures of which differ materially at equal depths.

What is the Geological nature of the Wyville Thomson Ridge?—Is it an outcrop of ancient rocks like those of the north of Scotland? Is it of volcanic origin? Is it the remains of an ancient moraine? We have no very definite information on this point, but such as we have seems to indicate that the last supposition is the correct one. The two dredgings on the ridge—the one about mid-channel and the other at the north end of the ridge—both gave large stones,—Cambrian sandstone, diorite, micaceous sandstone, mica schist, gneissic rock, limestone, amphibolite, chloritic rock. These were all more or less rounded, and in some cases glacial markings could be detected. The assemblage of stones altogether resembled very much what we would expect to find in a moraine heap, such as would be formed from rocks found in the north of Scotland, rather than from those found in the Faroe Islands, which are volcanic.

We know of no agent at work at present in this region which could transport these stones to their present position. When lying on the bottom many of the stones projected above the deposit; and their

* On the recommendation of the President and Council of the Royal Society of London, and the Hydrographer, the Lords Commissioners of the Admiralty have detached H.M. surveying vessel “Triton” for two months during this summer (1882), to complete the work commenced in the “Knight Errant.”

No. of Sounding.	Date.	Time.	Position.		Depth in Fathoms.	Nature of Bottom.	Bot. Temp.		Meteorological Observations.						Remarks.	
			Lat.	Long.			No. of Therm.	Reading of Therm.	Wind.	Force.	Weather.	Sea.	Barometer, unconnected.	Air.		Temp. Sea Surface.
1	1880, July 27	5.5 a.m.	59 15 N.	6 4 W.	58	gravel	O, 2 0, 6	50.0 50.8	E.N.E.	2	c.	mod.	29.818	54.5	56.2	Dredging Station No. 1.
2	"	6.50 "	59 21 "	6 19 "	88	shells	O, 2 0, 6	49.5 50.2	E.N.E.	3	f.	mod.	29.800	54.5	57.0	
3	"	8.40 "	59 28 "	6 33 "	178	hard	O, 2 0, 6	49.6 50.2	E.N.E.	3	c.	mod.	29.800	54.5	56.2	
4	"	10.40 "	59 37 "	6 43 "	400	hard	O, 2 0, 6	48.2 47.2	E.N.E.	2	b.c.	mod.	29.800	55.5	57.8	
5	"	10.45 p.m.	59 44 "	6 55 "	560	grey ooze	O, 2 0, 6	45.2 45.8	E.N.E.	2	b.c.	mod.	29.832	55.5	57.5	
6	"	3.0 "	59 51 "	7 7 "	540	hard	O, 2 0, 6	46.0 46.5	E.N.E.	2	b.c.	mod.	29.832	54.0	54.0	
7	"	5.20 "	59 58 "	7 22 "	300	mud	O, 2 0, 6	47.5 48.5	E.N.E.	2	b.c.	mod.	29.832	52.5	55.0	
8	"	7.20 "	60 4 "	7 37 "	305	mud	O, 2 0, 6	46.5 47.7	E.N.E.	1	c.	mod.	29.080	52.0	54.8	
9	"	5.40 a.m.	60 3 "	7 52 "	405	ooze	O, 2 0, 6	46.5 47.0	E.N.E.	1	c.	mod.	29.760	51.0	54.0	
10	"	7.35 "	60 11 "	7 58 "	355	sand and coral	O, 2 0, 6	43.8 45.0	East	2	c.	mod.	29.760	51.0	53.0	
11	"	9.30 "	60 19 "	8 15 "	270	sand	O, 2 0, 6	43.5 45.0	East	1	b.c.	mod.	29.760	52.0	53.5	
12	"	11.15 "	60 25 "	8 28 "	335	sand and gravel	O, 2 0, 6	41.0 41.8	E.N.E.	2	b.c.	mod.	29.760	52.0	53.8	
13	"	1.0 p.m.	60 31 "	8 37 "	245	sand, gravel, and shells	O, 2 0, 6	41.8 42.5	E.N.E.	2	b.c.	mod.	29.760	51.5	53.0	
14	"	2.30 "	60 36 "	8 43 "	120	sand	O, 2 0, 6	47.5 48.0	E.N.E.	2	o.	mod.	29.760	51.0	52.5	
15	"	4.0 "	60 41 "	8 34 "	130	sand	O, 2 0, 6	46.0 47.2	E.N.E.	2	b.c.	mod.	29.750	51.5	52.0	
16	"	5.30 "	60 36 "	8 21 "	370	mud	O, 2 0, 6	33.5 34.0	E.N.E.	2	o.	mod.	29.760	51.0	52.5	
17	"	7.10 "	60 29 "	8 19 "	375	mud	O, 2 0, 6	31.0 31.0	E.N.E.	2	o.	mod.	29.760	51.0	53.0	
18	"	6.0 a.m.	60 26 "	8 17 "	375	mud	O, 2 0, 6	31.5 31.5	N.E.	4	o.c.	mod.	29.590	50.0	53.0	
19	"	8.0 "	60 20 "	8 3 "	285	gravel	O, 2 0, 6	32.5 33.6	N.E. by E.	4	o.c.	mod.	29.560	51.0	53.0	
20	"	9.45 "	60 15 "	7 49 "	210	hard	O, 2 0, 6	47.0 48.0	N.E. by E.	4	o.c.	mod.	29.560	51.0	53.0	

21	Aug. 4	5.15 a.m.	59 19 "	6 2 "	56	sand and shells	O, 2	51.0	South	1	o.	mod.	29.710	55.0	54.5	Dredging Station No. 4. Dredging Station No. 5. Dredging Station No. 8.	
22	"	6.30 "	59 26 "	6 10 "	79	sand and shells	O, 2	51.5	South	1	o.	mod.	29.710	55.0	55.0		
23	"	8.0 "	59 34 "	6 19 "	93	sand	O, 2	50.8	South	1	o.	mod.	29.720	56.5	55.0		
24	"	9.30 "	59 41 "	6 28 "	145	sand	O, 2	49.5	South	1	b.c.m.	mod.	29.720	56.5	55.5		
25	"	11.0 "	59 49 "	6 37 "	202	sand and gravel	O, 2	48.2	South	1	b.c.m.	mod.	29.720	56.5	56.0		
26	"	0.30 p.m.	59 54 "	6 51 "	460	mud	O, 2	49.0	South	1	m.	mod.	29.720	59.0	57.0		
27	"	2.0 "	59 59 "	6 47 "	255	gravel	O, 2	47.0	South	1	m.	mod.	29.720	59.0	56.2		
28	"	3.30 "	60 02 "	7 4 "	285	sand and mud	O, 2	48.0	South	1	m.	mod.	29.720	59.0	56.5		
29	"	5.30 "	60 8 "	7 25 "	260	gravel	O, 2	47.5	S.E.	3	m.	mod.	29.690	56.8	55.0		
30	"	8.0 a.m.	59 33 "	7 14 "	555	mud	O, 2	48.0	S.W.	3	o.p.q.	westly swell	29.99	66.0	57.0		
31	"	9.0 "	59 26 "	7 19 "	515	ooze	O, 2	45.8	S.W. by W.	4	o.m.	"	30.26	65.0	56.6		
33	"	4.45 "	60 3 "	5 51 "	540	ooze	O, 2	46.5	N.N.E.	1.2	o.	smooth	30.40	57.0	56.5		
Serial Temperatures.																	
32	Aug. 11	p.m.	59 37 N.	7 19 W.	530 surface	ooze	...	...	S.W.	2	o.f.	mod.	30.32	59.0	57.0	Dredging Stations Nos. 6 and 7.	
33	" 17	a.m.	60 3 "	5 51 "	50		21	57.0	N.N.E.	1.2	o.	smooth	30.40	57.0	56.2		
					100		23	49.0									
					150		O, 6	48.8									
					200		O, 2	48.0									
					250		21	49.2									
					300		22	48.6									
					350		0	48.0									
					400		O, 6	47.5									
					450		23	47.2									
					500		O, 2	46.5									
					540 surface	ooze	...	...									
					50		O, 2	56.2	{	O, 6							
					100		O, 6	49.2									
					150		0	48.2									
					200		21	47.5									
					250		22	48.0									
					300		23	47.0									
					350		23	40.5									
					400		21	36.8									
					450		22	31.5									
					bottom		23	30.5									
							O, 2	28.0									
							O, 6	30.5									

upper surfaces were covered with a coating of peroxide of manganese, and had living *Serpulæ* attached. The line to which a stone was imbedded in the deposit was sharply marked by the manganese deposit. It would seem as if currents existed here towards the north-east strong enough to carry fine mud away from the top of the ridge, and to leave the larger stones exposed, or at least strong enough to prevent a deposit of fine mud from forming.

It is worthy of remark that we dredged no large stones in either the cold or warm area, some distance away from the ridge.

In the deposit of the warm area the average size of the mineral particles is only .15 m.m., and these are nearly all angular fragments of quartz, feldspar, &c., but no fragments of the ancient rocks of the north of Scotland of sufficient size to be detected. In the cold area the mean diameter of the mineral particles is .35 m.m., with many larger fragments of Cambrian (?) sandstone, mica schist, amphibolite gneiss, &c. (see description of deposits, pages 29–33).

3. *Temperature*.—The serial temperatures show that from the surface to a depth of a little over 200 fathoms the temperature of the water is nearly the same over both the warm and cold areas, but at greater depths there are wide differences.

Similar results were obtained by the “Porcupine” in 1869.

It is very probable that throughout the winter, the temperature at the sea surface and to the depth of 200 fathoms in this vicinity, is from 48° to 49°. This temperature is much warmer than that found in the same latitude in any other part of the North Atlantic. It is evidently, therefore, not derived from the locality or from a more northern source, but certainly comes from a southern latitude.

For these reasons we believe that the whole body of water on the south-western side of the Wyville Thomson Ridge is moving toward the north-eastward, and that the layers deeper than 200 fathoms are stopped or deflected, when they come in contact with the ridge, while those less deep than 200 fathoms flow onward to the north-eastward.

The cold water, which fills the deeper part of the basin to the N.E. of the ridge, must come from the Arctic Ocean.

Here we would point out a peculiarity in the distribution of temperature in the Faroe Channel, a peculiarity not met with in any of the regions examined during the “Challenger” expedition.

In the diagram (fig. 1) given on page 5, we have represented that the basin on the right is filled with water of a uniform temperature, which is believed to have flowed over the top of the ridge (A), so that the minimum temperature in this basin is found at a depth the same as that over the top of the submarine ridge.

In the Faroe Channel, however, as is shown in the diagram here given (fig. 2), although the water on the one side of the ridge is

Fig. 2.

warmer, at depths exceeding 200 fathoms, than that on the other side, yet on both sides of the ridge the *minimum temperature is only reached at the bottom*; the water in the right hand basin cannot, therefore, have passed over the ridge, as in the case illustrated by diagram fig. 1. Indeed we have shown that the cold water at the bottom of the N.E. basin must come from the Arctic Ocean or Spitzbergen Sea.

Along the whole eastern side of the Atlantic, from the island of Teneriffe to the Faroe Islands, the isotherm of 40° is at a depth of no less than 900 fathoms from the surface. If we except the enclosed areas of the Mediterranean, Red Sea, and Sulu Sea, this is the only part of the world where so high a temperature is found at so great a depth.

It is owing, doubtless, to the comparative shallowness of the water, that the minimum temperature on the Atlantic side of the Wyville Thomson Ridge is so high. We have every reason to believe that if the depth here exceeded 2000 fathoms the minimum temperature would be 36.5° , as in the whole eastern basin of the Atlantic.

What becomes of the underflow of cold arctic water shown by the

shaded portion of the above diagram (2)? Does any of it pass over the ridge to the west? What becomes of the excess of this cold water? At present we can give no satisfactory answer to this question. A discussion on this point may appropriately be deferred till the further observations and more detailed investigations which it is proposed to undertake during the present season have been completed.

Bearing in mind the peculiarity pointed out above as existing in the Faroe Channel, the doctrine of submarine barriers may be stated in more general terms than those used on page 4, as follows:—*A divergence of temperature between the deep waters of two contiguous areas of the ocean indicates the level of the lowest point of the ridge of a submarine barrier separating the two areas.*

4. *Surface Dredgings by means of the Tow-net.*—During each of the trips the tow-net was worked from the ship whenever the weather would permit. For several days *Acanthometræ* were enormously abundant at, and for several fathoms beneath, the surface: during our last trip to the cold area very few of them were met with. Pelagic foraminifera had never been taken near the British Islands, but relying on our “Challenger” experience, we predicted that they would be captured in the tow-net so soon as the water beyond the Butt of Lewis was reached. Our anticipations were realised. So soon as we got into true oceanic waters globigerinæ were procured in considerable abundance at the surface. Orbulinæ were rare, and we only noticed one *Pulvinulina micheliniana*. All these specimens were dwarfed, and quite similar to the dead shells found at the bottom both with regard to their size and relative frequency. These observations were quite in accordance with those made by the “Challenger” in various parts of the world. The occurrence of these surface forms in the deposits of the cold area shows that the upper layers of water are passing to the north-east; while *Globigerina borealis*, which we believe to be an arctic surface species, does not apparently occur in the warm area deposits, this would seem to show that the arctic water does not pass over the ridge to the south-west.

On one occasion, several miles off the Butt of Lewis, we spent some hours in examining a portion of the sea where numerous puffins, gannets, razorbills, and other birds were feeding, one of those

places, in short, where fishermen go to shoot their herring nets, guided by the presence of the birds and other animals. Here, within one or two fathoms of the surface, the tow-net gave only a few Copepods, Diatoms, and Echinoderm larvæ. When, however, the tow-net was dragged at a depth of from 7 to 10 fathoms, it came up filled and covered with a mass of beautiful yellow or orange-coloured slime. This, on examination, was found to be composed of immense multitudes of *Peridinium tripos*. We may remark that none of these were *in catena*; whereas in the open ocean and more southern latitudes, these organisms are frequently met with in chains consisting of nine or ten individuals. Although these *Peridinia* are often regarded as flagellate infusorians, yet we could never detect either a flagellum or cilia, though we have observed them for several years. Indeed they seem to be undoubted algæ, and their production in enormous abundance most probably depends on certain conditions of sunlight and temperature. Another haul of the tow-net at a depth exceeding 10 fathoms, gave vast numbers of the *megalopa* stage of crabs, together with a good many Copepods, Amphipods and larval fish. The stomachs of these Crustaceans were filled with *Peridinia*, so that these minute Algæ supplied them with food. The herring and mackerel, which we procured from the fishermen, had their stomachs filled with these minute Crustaceans. The birds, again, were feeding upon the herring. Dolphins, whales, and dog fish were also busy upon the same ground, but, unfortunately we had no opportunity of examining their stomachs.

We have here a chain of phenomena, which if carefully worked out, might give much information concerning the habits of many of our food fishes. The abundance of *Peridinia* gives food for the minute animals which are in a process of development in the ocean, and these again serve as food for our edible fishes. A knowledge of the food supply of these fishes, indeed, and of the conditions to which it is subject, would probably give the key to the solution of the mystery which at present surrounds the migrations of many of these fishes. That knowledge can best be acquired by a diligent and continued use of the tow-net, together with an examination of the stomachs of the fish. In the stomach of the herring and mackerel which we examined during our cruises the following were observed :—Young of herring, sprat and other fish, *Zoeas* of crabs,

Galathea, *Algæ*, *Mysis*, *Euphausia*, *Thysanopoda*, *Hyperia*, *Cythere*, *Lemora*, *Evadne*, *Larvæ* of Molluscs, *Sagitta*. The Schizopods were sometimes very numerous in the stomachs.

Dr. James Rae, R.N., gives the following list of Diatoms from the "Knight Errant" surface gatherings :*—

<i>Coscinodiscus concinnus.</i>	<i>Hemidiscus cuneiformis.</i>
„ <i>radiatus.</i>	<i>Rhizosolenia</i> , sp. (?).
„ <i>oculus iridis.</i>	<i>Chetoceras</i> , sp. (?).
<i>Campylodiscus costatus.</i>	

Professor Ernst Haeckel gives the following list of Radiolaria :—

<i>Acanthometra.</i>	<i>Rhizosphaera.</i>	<i>Actinocyrtis.</i>
<i>Xiphacantha.</i>	<i>Actinomma.</i>	<i>Amphilonche.</i>
<i>Dorataspis.</i>	<i>Spongocyrtis.</i>	<i>Spongodiscus.</i>
<i>Ethmosphaera.</i>	<i>Thalassicolla.</i>	<i>Thalassosphaera.</i>
<i>Heliosphaera.</i>	<i>Calcaromma.</i>	

Dr. George Brady gives the following list of Copepoda and Cladocera :—

<i>Oithona spinifrons?</i>	Boeck.
<i>Calanus finmarchicus.</i>	Gunner.
<i>Temora longicornis.</i>	Müller.
<i>Dias longiremis.</i>	Lilljeborg.
<i>Eucalanus attenuatus.</i>	Dana.
<i>Centropages typicus.</i>	Kroyer.
<i>Anomalocera patersonii.</i>	Templeton.
<i>Evadne nordmanni.</i>	
<i>Pleopis polyphemoides.</i>	Lovén.

* In a letter Mr. E. Grove gives me the following additional diatoms from the "Knight Errant" surface gatherings in the Faroe Channel :—

<i>Hyalodiscus maculatus.</i>	(Podosira, W.S.)
<i>Coscinodiscus centralis.</i>	(1 specimen only.)
<i>Melosira sulcata.</i>	(scarce.)
<i>Actinophychus undulatus.</i>	(1 specimen only.)
<i>Actinocyclus ehrenbergii.</i>	(1 fragment.)
<i>Biddulphia mobiliensis</i> , Bail.	(scarce.)
<i>Rhizolenia styliformis.</i>	(frequent.)
„ <i>alata.</i>	(not unfrequent.)
„ <i>imbricata?</i> var.	(scarce.)
<i>Chaetoceras decipiens?</i> Cleve.	(common.)
(? <i>Chaet. bacillaria</i> , Bailey.)	
<i>Chaet. boreale</i> , Bail.	(scarce.)
„ var. <i>brightwellii</i> , Cleve.	(frequent.)
<i>Navicula distans.</i>	(1 specimen.)
<i>Pleurosigma directum</i> , Grun.	(frequent.)
(Scarcely sigmoid, has appearance of a <i>Navicula</i> .)	
<i>Synedra thalassiothrix</i> , Cleve.	(frequent.)

In addition to the above the following were observed :—

<i>Globigerina bulloides.</i>	}	See Mr. H. B. Brady's Report.
<i>Globigerina inflata.</i>		
<i>Orbulina universa.</i>		
<i>Pulvinulina micheliniana</i> (one).		

Salpæ, Sagittæ, Schizopods, Amphipods, larvæ of *Membranipora*, Lamellibranch, Gasteropod and Echinoderm larvæ, *Peridinium tripos*, and Coccospheres.

5. *Dredgings, Trawlings, and Soundings.*—For convenience of reference and comparison we divide these into (a) those on the plateau surrounding North Rona and Sulisker, (b) those in the warm area, (c) those in the cold area, and (d) those on the Wyville Thomson ridge.

(a.) *On the Plateau surrounding North Rona and Sulisker.*

(1) *Soundings.*—A great many soundings were taken on the plateau which surrounds North Rona, and between it and the Butt of Lewis and Cape Wrath. The depths were from 30 to 80 fathoms, the average being about 50 fathoms.

The bottom was sometimes a fine calcareous sand, sometimes a quartz sand, and sometimes a fine gravel. These varieties of deposits occurred without any apparent relation to depth. Generally the particles were more or less rolled, and all the materials collected on this plateau out to the 100 fathom line, gave the impression that they were often set in motion and frequently sorted by the action of waves and currents. None of the soundings indicated the presence of mud or argillaceous matter.

The calcareous particles were composed of broken and rolled fragments of mollusc shells, polyzoa, Annelid tubes, echinoderms and foraminifera.

The sandy particles were chiefly rounded fragments of quartz, with some pieces of mica, hornblende, and feldspar.

The gravel was composed of rolled pieces of the older rocks, as amphibolic gneiss, Cambrian sandstone, diorite, and pieces of jasper.

The following were the percentages of carbonate of lime in four of these soundings :—

S.S.W. of	{	3rd August.	53 fathoms.	80·15 per cent.
North Rona	{	3rd „	59½ „	31·54 „
W. of	{	18th „	43 „	77·00 „
North Rona	{	18th „	54 „	22·61 „

(2) *Dredgings*.—Two hauls of the dredge were taken N.N.W. of North Rona on the 3rd and 4th August 1880. Lat. 59° 12' N., long. 5° 57' E., in 53 fathoms.

1st haul.—The dredge was lowered at 5.30 p.m. and hauled in again at 8 p.m., it had two swabs and a tow-net attached. The bag of the dredge and the tow-net attached were filled with sand and gravel, and several echini, starfish, ophiurids, polyzoa, lamellibranchs, annelids, hydroids, and attached foraminifera.

2nd haul.—The dredge, with swabs, was put over at 9.30 p.m. on the 3rd, and hauled in at 3.30 a.m. on the morning of the 4th August. The bag of the dredge was burst, or rather the lower surface had been torn away by passing over rough ground, one swab was carried away, and the other was covered with polyzoa. In the dredge and on the swab were several starfish, one comatula, ophiurids, crustacea, gasteropods, and lamellibranchs, many polyzoa, cirripeds, pycnogonids, sponges, hydroids, and attached foraminifera.

The largest pieces of rock were about 4 centimetres in diameter, and all the fragments were more or less rounded.

The following were the principal varieties of rocks observed :—

1. Mica-schist, composed of alternate bands of feldspar and quartz with mica.
2. Quartzite.
3. Micaceous quartzite (Cambrian?).
4. Red micaceous sandstone.
5. Limestone.
6. Syenitic rock containing feldspar and hornblende, quartz, passing to amphibolite.
7. Large grained sandstone (Cambrian?), containing feldspar.
8. Arkose, containing quartz, feldspar, and Muscovite.

The sand is composed of grains of quartz, more or less rounded, feldspar grains are much less abundant, hornblende, small fragments of rocks, quartzite, sandstone, amphibolite. The sand seems to come from the decomposition of granite and gneiss. It is strange, however, that mica appears to be quite absent. We subjoin a list of the animals obtained.

Mollusca.

<i>Circe minima.</i>	Montagu.
<i>Venus fasciata.</i>	Da Costa.
<i>Tapes virgineus</i> (young).	Linné.
<i>Tellina crassa.</i>	Gmelin.
<i>Psammobia costulata.</i>	Turton.
<i>Macra solida</i> , var. (<i>elliptica</i>).	L.
<i>Saxicava rugosa</i> , var. (<i>arctica</i>).	L.
<i>Eulima polita.</i>	L.
<i>Natica montacuti</i> (montagui).	Forbes.
<i>Aporrhais pes-pelecani.</i>	L.

Asteroidea.

<i>Luidia sarsii.</i>	Düb. & Kor.
<i>Porania pulvillus.</i>	O. F. Müll.
<i>Cribrella oculata.</i>	Linck.
<i>Crossaster papposus.</i>	Linck.
<i>Asteracanthion rubens.</i>	Linné.
„ <i>mülleri.</i>	Sars.

Crustacea.

<i>Stenorhynchus longirostris.</i>	Fabr.
<i>Hyas coarctatus.</i>	Leach.
<i>Ebalia tuberosa.</i>	Pennant.
<i>Munida rugosa.</i>	Fabr.
<i>Ligia oceanica.</i>	
<i>Eurydice truncata.</i>	Norman.
<i>Scalpellum vulgare.</i>	Leach.
<i>Balanus.</i>	

Pycnogonida.

<i>Pycnogonum littorale.</i>	Ström.
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Annelida.

<i>Lagisca propinqua.</i>	Mgn.
<i>Evarne</i> , n.s.p.	
<i>Glycera capitata.</i>	Ørsted.
<i>Onuphis bilineata.</i>	Baird.
<i>Lumbriconereis fragilis.</i>	O. F. M.
<i>Ditrypa arietina.</i>	O. F. M.
<i>Serpula vermicularis.</i>	L.

Echinoidea.

<i>Echinus norvegicus.</i>	Düb. & Kor.
„ <i>acutus.</i>	Lamk.
„ <i>melo.</i>	Lamk.
<i>Echinocyamus pusillus.</i>	Gray.
<i>Spatangus purpureus.</i>	Leske.
<i>Echinocardium flavescens.</i>	A. Ag.
„ <i>pennatifidum.</i>	Norm.

Ophiuroidea.

<i>Ophiocoma nigra.</i>	Müll. and Tr.
<i>Ophiopholis aculeata.</i>	Gray.
<i>Ophiothrix pentaphyllum.</i>	Ljn.

Hydroida.

<i>Thuiaria thuia.</i>	
<i>Tubularia indivisa.</i>	

Other Hydroids.

Porifera.	
<i>Tetilla cranium.</i>	Müll.
Crinoidea.	
<i>Antedon rosacea.</i>	
Polyzoa.	
<i>Bugula flabellata.</i>	J. V. T.
„ <i>plumosa.</i>	Pallas.
<i>Flustra foliacea.</i>	Linn.
<i>Cellepora ramulosa.</i>	Linn.
<i>Cellepora avicularis.</i>	Hincks.
<i>Eschara compressa.</i>	Sowerb.
<i>Retepora beaniana.</i>	King.
<i>Salicornaria farciminoidea.</i>	Solander.
<i>Lepralia unicornis</i> , var. <i>ansata.</i>	
<i>Porella levis.</i>	Fleming.

(b.) Soundings, Dredgings, and Trawlings in the Warm Area.

Sounding No. 5 and dredging stations 4, 5, 6, and 7 are all in the warm area, and are all within a few miles of each other. The depths are nearly the same, and the general character of the deposit in each case is similar.

Station 4. 10th August. 555 fathoms. Lat. 59° 33' N., long. 7° 14' W. Bottom temperature, 44·4°; surface temperature, 57·0°.

A small quantity of a grey calcareous mud came up in the sounding tube. Trawl without swabs or tow-nets was used. It was put over at 8.30 A.M., and hauled in at 11.30 A.M. There were in it several fish, several hundred holothurians, crustacea, annelids, &c., as follows :—

Pisces.	
<i>Chimæra monstrosa.</i>	L.
<i>Cottus thomsonii</i> , n. sp.	
<i>Haloporphyrus lepidion.</i>	Risso.
<i>Macrurus</i> , sp. n. (probably young of <i>M. trachyrhynchus</i>).	
Echinoidea.	
<i>Phormosoma uranus.</i>	Wyv. Thom.
„ <i>placenta.</i>	„ „
Asteroidea.	
<i>Mimaster tizardi</i> , n.gen. and sp.	
Actinia.	
<i>Actinia.</i>	
Holothurioida.	
<i>Lætmogone violacea</i> (about 300 speci- mens).	} Thél.
<i>Stichopus</i> (?) <i>tizardi</i> , n. sp.	

Crustacea.

Munida tenuimana.

G. O. Sars.

Nephropsis atlantica, n. sp.

Annelida.

Empty chitinous tube.

Station 5. 11th August. Lat. 59° 26' N., long. 71° 19' W. 515 fathoms. Bottom temperature 45·4°; surface temperature, 56·6°.

The trawl had a tow-net attached to the beam, but without swabs, and without a bag in the bottom of the trawl. It was put over at 9 A.M., and hauled in at 11.30 A.M.

The tow-net came up with a small quantity of mud, some surface organisms, and in the trawl there were some crustacea, holothurians, and annelids, &c., as follows :—

Mollusca.

Fusus sarsi (young).

Jeffreys.

Holothuriodea.

Lætmogone violacea.

Théel.

Crustacea.

Dorhynchus thomsoni.

Norman.

Amathia carpenteri.

Norman.

Munida tenuimana.

G. O. Sars.

Pycnogonida.

Nymphon stræmii.

Kröyer.

Annelida.

Evarne johnstoni.

M'Intosh.

Nemerteans (*Enopla* and *Anopla*).

Crinoidea.

Rhizocrinus lofotensis.

M. Sars.

Ophiuroidea.

Ophiacantha tridentata.

Ljn.

Echinoidea.

Echinus (?).

Stations 6 and 7. 11th August. 530 fathoms. Lat. 59° 37' N., long. 7° 19' W. Bottom temperature, 46·5°. Surface temperature, 57·0°.

1st haul.—No sounding was taken, the position being the same as that of a "Porcupine" station in 1869, giving a depth of 530 fathoms.

The trawl was put over at 2 P.M., and hauled in at 6.30 P.M. with tow-net attached to the beam, but no bag in the bottom of the trawl

nor swabs were used. In the tow-net there was a little of the deposit evidently knocked up by the action of the trawl in passing over the bottom, and in the trawl were many animals.

2nd haul.—Dredge with two swabs attached was put over at 8 P.M. on the 11th, and hauled in at 4 A.M. on the 12th August. The bag of the dredge was full of a grey mud (about 40 litres) with Echinoderms, Annelids, Gasteropods, &c.

*Description of the Deposit.**

GREY MUD coherent, finely granular, homogeneous, earthy, calcareous, has a greenish tinge when wet.

* The description of these deposits has been made upon the plan which we have adopted in our work in preparation upon the oceanic deposits, to form one of the reports on the scientific results of the "Challenger" expedition.

This is not the place to develop the reasons which have guided us in adopting this mode of description, or to expose, in detail, the methods which we have systematically employed for all the sediments which we are engaged in describing. These will be given in great detail in the introduction to our "Challenger" report. We limit ourselves here, in order to facilitate the comprehension of our descriptions, to describe the order of our tables, and to explain the meanings and arrangement of terms and abbreviations.

The description commences by indicating the kind of deposit (red clay, grey mud, globigerina ooze, &c.), and comprises the microscopic determination of the characters of the deposit, when wet or dry.

When we have not given a complete analysis of the deposit, we have always determined the amount of CARBONATE OF CALCIUM. This determination was generally made in estimating the carbonic acid. We took usually, for this purpose, a gram of the substance, and calculated in this manner the carbonate of calcium. Weak and cold hydrochloric acid was used. However, as, independent of the carbonate of calcium, the deposits often contain carbonates of magnesia and iron, the results calculated in placing the carbonic acid to CaO are not perfectly exact. These carbonates of magnesia and iron are almost always in very small proportion, and the result of the process gives that degree of accuracy which we think necessary. The number which follows the words "carbonate of calcium" indicates the percentage of CaCO_3 ; we then give the general designations of the principal calcareous organisms forming the carbonate of lime in the deposit. The part insoluble in the acid, after the determination of the carbonic acid, is designated in our descriptions by the name RESIDUE. The number which follows this word indicates its percentage in the deposits; then follow the colour and principal physical properties. This residue is washed and submitted to regular decantations, which permit the several elements of this insoluble portion being separated according to their density. We divide these portions into three groups—(1) *Minerals*, (2) *Siliceous Organisms*, (3) *Fine Washings*.

1. *Minerals*.—The number within brackets indicates the percentage of particular minerals and fragments of rocks. This number is the result of an

CARBONATE OF CALCIUM 32·72 per cent., consists of Coccoliths, Coccospheres, Globigerinas, Pulvinulinas, Orbulinas, Nodosarias, Truncatulinas, Nonioninas, &c. Fragments of Echini, Molluscs, Ostracodes, one or two Pteropod fragments.

RESIDUE 67·28 per cent., greyish-brown, consists of—

Minerals [40·00], *m. di.* 0·1 mm., almost all angular; quartz, hornblende, augite, magnetite, volcanic glass, glauconite, feldspar.

Siliceous organisms [5·00]: Diatoms, Radiolarians, Sponge spicules, and a few glauconitic casts of Foraminifera.

Fine washings [22·28]; argillaceous matter with minute fragments of minerals and siliceous organisms.

Remarks.—The larger portion of the mud was passed through fine

approximate valuation, of which we will give the basis in our report. As it is important to determine the dimensions of the grains of minerals which constitute the deposit, we give, following the contraction *m. di.*, their mean diameter in millimetres. This evaluation is made with the micrometer. We give next the form of the grains, if they are rounded, &c., then follows the enumeration of the species of minerals and rocks. In this enumeration we have placed the minerals in the order of the importance of the rôle which they play in the deposit. The specific determinations have been made with the microscope, and with the aid of Nicol's prisms, by parallel or convergent light.

2. *Siliceous Organisms.*—The number between brackets indicates the percentage of siliceous organic remains. We obtain it in the same manner as that placed after the word *Minerals*. The siliceous organisms and their fragments are examined with the microscope. We have also placed under this heading the glauconitic casts of the foraminifera and other calcareous organisms.

3. *Fine Washings.*—We designate under this name the particles which, resting in suspension, pass with the first decantation. They are about 0·05 mm. or less in diameter. We have not been able to arrange this microscopic matter under the category of *Minerals*, because at this small size it is impossible to determine the species. We have always found that the *Fine Washings* is in considerable quantity as the deposit passes to a clay, and it is from this point of view that the subdivision has its *raison d'être*. We often designate the lightest particles by the name argillaceous matter, but usually there are associated with this very small fragments of indeterminable minerals, and fragments of siliceous organisms. The number within brackets which follows the words *Fine Washings* is obtained in the same manner as the similar numbers referred to in the two preceding paragraphs.

These few words will suffice to render our descriptions intelligible. Greater details will be given, as already stated, in our larger work. We may add that in the majority of cases we have solidified the sediments and formed them into thin slides for microscopic examination, and that at all times the examination by transmitted light has been carried on at the same time as the examination by reflected light. Each description is followed by notes upon the dredging or sounding, upon the animals collected, and a discussion of the analysis whenever a complete analysis has been made.

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sieves, and the washings thus obtained consisted of sandy and calcareous Foraminifera, small Gasteropod and Lamellibranch shells, a few fragments of Pteropod shells, worm-tubes, sponge spicules, a few Radiolaria, and grains of quartz.

When the mud itself is passed between the finger and thumb small hard particles are felt.

Chemical analysis gave the following :—

From Station 4. Sounding tube. 555 fathoms.

Insoluble in HCl,	.	.	.	.	.	69·43
Soluble in HCl {	Al ₂ O ₃ - Fe ₂ O ₃ ,	.	.	.	.	1·17
	CaCO ₃ - MgCO ₃ ,	.	.	.	.	28·96
						<hr/> 99·56 <hr/>

Microscopically examined, the carbonate of calcium appears to make up fully one-half of the deposit in bulk, and consists almost entirely of the dead shells of Globigerina, Pulvinulina, and Orbulina, along with Coccoliths and Coccospheres, which have fallen from the surface to the bottom. Many other genera of Foraminifera, as Textularia, Uvigerina, Nonionina, Truncatulina, Nodosaria, &c., together with fragments of Polyzoa, Echinoderms, Gasteropods, Lamellibranchs, Pteropods, and Cypridina valves were observed, but these do not seem to make up more than 2 per cent. of the total quantity of carbonate of lime in the deposit.

The insoluble residue is essentially composed of grains of quartz, often covered with hydrate of iron, and having a diameter of .5 mm., associated with these are many black particles, which may be extracted by the magnet and are magnetic iron, while others are particles of mica and hornblende.

There are numerous glauconitic casts of Foraminifera and other organisms of a yellow and greenish tinge; radiolarians and sponge spicules are also present.

When the deposit is hardened and made into thin microscopic slides, it can be observed that the quartz is of clastic origin, and generally rounded or of an irregular shape, the black mineral particles are seen to be transparent, green, dicroscopic, and formed of biotite. The magnetic iron and hornblende particles are much less abundant than the mica, one rarely sees the cleavage characteristic of hornblende; some small particles of a blue colour, very dicroscopic, might

be referred to tourmaline ; some of the arenaceous Foraminifera are uniformly coloured red.

List of the Animals taken at these Stations.

Pisces.

<i>Haloporphyrus lepidion.</i>	Risso.	Stat. 6.
<i>Brosmius brosme.</i>	Müll.	„

Mollusca.

<i>Amussium hoskynsi.</i>	Forbes	„
<i>Aporrhais serresianus.</i>	Michaud.	„
<i>Fusus fenestratus.</i>	Turt.	„
<i>Fusus berniciensis</i> , var. (<i>elegans</i>).	King.	„
<i>Arca pectunculoides.</i>	Sc.	Stat. 7.
<i>Leda lucida.</i>	Lov.	„
„ <i>frigida.</i>	Torell.	„
<i>Nucula tumidula.</i>	Malm.	„
„ <i>corbuloides.</i>	Seguenza.	„
<i>Cardium minimum.</i>	Ph.	„
<i>Næra striata.</i>	Jeffr.	„
„ <i>obesa.</i>	Lov.	„
<i>Hela tenella</i> (young).	Jeffr.	„
<i>Natica montacuti</i> (young).	Forbes.	„
<i>Aporrhais serresianus</i> (young).	Mich.	„
<i>Cerithium metula.</i>	Lov.	„
<i>Columbella halizæti.</i>	Jeffr.	„
„ <i>costulata.</i>	Cant.	„
<i>Cylichna alba.</i>	Brown.	„
„ <i>ovata.</i>	Jeffr.	„

Echinoidea.

<i>Spatangus purpureus</i> (young) ? ?	Leske.	Stat. 6.
<i>Phormosoma placenta.</i>	W. Th.	„
<i>Porocidaris purpurata.</i>	W. Th.	Stat. 7.
<i>Dorocidaris papillata.</i>	A. Ag.	„
<i>Echinus norvegicus.</i>	Düb. & Kor.	„

Ophiuroidea.

<i>Ophioglypha aurantiaca.</i>	Vll.	Stat. 6.
<i>Ophiactis abyssicola.</i>	Ljn.	Stat. 7.

Holothurioida.

<i>Lætmogone violacea.</i>	Théel.	Stat. 6.
<i>Thyone raphanus.</i>	Düb. and Kor.	Stat. 6 & 7.
<i>Stichopus</i> (?) <i>tizardi.</i>	n. sp.	Stat. 6.
<i>Echinocucumis typica.</i>	Sars.	Stat. 7.

Crustacea.

<i>Geryon tridens.</i>	Kröyer.	Stat. 6.
<i>Munida tenuinana.</i>	G. O. Sars.	Stat. 6 & 7.
<i>Amathia carpenteri.</i>	Norman.	Stat. 7.
<i>Eurydice polydendrica.</i>	N. & Stebbing.	„
<i>Haploops setosa.</i>	Boeck.	„
<i>Ampelisca compacta.</i>	n. sp. (?)	„

Pycnogonida.

<i>Nymphon strömii.</i>	Kröyer.
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Annelida.		
<i>Nothria</i> (small).		Stat. 6
Empty muddy tubes.		"
<i>Aphrodita aculeata</i> .	L.	Stat. 7.
<i>Læmonice filicornis</i> .	Kbg.	"
<i>Leanira hystericis</i> .	Ehlers.	"
<i>Maldane</i> , near <i>sarsi</i> .	Mgn.	"
<i>Ampharete arctica</i> .	Mgn.	"
<i>Hydroides norvegica</i> .	Gunn.	"
<i>Protula</i> (fragt.).		"
Asteroidea.		
<i>Archaster bifrons</i> .	Wyv. Thom.	"
<i>Astropecten andromeda</i> .	Müll. & Tr.	,
Porifera.		
<i>Holtenia</i> , sp.?		
Crinoidea.		
<i>Rhizocrinus</i> , fragt.		"
Pennatulida.		
<i>Kophobelemnion mülleri</i> (?)	Sars.	Stat. 6 & 7.
<i>Pennatula rosacea</i> .		Stat. 7.
,, sp.		

Sounding 5. 27th July 1880. Depth, 560 fathoms.

GREY MUD with slight greenish tinge, plastic, granular, calcareous, earthy, with small hard particles.

CARBONATE OF CALCIUM 27·36 per cent., consists of Coccoliths, Coccospheres, Globigerinas, Pulvinulinas, Uvigerinas, Cassidulinas, Nonioninas, Nodosarias, &c., fragments of Echini, Ostracode valves.

RESIDUE 72·64 per cent., brownish-grey, consists of—

Minerals [55·00], m. di. 0·15 mm., a few particles nearly ·5 mm.; quartz, hornblende, mica, feldspar, glauconite. The quartz grains are often rounded, the other particles are angular.

Siliceous organisms [2·00]: Diatoms, spicules of Sponges, and casts of Foraminifera of a pale yellow-green colour.

Fine washings [15·64]; argillaceous matter with fragments of siliceous organisms and minute mineral particles.

(c.) *Dredgings and Trawlings in the Cold Area.*

Station 8. 17th August. 540 fathoms. Lat. 60° 3' N., long. 5° 51' W. Bottom temperature, 29·2°. Surface temperature, 56·5°.

In the sounding tube there was a small quantity of blue mud.

The trawl was used with a swab at one end and a tow-net at the other end of the beam, and a bag at the bottom of the netting. In the tow-net there was about a litre of mud, and about 5 litres in the bag of the trawl. In the trawl there were, besides many hundreds of pycnogonids, many fish, some starfish, ophiuroids, echini, &c.

BLUE MUD with greenish tinge, grey when dry, sandy, calcareous.

CARBONATE OF CALCIUM 12·75 per cent., consists of many *Coccoliths* and *Coccospheres*, *Globigerinas*, *Pulvinulinas*, *Nonioninas*, *Lagenas*, &c., fragments of *Echini*, *Ostracodes*, *Molluscs*.

RESIDUE 87·25 per cent., consists of—

Minerals [65·00], m. di. ·3 mm., with some particles over 1 mm., often rounded; quartz, often covered with oligist, augite, hornblende, magnetite, mica, fragments of ancient and recent rocks.*

* We will not seek here to justify in detail the employment of the terms *ancient* and *recent* rocks, but limit ourselves to indicating the meaning which we give to these terms, and the reasons which have guided us in introducing into our descriptions this subdivision of massive crystalline rocks into two groups. This is not the place to enter into the discussion, which is being carried on at the present time among a certain number of lithologists, as to whether the same denomination ought to be applied to the same lithologic type without respect to its geological position.

Whatever may be the issue of these discussions, it remains, nevertheless, true, that there exist certain minute details of structure, and certain characters in the constituent minerals of rocks, differences, in short, sufficiently important to indicate generally if a massive crystalline rock belongs to ante-tertiary or tertiary and post-tertiary periods. If, as we think, these two groups can be practically distinguished, even although they present insensible transitions from one to the other, then it is important, for an exact knowledge of the origin of sediments, to take this division into consideration in our descriptions of marine deposits. These sediments we know include at the same time rocks and free minerals produced by the disintegration of these rocks. If we are able to apply the distinction into ancient and recent rocks, then we ought, in a certain sense, to be able to tell whether the isolated minerals found in the deposit come from the one or the other type of rock. We should be able, by the aid of this distinction, to determine with probability whether the mineral fragments found in deposits come from continents, are the result of submarine eruptions, or have been carried by floating ice, &c.

Notwithstanding the care which has been taken to establish these distinctions, we are often unable to pronounce with certainty; for, as we have said, the distinctive characters which we have alluded to are not so well marked, the fragments which are present in the deposits are very minute, and many of the finer details have been removed by decomposition. As to the minerals, with which we have more frequently to deal than with the rocks them-

Siliceous organisms [3·00]: Sponge spicules, Diatoms and Radiolarians, and one or two pale glauconitic casts.

Fine washings [19·25]; argillaceous matter with minute fragments of minerals, diatoms, and other siliceous organisms.

Remarks.—When the mud is passed between the fingers many gritty particles are found to be present. These can be observed generally to be fragments of quartz and rocks.

Chemical analysis gave the following:—

Insoluble in HCl,	.	.	.	.	.	84·55
Soluble in HCl {	Al ₂ O ₃ -	Fe ₂ O ₃ ,	.	.	.	1·22
	CaCO ₃ -	MgCO ₃ ,	.	.	.	14·34
						<hr/>
						100·11
						<hr/>

The carbonate of lime appears to make up about one-fourth of the deposit in bulk, and consists almost wholly of pelagic Foraminifera, Coccoliths, and Coccospheres, the same as found at the stations in the warm area.

Mixed up with these are a few of the bottom living Foraminifera and fragments of Echinoderms. The insoluble residue is essentially

selves, the difficulty is still greater, on account of their isolated condition and the physico-chemical actions which they have undergone. However, we are often aided by their association with fragments of rock, whose classification is possible; by their being sometimes seen, on microscopic examination, to be bordered by remains of the rock of which they were formerly an integral part; and by their geographical position (which point is also applicable to the determination of the age of fragments of rocks). Whatever we may think of the causes of the characteristic differences of these two lithologic groups, this distinction offers, none the less, a very practical advantage, and if it is applied with care, it throws some light on the interpretation of the facts with which we have to deal.

We cannot dwell, in this note, upon the diagnostic characters which we have employed; we will return to that in the introduction to our Report on the deposits collected during the "Challenger" expedition. As we have had, especially, to study very minute fragments of rocks and of isolated minerals, questions relative to the structure of rocks, properly so called, have been considered only in a subsidiary manner. We give some of the characters which have guided us in the classification into the two groups. We repeat that these peculiarities have only a relative value, and we do not regard them as absolutely conclusive in every case.

We may add that it is especially on the microscopic examination that we have relied for our determinations.

Column I. presents the characters of the principal minerals of *ancient* rocks

composed of quartz grains, of which some are milky, and a good many are covered with hydrate of iron. Associated with the quartz are many black particles of hornblende, mica, magnetite, and yellow and

—ante-tertiary, the second (II.) those of *recent* rocks—tertiary and post-tertiary. We only mention those minerals which are found in the deposits.

I.

Quartz—containing many liquid enclosures.

Orthoclase—without inclusions or rare liquid inclusions, dull aspect, and milky colour, crystals tabular and thick, Carlsbad twins.

Microcline.

Plagioclase—in general aspect dull, decomposed in micaceous substance into epidote, in pinitoïde, in fibro-radiate zeolithic matter, in quartz, in calcite.

Pyroxene—enstatite, bronzite, diallage and augite, the latter very often decomposed, transformed into ouralite.

Amphibole—greenish colour, often decomposed into epidote, &c., associated with quartz and calcite; fibrous forms, extremely irregular (Hypersthene).

Muscovite.

Wanting.

Wanting.

Wanting.

Tourmaline.

Anatase, Rutile, Brookite.

Cordierite.

II.

Quartz—containing vitreous enclosures.

Sanidine—many vitreous and gaseous inclusions, aspect vitreous and brilliant, structure zonary, characteristic cracks independent of the cleavage; cleavage following $\infty P \infty$. Baveno twins.

Wanting.

Plagioclase—(Microtine), aspect vitreous, in general decomposition less advanced in the Microtine than in the plagioclases of ancient rocks; vitreous and gaseous enclosures more frequent and better marked; enclosures of associated minerals, &c.

Pyroxene—especially augite, slightly decomposed; numerous vitreous enclosures, especially in the augites of basalts, zonary.

Amphibole—deep brownish tint, generally with crystallographic contours more marked, zones of different colours, sections surrounded with magnetite, compact, numerous inclusions.

Wanting or secondary.

Trydimite.

Leucite.

Nosean and Hauyne.

Zeolithes.

Wanting.

Wanting.

Extremely rare.

It is scarcely necessary to mention that all the foregoing refers only to massive crystalline rocks, and when the minerals are in an isolated state we cannot always say whether they come directly from these rocks, or from the disintegration of sedimentary layers, or from schisto-crystalline rocks. These latter frequently occur in the deposits. In these questions we have always taken into consideration the lithological associations and the geographical position of the deposit.

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greenish coloured glauconitic casts of Foraminifera. Most of the quartz particles are seen to be of clastic origin. Sections of a pale green mineral of a lamellar structure are biotite. Some sections have the characteristic cleavage of hornblende; kaolinised feldspar is rare.

Some of the larger mineral particles making up the annelid tubes are about 6 mm. in diameter, these are pieces of quartz, and little pebbles, which last, by transmitted light, are seen to be pieces of Cambrian (?) sandstone, composed of angular quartz, triclinic feldspar, and mica. Others of these fragments are diabase, composed of augite, triclinic feldspar, and quartz, others are tourmaline rock, of which the base is quartz; and finally, other pebbles are fragments of gneiss and amphibolic gneiss.

In the mud in the sounding-tube there was a rolled fragment of gneiss 2 centimetres in diameter.

List of the Animals taken at this Station.

Pisces.

<i>Cottunculus microps.</i>	Collett.
<i>Liparis liparis.</i>	L.
<i>Lycodes muræna.</i>	Collett.
„ <i>pallidus.</i>	„
<i>Motella macrophthalmia.</i>	Stur.

Mollusca.

<i>Arca pectunculoïdes</i> , var. (<i>septentrionalis</i>).	Sc.
<i>Buccinum mörchi.</i>	Friele.
„ <i>hydrophanum</i> , var.	Hancock.
<i>Fusus turritus.</i>	M. Sars.
„ <i>lachesis.</i>	Mörch.
„ <i>sabini.</i>	Gray.
<i>Mohnia alba.</i>	Fr.

Echinoidea.

<i>Pourtalesia jeffreysii.</i>	Wyv. Thom.
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Ophiuroidea.

<i>Ophioglyphia signata.</i>	VII.
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Asteroidea.

<i>Archaster tenuispinus.</i>	Düb. & Kor.
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Crustacea.

<i>Bythocaris payeri.</i>	Heller.
<i>Hymenodora glacialis.</i>	Bucholz.
<i>Diastylis josephinæ.</i>	G. O. Sars.
„ <i>longipes.</i>	G. O. Sars.
<i>Cyclaspis longicaudata.</i>	G. O. Sars.
<i>Boreomysis insignis.</i>	G. O. Sars.
<i>Eurycope gigantea.</i>	G. O. Sars.
„ <i>corunta.</i>	G. O. Sars.
<i>Anonyx lagena.</i>	Kröyer.

<i>Atylus carinatus.</i>	Fabr.
<i>Eusirus cuspidatus.</i>	Kröyer
<i>Halirages elegans.</i>	n. sp.
<i>Haploops setosa.</i>	Böck.
<i>Ægina spinosissima.</i>	Stimpson.
<i>Scalpellum nymphocola.</i>	n. sp.
Pycnogonida.	
<i>Nymphon stroemii.</i>	Kröyer.
„ <i>grossipes.</i>	Fabricius.
„ <i>macronyx.</i>	G. O. Sars.
<i>Colossendeis proboscidea.</i>	Sabine.
Annelida.	
<i>Eunoe equitis.</i>	n. sp.
<i>Nephtys longisetosa.</i>	Ørst.
<i>Nothria hyperborea.</i>	Hansen.
<i>Trophonia.</i>	n. sp.
<i>Thelepus circinatus.</i>	Fabr.
<i>Sabella</i> (fragt.).	
<i>Nemertes.</i>	n. sp.
<i>Phascolosoma.</i>	
<i>Tomopteris onisciformis.</i>	
Medusæ.	
* <i>Lucernaria bathyphila</i> , n. sp.	Haeckel.
Porifera.	
<i>Stylorhiza stipitata.</i>	Osc. Schmidt.
Polyzoa.	
<i>Alcyonidium.</i>	
Alcyonaria.	
<i>Alcyonium.</i>	

(d.) Soundings, Dredgings, and Trawlings on the Ridge.

Sounding 7. Lat. 59° 58' N., long. 7° 22' W. 27th July 1880.
Depth, 300 fathoms. Surface temperature, 55·0°; bottom temperature, 48·0°.

BLUE MUD, plastic, earthy, with many gritty particles.

CARBONATE OF CALCIUM 11·77 per cent., consists of a few Cocoliths and Cocospheres, Globigerinas, Orbulinas, Pulvinulinas, Truncatulinas, Uvigerinas, Miliolas, &c., fragments of Echini, Ostracodes, Molluscs.

RESIDUE 88·23 per cent., blue-brown, consists of—

Minerals [70·00], m. di. ·25 mm., with many much larger particles, many rounded; quartz, mica, augite, hornblende, magnetite, chert, mono- and triclinic feldspar, fragments of sandstone, mica-

* This species is described in Haeckel's "*System der Medusen*," p. 640.

schists, and other rocks, glauconite, and many fragments of highly altered rocks resembling glauconite.

Siliceous organisms [1·00]: one or two Radiolarians and fragments of other siliceous organisms, and a few glauconitic casts.

Fine washings [17·23]; fine mineral particles with argillaceous matter.

Remarks.—The carbonate of lime consists chiefly of the remains of surface organisms.

The feldspar is generally kaolinised; typical glauconite is found in grains more or less mammillated and furrowed; some are quite green, while others are reddish coloured. Among the larger fragments are pieces of feldspathic sandstone (6 mm. in diameter) of granite and fine-grained mica schist.

Sounding 17. Station 2. Lat 60° 29' N., long. 8° 19' E. 28th July. Depth, 375 fathoms. Surface temperature, 53·0°; bottom temperature, 31·0°.

A small quantity of mud came up in the sounding tube, of which the following is a description:—

BLUE MUD, plastic, coherent, with many rather large gritty particles—streak lustrous.

CARBONATE OF CALCIUM 14·20 per cent., consists of a few *Coccoliths*, *Globigerinas*, a few *Miliolinas*, *Rotalias*, *Nonioninas*, *Truncatulinas*, *Ostracode* valves, and fragments of *Echini*.

RESIDUE 85·80 per cent., brownish, consists of—

Minerals [70·00], m. di. 25 mm., with many particles over 1 mm. in diameter—quartz, mica, magnetite, feldspar, hornblende, glauconite, augite, fragments of ancient and recent volcanic rocks.

Siliceous organisms [2·00]: one or two *Sponge* spicules, glauconitic casts of *Foraminifera*, few *Diatoms*.

Fine washings [13·80]; fine mineral particles with argillaceous matter, and a very few fragments of siliceous organisms.

Remarks.—The dredge, with two swabs and a bread bag in the netting, was put over at 8 P.M. on the 28th, and hauled in at 4 A.M. on 29th July.

It contained over a quart of gravel and small stones, and some larger stones—some of them were covered with a thin coating of peroxide of manganese on one of their surfaces, and had many *serpulæ* and *polyzoa* attached.

The following are the principal varieties of rocks dredged :—

1. A fine-grained reddish sandstone (Cambrian?) compact, with lamellæ of mica. This fragment is about $12 \times 8 \times 4$ inches, and had polyzoa, serpulæ, and rhizopods attached to it. The angles are more or less rounded. On the upper surface there are parallel striæ, which may be glacial markings. The whole upper surface and edges are blackened by manganese deposit. This fragment was only very partially imbedded in the mud.

2. A rounded fragment of diorite, fine-grained, containing plagioclase, orthoclase, hornblende, and quartz. This fragment was also blackened by manganese except the under surface, where it evidently rested on the mud, and is about 4 inches in length.

3. A micaceous sandstone, fine-grained; the mica appears to be biotite. This fragment is about 5 inches long and is angular.

4. Mica-schist with biotite.

5. Altered mica-schist.

6. Gneissic rock, with quartz, orthoclase, and mica.

7. Diorite—containing plagioclases, amphibole, and quartz.

8. A fine-grained limestone.

9. Compact crystalline rock, containing hornblende, quartz, and feldspar passing to diorite.

10. Amphibolic rock.

11. Chloritic rock.

The majority of these fragments were covered on one of their surfaces with a black deposit of manganese, and nearly all of them when lying on the bottom most probably projected above the deposit in which they were placed. Some of them were perfectly rolled fragments with smooth surfaces, while others were angular.

List of the animals taken in the dredge.

Mollusca.

Fusus islandicus (young).

„ *lachesis*.

Pleurotoma declivis.

Chemnitz.

Mörch

Lovén.

Ophiuroidea.

Ophiactis abyssicola.

Ophioscolex glacialis.

Ljn.

Müll. & Tr

Asteroidea.

Crossaster papposus (Linck), var. *septentrionalis*. n. sp.

Porifera.

Tisiphonia agariciformis.

Wyv. Thom.

Reniera, sp.*Holténia* (?) (fragment).

Annelida.

Serpula, attached to stones.

Actinia.

Halcampa clavus.

Hydroida.

*Tubularia indivisa.**Hydroid* (?)

Cephalopoda.

Cephalopod.

Polyzoa.

Lepralia (Alysidota) alderi.

Bk.

,, *granifera.*

Johnst.

,, *polita.*

Norman.

,, *duerterrei.*

Aud.

Alecto (Stomatopora) granulata.

Hincks.

*Diastopora obelia.**Discoporella hispida.*

Hincks.

Pycnogonida.

Nymphon.

Sounding 28. Lat. 60° 2' N., long. 7° 4' W. 4th August 1880.
Depth, 285 fathoms. Surface temperatures, 56·5°. Bottom temperature, 48·0°.

BLUE-BROWN MUD, slightly coherent with many gritty and sandy particles.

CARBONATE OF CALCIUM 16·29 per cent., consists of Coccoliths, Coccospheres, Globigerinas, Orbulinas, Truncatulinas, Miliolinas, Pulvinulinas, Nonioninas, &c, fragments of Echini, Molluscs, Ostracode valves.

RESIDUE 83·71 per cent., brownish, consists of—

Minerals [70·00], m. di. ·25 mm., with fragments over 1 mm. in diameter. Quartz, rounded fragments of sandstone and other rocks, magnetite, hornblende, glauconite, and highly altered fragments of rocks resembling glauconite.

Siliceous organisms [2·00]: a few Diatoms and glauconitic casts.

Fine washings [11·71]; fine mineral particles and argillaceous matter.

Station 1. 27th July. 305 fathoms. Lat. 60° 4' N., long. 7° 37' W. Bottom temperature, 47·1°. Surface temperature, 54·8°.

A little bluish mud came up in the sounding tube.

The dredge was used without bag.

It came up with about a pint of rounded and angular stones,—sandstone, gneiss, mica-schist, diorite,—the same as those taken at Station 2.

List of the animals taken.

Mollusca.	
<i>Platydia anomioïdes.</i>	Sc. and Ph.
<i>Astarte sulcata</i> , var. (<i>minor</i>).	Da Costa.
Echinoidea.	
<i>Dorocidaris papillata.</i>	A. Ag.
<i>Echinus norvegicus.</i>	Düb & Kor.
Crustacea.	
<i>Munida rugosa.</i>	Fabr.
Annelida.	
<i>Placostegus tridentatus.</i>	Fabr.
<i>Serpula</i> , attached to stones.	
Porifera.	
<i>Sponges</i> , attached to stones.	
Cephalopoda.	
<i>Cephalopod.</i>	
Corals.	
<i>Caryophyllia.</i>	
Polyzoa.	
<i>Lepralia granifera.</i>	

CONCLUDING REMARKS.

The dredgings and trawlings during the “Knight Errant’s” cruise have, according to the above lists and the supplementary reports which follow, given us 16 new species and one new genus.

The trawlings and dredgings in the warm area (stations 4, 5, 6, and 7) yielded 71 species. The single trawling in the cold area (station 8) yielded 47 species.

It is a somewhat remarkable fact that in these dredgings there are only 2 species common to both areas, viz., *Haploopsis setosa* and *Nymphon stræmii* excluding of course the foraminifera.

It will be interesting to learn if the same remarkable difference in the fauna on either side of the Wyville Thomson Ridge will be shown by more extended dredgings and trawlings during the present season in H.M.S. “Triton.”

The dredgings on the ridge did not yield many animals, and these resemble rather those of the warm, than of the cold area.

The animals captured at the stations surrounding North Rona all belong to known British species.

What is the legitimate limit of the "British fauna"? Are the Farøe Channel animals to be included in it? These are questions which have been often asked, and, although they appear to us unimportant, yet are not without interest.

When we regarded the marine fauna as having a depth limit, the question answered itself—the British fauna ended doubtless with the existence of the fauna. Now, since we know that the marine fauna has no depth limit, we must, if we wish a limit, fix an artificial one.

Temperature is the most important factor in the distribution of marine species. The mean annual temperature of the ocean and of the shallow water around coast-lines varies from about 29° Fahr. in the polar regions to about 75° Fahr. under the equator. This great inequality of temperature is the limiting cause of the distribution of marine species, both at the surface of the sea and in shallow water.

Pelagic species have a marked and limited distribution depending on temperature,—quite as much as species inhabiting the shore waters,—and this distribution can be traced on the bottom of the ocean in many instances.

By an examination of an oceanic deposit, it is possible to tell approximately its latitude from the character of the dead shells of surface organisms found in it. The depth from which the deposit came, and also its longitude, can in many instances be approximately determined by careful microscopic examination of the fragments, organic and inorganic, of which it is composed. While the surface of the ocean, like the surface of the land, has its climates, it is quite otherwise with the deep sea.

The mean temperature of the bottom of the ocean is about 35° Fahr., so that an enormous expanse of the sea-bottom, covering nearly three-fourths of the surface of the earth, is under circumstances where there is no bar to general diffusion, and the result is that this vast area, with a temperature say under 40° Fahr., admitting of free migration, is inhabited by a fauna whose most marked characteristic is extreme uniformity.

The temperature of 35° Fahr. rises in the polar regions towards the surface, and we should expect therefore that the shore and deep-

sea faunas would meet in these regions in comparatively shallow water.

Our deep-sea investigations give many examples which tend to corroborate this view.

In the Faroe Channel we have a mixture of abyssal, arctic, and modified British forms. Further investigations may show that a temperature limit can be drawn within which the British fauna should be restricted, but it is at the same time evident that this fauna is continuous, on the one hand, with the abyssal, and, on the other, with the arctic fauna in the Faroe Channel.

We desire to acknowledge our indebtedness to the many scientific men who have supplied us with information and furnished us with reports.

In the work of the exploration we were throughout assisted by Lieut. Hammond, R.N.

In the practical zoological work we received much assistance from Mr. Frederick Pearcey and Mr. James Chumley, assistants on the staff of the “Challenger” Expedition Commission.

JOHN MURRAY.

THOS. H. TIZARD.

“CHALLENGER” OFFICE, 32 QUEEN STREET,
EDINBURGH, *May* 1882.

Report on the FISHES. By Dr. A. Günther, F.R.S.

This Report was received by the late Sir C. Wyville Thomson in
November 1880.

The bathybial fish-fauna which surrounds the British Islands was hitherto almost unknown. Besides the stray specimens which now and then were found thrown ashore or floating on the surface, no further evidence of the existence of this fauna was obtained, except on two occasions, viz., on a dredging excursion of Dr. Gwyn Jeffreys in 1867, from a depth of from 80 to 90 fathoms;* and during the cruise of H.M.S. “Porcupine” in 1869, from a depth of from 200 to 500 fathoms.†

Neither of these two contributions can compare as regards interest

* See *Ann. and Mag. Nat. Hist.*, 1867, vol. xx. p. 287.

† *Ibid.*, 1874, xiii. p. 138.

and number of specimens with the series obtained during the cruise of the "Knight Errant"; and it would seem as if now only the rich spoil, which I ventured to indicate in 1867 as likely to result from an exploration of the deep sea round the British Islands, were being gathered. Six out of the ten species obtained are new to the British fauna, and, of course, represent but a small fraction of the actual number of British deep-sea fishes. Much, therefore, remains to be done. The laws which govern the bathymetrical distribution of fishes are still obscure; and it is evident that a series of continued systematic observations, such as can be made in a limited oceanic district, like that round the British Islands, whose hydrographic conditions, with its surface and coast fauna, are so well known, is most likely to reveal the chain of facts which cannot be recognised in disjointed observations made at distant localities. Besides, there are not a few obscure points in the life history of our food-fishes which may well be expected to be cleared up by the deep-sea dredge; such are the unaccountable disappearance from certain parts of the coast of fishes like the haddock, and the change of habitat of many fishes according to the season, a change which evidently much more frequently takes place in a vertical than in a horizontal direction. It is therefore to be hoped that the present successful expedition will be followed by equally well conducted efforts.

The collection submitted to my examination contains a much greater proportion of arctic forms than of southern, and in this respect differs entirely from that made by Mr. Gwyn Jeffreys at a less depth. The only southern form is *Haloporphyrus lepidion* which we knew previously from the Mediterranean, Japan, and South Atlantic. Singularly, again, no trace of a *Trachypterus* or *Regalecus* was obtained; and we can account for their absence only by the supposition that it is difficult to enclose these long snake-like fishes in the dredge, and that young specimens, from their extreme delicacy of structure, are probably torn into fragments and lost long before the net reaches the surface. Some of the species had been previously obtained by the Scandinavian expeditions in similar latitudes towards the east. As all the species will be fully referred to or described in my report on "Challenger" deep sea fishes, only a few notes on them are appended here.

1. *Chimæra monstrosa*, L.—A young specimen was obtained at a

depth of 555 fathoms ; therefore, this fish will have to be admitted in the fauna of the deep sea. Its horizontal distribution includes the northern and southern coasts of Europe, Japan, and the Cape of Good Hope.*

2. *Cottus thomsonii*, sp. n.—Hitherto one species only of this littoral genus was known from the deep sea, viz., *Cottus bathybius*, which was dredged on the “Challenger” expedition near Japan in a depth of 565 fathoms. The single specimen before us was obtained in 555 fathoms (Station 4), and is 7 inches long. It may be shortly characterised thus :—

The præopercular spines, like the remainder of the armature of the head, are short pointed tubercles covered by the skin. Four similar spines are placed in a quadrangle on the crown of the head, the quadrangle being much longer than broad. Eyes large, as long as the snout, their longitudinal diameter exceeding the width of the interorbital space. Vomerine teeth in two oblique bands separated in the middle ; palatine teeth none. The first dorsal fin enveloped in skin, continuous with the second. Ventrals rather short, terminating at a considerable distance from the vent. Skin with scattered minute granules. Colourless (in spirits). D. $\frac{5}{17}$, A. 13, P. 22, V. 2.

3. *Cottunculus microps*, Collett.—This singularly shaped Cottoid is quite a recent discovery, a single very young specimen having been obtained by the Scandinavian explorers and described by Mr. Collett. Adult examples, up to 12 inches long, in a perfect state of preservation, are in the collection. Station 8, 540 fathoms.

4. *Liparis liparis*, L.—New to the deep-sea fauna. Station 8, 540 fathoms.

5. *Lycodes muræna*, Collett, and 6. *Lycodes pallidus*, Collett—both new to the British fauna, and only recently described. Station 8, 540 fathoms.

7. *Haloporphyrus lepidion*, Risso.—Specimens of this fish, which was originally known from Madeira and the Mediterranean, and met

* This specimen was 2 feet in length (caudal filament included). When taken from the trawl the pectoral and dorsal fins were covered with a green sheen on a velvety black ground, the sheen being more pronounced at the base of the fins than towards the tips. The back, tail, and head were light brown. The belly and long whip-like portion of the tail were white. There was a bluish colour about the mouth and gills. The eye had a beautiful golden appearance. A green sheen surrounded the pupil. J. M.

with by the "Challenger" in the Japanese Sea and South Atlantic at depths of 345 and 600 fathoms, seem to be quite common in the British district, having been obtained at Station 4 in 555 fathoms, and at Station 6 in 530 fathoms.

8. *Brosmius brosmie*, Müll.—A large example in 530 fathoms (11th August 1880); new to the deep-sea fauna.

9. *Motella macrophthalma*, Stur.—Previously known from a depth of 80 fathoms; the specimens obtained on this occasion come from a depth of 540 fathoms; Station 8.

10. *Macrurus*, sp. n. (?).—Two young specimens from Station 4, 555 fathoms, which have lost the greater part of their scales, approach closely *M. trachyrhynchus*, and may possibly represent only the young state of this species. Their snout is conspicuously shorter than in a large specimen of the true *M. trachyrhynchus*, from the Mediterranean, but as this may be due to age, I hesitate to give an opinion, until I have had an opportunity of examining smaller specimens from the Mediterranean. New to the British fauna.

Report on the MOLLUSCA. By Dr. Gwyn Jeffreys, F.R.S.

This Report was received by the late Sir C. Wyville Thomson in November 1880.

Station 1 ; 305 fathoms.

Platydia anomioïdes, Scacchi and Philippi.

Astarte sulcata, Da Costa ; var. *minor*.

Station 2 ; 375 fathoms.

Fusus islandicus, Chemnitz (young).

F. lachesis, Mörch.

Tritonium terebrale, M. Sars (MS.) ; not *F. terebralis*, Gould, which is *F. spitzbergensis* of Reeve.

Pleurotoma declivis, Lovén.

Station 3 ; 53 fathoms.

Circe minima, Montagu.

Venus fasciata, Da Costa.

Tapes virgineus, Linné (young).

Tellina crassa, Gmelin.

Psammobia costulata, Turton.

Mastra solida, L. ; var. *elliptica*.
Saxicava rugosa, L. ; var. *arctica*.
Eulima polita, L.
Natica montacuti, (*montagu*) Forbes.
Aporrhais pes-pelecani, L.

Sounding ; 38 fathoms.

Venus fasciata, Da Costa.

Station 5 ; 515 fathoms.

Fusus sarsi, Jeffreys ; (young).
F. togatus, Mörch.
F. mæbii, Dunker and Metzger.

N.B.—*F. ebur* of Mörch was admitted by him to be only a worn specimen of a variety of *F. propinquus*, Alder.

Station 6 ; 530 fathoms.

Amussium hoskynsi, Forbes.
Pecten imbrifer, Lov.
P. mammillatus, M. Sars.
Aporrhais serresianus, Michaud.
Fusus fenestratus, Turton.
Buccinum fusiforme, Broderip.
F. berniciensis, King, var. *elegans*.
F. islandicus, Lov. ; not of Chemnitz.

Station 7 ; 530 fathoms.

Arca pectunculoïdes, Sc.
A. raridentata, S. V. Wood.
Leda lucida, Lov.
L. frigida, Torell.
Nucula tumidula, Malm.
N. pumila (Lov.), Asbjørnsen.
N. corbuloides, Seguenza.
Cardium minimum, Ph.
Næra striata, Jeffreys.
N. obesa, Lov.
Hela tenella, Jeffreys ; young.
Natica montacuti, Forbes ; young.
Aporrhais serresianus, Michaud ; young.

Cerithium metula, Lov.

Columbella costulata, Cantraine.

C. haliæti, Jeffreys.

Back. Synonym.

Cylichna alba, Brown.

C. ovata, Jeffreys.

Station 8 ; 540 fathoms.

Arca pectunculoïdes, Sc. ; var. *septentrionalis*.

Buccinum hydrophanum, Hancock ; var.

B. mörchi, Friele.

Fusus turritus, M. Sars.

Not *F. propinquus*, Alder ; var.

F. lachesis, Mörch.

F. sabini, Gray.

F. stimpsoni, Mörch.

Mohnia alba, Friele.

I subjoin a list of what I consider the northern species of *Buccinum*. For their synonyms see the "Annals and Magazine of Natural History for December 1880" :—

1. *Buccinum glaciale*, Linné.

2. *B. undatum*, L.

3. *B. groenlandicum*, Chemnitz.

This is closely allied to *B. undatum* ; and both may be one and the same species.

4. *B. hydrophanum*, Hancock.

5. *B. humphreysianum*, Bennett.

Not *B. humphreysianum* of Möller, Lovén, Middendorff, M. Sars, Danielssen, or Malm.

6. *B. totteni*, Stimpson.

7. *B. tenue*, Gray.

8. *B. ciliatum*, Fabricius.

Report on the CRUSTACEA. By the Rev. A. M. Norman, Burnmoor Rectory, Fence Houses, Co. Durham.

This Report was received by the late Sir C. Wyville Thomson in November 1880.

Mr. Norman says:—"I send a list; it is a very interesting one. No. 8 was a grand haul, the best I have ever examined from the North Atlantic. It leads off with a species (*Bythocaris Payeri*, Heller) discovered by the German Arctic Expedition. The second (*Hymenodora glacialis*, Bucholz) was discovered in the Austrian Arctic Expedition, and there follow several of the species of the Norwegian Expeditions. You will see that there are three or four things which I take to be new; one of these, the *Nephropsis*, is not unlike *Nephrops norvegicus*, but the arms quite different, not angled, and hairy, and the eye rudimentary.

Station 1.

Munida rugosa, Fabr.

Station 3.

Stenorhynchus longirostris, Fabr.

Hyas coarctatus, Leach.

Ebalia tuberosa, Pennant.

Munida rugosa, Fabr.

Ligia oceanica (this must have been from Shore).

Eurydice truncata, Norman.

Scalpellum vulgare, Leach.

Station 4.

Munida tenuimana, G. O. Sars.

Nephropsis atlantica, n. sp.

Station 5.

Dorhynchus thomsoni, Norman.

Amathia carpenteri, Norman.

Munida tenuimana, G. O. Sars

Two or three Amphipods (small) to be examined.

Station 6.

Geryon tridens, Kröyer.

Munida tenuimana, G. O. Sars.

Station 7.

Amathia carpenteri, Norman.

Munida tenuimana, G. O. Sars.

Eurydice polydendrica, Norman and Stebbing (MS.).

Haploops setosa, Boeck.

Ampelisca compacta, n. sp.

One or two more Amphipods to be examined.

Station 8.

Bythocaris payeri, Heller.

Hymenodora glacialis, Bucholz.

Boreomysis insignis, G. O. Sars.

Diastylis Josephinæ, G. O. Sars.

„ *longipes*, G. O. Sars.

Cyclaspis longicaudata, G. O. Sars.

Eurycope gigantea, G. O. Sars.

„ *cornuta*, G. O. Sars.

Anonyx lagena, Kröyer.

Atylus carinatus, Fabricius.

Eusirus cuspidatus, Kröyer.

Halirages elegans, n. sp.

Haploops setosa, Boeck.

Ægina spinosissima, Stimpson.

Nephropsis atlantica, Norman, n. sp.

Carapace finely granulated and pubescent all over, with strongly marked transverse lines ; rostrum rather longer than the peduncle of the upper antennæ, its extremity acute, its sides bearing two pairs of strong spines ; a third pair of spines is situated at its base, and a fourth pair on the front of the carapace over the insertion of the exterior antennæ. The spines just described are the largest, but there are also on the central portion of the carapace two rows of about six spines each, of which the foremost is the largest, while the others are very small, these rows pass backward from the central portion of the base of the rostrum ; there is another and strong spine on a line with and behind the spine which is situated on each side of the base of the rostrum.

Pleon having the segments furnished with a slight central keel dorsally; the epimera of the first segment not produced downwards, those of the four following segments, greatly produced downwards triangularly, and gradually attenuating, end in sharp spine-like points, the anterior margins of the epimera of the second segment furnished with a single acute anteadly directed spine; epimera of the sixth segment with two small spine-like points, one directed downwards, the other backwards over the insertion of the outer uropods; telson quadrate, the extremity truncated, bearing two divergent ridges which terminate at the distant corners in spine-like points; uropods gently rounded at their extremities, each with two raised ridges, one central, the other running along the outer margin and terminating in strong spines; there is also a spine on the upper surface of the basal joint.

Eyes minute, and apparently devoid of lenses, of a pink colour, lying close together and touching each other, being situated directly under the rostrum, by which they are entirely concealed, and resting on the upper antennæ.

Upper antennæ, which are furnished with two flagella as in allied genera, have the first and third joint subequal in length, and the middle joint about half their length; the flagella are about half as long again as the peduncle.

Lower antennæ are, in the specimen procured, imperfect, but the peduncle is short, equal in length to that of the upper antennæ; green gland with a conspicuous opening on the under side of the basal joint.

Chelipeds densely setose; with rounded joints, which present no appearance of angularity; the meros, which is the largest joint, does not quite reach the extremity of the rostrum; it bears a single spine at the extremity of the upper and outer margin, and another on the under surface; carpus furnished with three spines on the inner and one on the outer margin, and one on the under surface; hand unarmed, elongate, ovate, finger and thumb acute, with crenated inner margin, their tips crossing when closed.

The two following pairs of feet chelate, their coxæ furnished on the inner margin with large lobes, that of the third pair having a hook-shaped process on the outer side of the extremity of this lobe.

First pair of pleopods elongate, spatulate, porrected between the

bases of the pereopods, adpressed closely to the body, and reaching the coxæ of the third pair.

Length $3\frac{1}{2}$ inches. Length of chelipeds rather more than 2 inches.

“Knight Errant” August 10, 1880. Station 4; in 555 fathoms.

Mr. Wood Mason (*Journal Asiatic Society of Bengal*, vol. xiii. 1873; and *Ann. Nat. Hist.* ser. 4, vol. xii. 1873, p. 59), established the genus *Nephropsis* in 1873 for the reception of a small lobster-like crustacean which he procured in 260–300 fathoms off Ross Island, on the coast of the Andamans. The genus approaches very closely to *Nephrops*, but differs from it in the absence of the antennal scale of the lower antennæ. In 1880 Mr Spence Bate procured a second species, *Nephropsis cornubiensis*, off the Cornish Coast (*Report Brit. Assoc.*, 1880, p. 160), and mentioned that he had in his hands a third species taken during the “Challenger” Expedition in 700 fathoms, south of New Guinea, and a fourth, procured also by the “Challenger” in 800 fathoms off Bermuda, and remarked that “the resemblance of all four species is very close, and the distinction of one from the other is dependent chiefly upon the modified forms of more or less important parts.” In the same year Professor A. Milne Edwards described (*Ann. des Sci. Natur.*, vi. 9) *Nephropsis Agassizii* from 1500 meters, coast of Florida, but this description I have not seen; and almost at the same time Mr. S. I. Smith characterised (*Proc. National Museum, Washington*, vol. iii. p. 431) yet another form, *Nephropsis aculeatus*, which was taken off the coast of the United States in 100–126 fathoms. The foregoing description of *N. atlantica* was drawn up in November 1880, and the “Knight Errant” specimen was at the same time returned to Sir Wyville Thomson, and I have not since seen it. Comparing the description with that subsequently published by Mr. Smith, there is the strongest suspicion that they are the same species; but all the forms seem to be very closely allied, if indeed distinct. Mr. Smith describes the carapace of *N. aculeatus* as “showing no difference whatever” from *N. stewartii* except in having rather a longer rostrum. Now the spiny armature of *N. atlantica* is certainly different from that assigned to *N. stewartii*, and therefore I do not feel justified in assigning the “Knight Errant” specimen to *N. aculeatus*, though at the same time I very unwillingly give it a name.

Boreomysis nobilis, G. O. Sars.

Boreomysis nobilis, G. O. Sars, “Crustacea et Pycnogonida Nova in itinere 2do et 3tio Expeditionis Norvegicæ anno 1877 et 1878 collecta,” *Archiv. for Mathematik og Naturvidenskab*, 1880, p. 428.

Animal more or less mottled and suffused with red, younger specimens are paler in colour, but apparently the telson is always red. Rostrum horizontal, very acute, nearly as long as the eye when porrected. Antero-lateral corner of carapace produced into a triangular process projecting over the base of the inferior antennæ; hinder margin of carapace excavated in the centre, and there exposing the last segment of the pereion. Eyes rather flattened, broad, reaching slightly beyond the side of the carapace, having a small tubercle on the inner side of the peduncle and just below the well-developed dark-coloured eye itself. Upper antennæ having the second joint of the peduncle short, not half the length of the third, and not so patelliform as is usual in this genus. The lower antennæ have the scale much elongated, narrow, and gradually tapering, twice the length of the peduncle of the upper antennæ, its outer margin plain with a small spine at the apex; the apex slopes at once towards the inner margin and together with that margin is setose. Telson long, but not quite reaching the end of the inner uropods, which show no trace of an acoustic organ, and much shorter than the outer, excavated above, and cleft to about one-fifth of its length, its sides unarmed for half their length, but their distal half set with numerous (about 30) slender, closely-arranged, subequal spines, the cleft portion of the telson closely denticulated. Length about 65 millimetres.

Several specimens taken at Station 8, in 540 fathoms.

The above description was drawn up in 1880, when the specimens came into my hands. On comparison with the description published shortly afterwards by my friend Professor Sars, there can be no doubt of the identity of the “Knight Errant” example with the single male which was dredged by the Norwegian Expedition in 1878 in 459 fathoms, 79° 0' 59" N. lat., 5° 40' E. long. I may add to my original description that the tarsus of the legs is composed of three articulations, as in the type specimen of Sars.

Ampelisca compacta, Norman, n. sp.

Pleon not keeled, a very slight depression across the middle of the fifth segment, hind margin of that segment with a spine-like point, but not largely developed nor upturned. Upper antennæ exceeding the length of the peduncle of the lower by about a length equal to the last joint of that peduncle, flagellum consisting of ten articulations; lower antennæ much longer than the upper, and having the two last joints of the peduncle subequal to each other. Eyes apparently altogether absent. First two pairs of pereopods with the last joint about equal to the two preceding combined. The last pereopods have the basos with the posterior lobe well developed reaching to the end of the ischium, the lower margin truncate and slightly concave; ischium equal in length to the two following joints combined, meros short, carpus rather longer, manus not quite equal to the two preceding joints combined, dactylus half the length of manus; the lower joints are all flattened but simple (not produced downwards as in *A. lævigata*). First two pairs of uropods of the same length, subequal in length to the deeply cleft telson, and reaching to about one-fourth the length of the sparingly-ciliated branches of the last uropods; the outer margin of the outer branch of the second uropods bears two spines, and under a high power of the microscope is seen to be minutely crenulated. The entire animal has a rounded compact appearance, and is about 8 millimetres long.

A single specimen. Station 7; 530 fathoms.

Halirages elegans, Norman, n. sp.

Pereion and pleon not carinated, two last segments of the former and two first of the latter bearing a single central dorsal spine-like process, which is small on the first of these segments (and sometimes absent), but increases in size on each of the succeeding segments; fourth segment of pleon with a deep transverse sulcus. Lower and front angles of the head produced into an acute spine-like process; epimera of first and second pereion segments with serrated margins, the first also produced forwards into a sharp angle, rounded behind, the second rounded before and behind. Lower margin of the pleon segments not serrated, bearing rows of rather distant seta-like spines

a little within the borders, the second and third segments angled at the hinder corner, and the third also produced into a small spine-formed point, and the posterior margin not waved but finely crenated. Antennæ of both pairs very long, the upper pair as long as the entire animal, peduncles of both pairs remarkably round and smooth, peduncle of the upper pair reaching nearly to the end of the penultimate joint of that of the lower; the first joint large, round, and smooth, with two distal spines on the lower side; the second joint nearly as long as, but only half the thickness of, the first; the third very small. Peduncle of the lower antennæ having the two distal joints subequal in length. All the legs slenderly built, the two gnathopods small and slender, the hand shorter than the wrist, subquadrate, slightly widening from the base to the palm, which is only slightly oblique. Last uropods of great length, more than equal the combined length of the three posterior segments of the pleon, the peduncle not quite reaching to the end of the telson, rounded, smooth, with two distal spines above, branches narrow, round, smooth, margined with spinules, and about twice as long as the peduncle. Telson lanceolate, hollowed above, quite smooth, and not furnished with any spines, apex tridentate, the centre tooth large, the laterals small, the tridentate apex is formed by the telson itself (not by articulated spines).

Length 1 inch. Station 8, 540 fathoms.

This species comes very near to *Halirages quadridentatus*, G. O. Sars,* but differs from his description in the form of the epimera of the first segment of pereion, and in the third segment of pleon. Sars does not describe the telson, which is very characteristic.

Report on the PYCNOGONIDA. By Dr. P. P. C. Hoek.

From Station 3 there is one male *Pycnogonum littorale*, Ström, spec.

From Station 5 two specimens of *Nymphon stroemii*, Krøyer.

From Station 7 two specimens of the same species, and still ten other individuals were dredged at Station 8.

* “Prodromus descriptionis Crustaceorum et Pycnogonidarum, quæ in expeditione Norvegica, anno 1876, observavit G. O. Sars,” *Archiv. for Mathematik og Naturvidenskab*, 1876, p. 357.

The species, an extremely large quantity of which was obtained at Station 8, is the *Nymphon robustum*, Bell, the very same, of which Professor Wyville Thomson published a highly characteristic drawing in his *Depths of the Sea*, under the name of *N. abyssorum*, A. M. Norman.

I got large quantities of the same species from different dredging stations in the Barents Sea; in general the specimens from this locality are larger and stouter than those from the "Knight Errant." The same remark may be made with regard to the specimens of *N. stroemii*, dredged during the cruise of the "Knight Errant," Station 8, and those obtained by the Dutch schooner "Willem Barents" in higher northern latitudes. From the same station (8) a single specimen of *N. grossipes*, Oth. Fabr., and numerous *N. macronyx*, Prof. G. O. Sars, were obtained. The last named species is a very interesting one, which, till now, I knew only from the description of Prof. G. O. Sars. More than forty specimens I picked out from the three bottles with *N. robustum*.

As far as I know the cirriped on the *N. robustum* is new to science. It is a *Scalpellum* species, for which I propose the name, *Scalpellum nymphocola*.*

As for the large Pycnogonid, four specimens of which were dredged also at station 8, it is *Collossendeis proboscidea*, Sabine, spec., a species by no means rare in the cold area of higher northern latitudes. I will include these species in my Pycnogonid memoir; of *N. robustum*, Bell, *N. stroemii*, Kröyer, and *Collossendeis proboscidea*, Sabine, I prepared detailed descriptions for the narrative of the "W. Barents" cruise; so I will give only their names and a very short notice in my "Challenger" publication. (See Hoek Report Pycn. "Chall.," p. 94-99.)

Report on the POLYZOA. By Dr. Geo. Busk, F.R.S.

Station 1; 305 fathoms. A few fragments of rock, on which were minute colonies of

* A description of this species, with the necessary figures, will be given in my report on the Cirripedia of the Expedition of H.M.S. "Challenger."

1. *Lepralia granifera*, B. M. Cat.

? *Microporella impressa*, Audouin ; Hincks, in a highly calcified condition.

Station 2 ; 375 fathoms. Numerous pebbles and fragments of rock :—

1. *Lepralia (Alysidota) alderi*, Bk.

2. „ *granifera*, B. M. Cat.

3. „ *polita*, Norman.

4. „ *dutertrei*, Aud.

Lep. woodiana, Bk.

Lep. dutertrei, Hincks.

5. *Alecto granulata*, B. M. Cat.

Stomatopora granulata, Hincks.

- ? 6. *Diastopora obelia*.

- ? 7. *Discoporella hispida*, B. M. Cat.

Lichenopora hispida, Hincks.

Both the latter very small and much worn, so as to be scarcely recognisable.

Station 3 ; 53 fathoms.

1. *Cellepora ramulosa*, Linn.

2. *Cellepora avicularis*, Hincks.

3. *Eschara compressa*, Sowerb. (sp.).

Cellepora cervicornis, Fleming ; Couch ; Busk ; Sars ;
Alder ; &c.

Eschara cervicornis, formâ.

Eschara, Smitt ; D'orb ; Hincks.

Millepora compressa, Sowerb.

Porella cervicornis, Gray.

Porella compressa, Gray ; Hincks.

4. *Bugula flabellata*, J. V. T. (sp.)

Flustra avicularis, Sow.

Flustra angustiloba, Lamk.

Avicularia flabellata, J. V. T.

Bugula flabellata, B. M. Cat. ; Hincks, &c.

Bugula avicularia, formâ, 2. *flabellata*, Smitt.

5. *Bugula plumosa*, Pallas (sp.)

Bicellaria plumosa, Blain N.

Bugula plumosa, B. M. Cat. ; Alder ; Heller ; Hincks, &c.

6. *Flustra foliacea*, Linn. (sp.)
Eschara foliacea, Linn. Ed. 10.
Flustra foliacea, Linn. Ed. 12; Solander; B. M. Cat.;
Auctt.
7. *Retepora beaniana*, King.
Retepora cellulosa (pars) Anett.
Retepora beaniana, King; B. M. Cat.; Hincks, &c.
Retepora cellulosa, formâ.
beaniana, Smitt.
Eschara beaniana, Smitt. 1878.
8. *Salicornaria farciminoides*.
Sal. farciminoides, Solander; B. M. Cat.; Cuvier; Auctt.
Eschara and *Flustra fistulosa* (pars), Linn.
Cellaria salicornia, Lamx; Lamarck, &c.
Cellaria fistulosa, Searles Wood; Hincks; Smitt, &c.
9. *Lepralia unicornis* var. *ansata*, B. M. Cat.; Auctt.
Schizoporella unicornis, Hincks.
10. *Porella levis*, Fleming (sp.)
Cellepora levis, Fleming.
Eschara teres, Bk.
Eschara levis, Sars.
Porella levis (*Eschara* formâ), Smitt; Hincks.

The 17 species above enumerated include 13 Cheilostomata and 3 or 4 Cyclostomata. The latter are remarkable for their small size and strongly calcified condition; as were also some of the Lepralioid forms.

All are well-known northern forms, and none present any peculiarities worthy of remark, except that the two species of *Bugula* are represented by very luxuriant specimens. The condition also under which the specimens of *Porella levis* occurred was rather curious; the two or three fragments were, so to speak, enclosed in, and at first sight continuous with, the ramifications of *Cellepora ramulosa*, and were of the same diameter, so that at the first glance the growth appeared to be formed of two distinct kinds of cells.

All the species, it may be remarked, range as far south as the Mediterranean.

Report on the ANNELIDA. By Dr. M'Intosh, F.R.S.

This Report was received by the late Sir C. Wyville Thomson in
November 1880.

Station 1.

Placostegus tridentatus, J. C. Fabr.

Station 3.

Lagisca propinqua, Mgn.

Evarne, n. sp.

Glycera capitata, Ørsted.

Onuphis bilineata, Baird.

Lumbriconereis fragilis, O. F. M.

Ditrypa arietina, O. F. M.

Serpula vermicularis, L.

Station 4.

Empty chitinous tube, probably the same as one filled with ova
(molluscan?) from Canada.

Station 5.

Evarne johnstoni, M'I.

Several Nemerteans (*Enopla* and *Anopla*).

Station 6.

Small *Nothria*, and empty muddy tubes probably pertaining to the
Ampharetidæ.

Station 7.

Aphrodita aculeata, L.

Lætmonice filicornis, Kbg.

Leanira hystericis, Ehlers.

Maldane near *sarsi*, Mgn.

Ampharete arctica, Mgn.

Hydroides norvegica, Gunn.

Protula, fragt.

Station 8.

Eunoe equitis, n. sp.

Nephtys longisetosa, Ørst.

Nothria hyperborea, Hansen.

Trophonia, n. sp.

Thelepus circinatus, Fabr.

Sabella, fragt.

Nemertes, n. sp.

Phascolosoma.

Station 10. ?

Tomopteris onisciformis.

Report on the HOLOTHURIOIDEA. By Dr. Hjalmar Théel.

This Report was received by the late Sir C. Wyville Thomson in November 1880.

Lætmogone violacea, Théel (*Preliminary Report on the Holothuridæ of H.M.S. "Challenger,"* vol. i.; *Bihang Till K. Sv. Vet. Akad. Handl*, Bd. 5, No. 19, Stockholm, 1879, p. 11).

Station 4, 555 fathoms. Several hundred specimens.

Station 5, 515 fathoms. One specimen.

Station 6, 630 fathoms. One specimen.

It is a somewhat surprising and highly interesting fact that this beautiful animal should be found in abundance in a locality so far from Australia (Station 164, lat. 34° 8' S., long. 152° 0' E.) where the two specimens hitherto known were dredged up during the "Challenger" expedition, at a depth of 950 fathoms. Moreover, it is impossible to discover any characteristic by which these almost antipodal specimens may be distinguished one from the other.

Some species of *Elasipoda* vary a good deal in the number and size of the processes and pedicels; in *Lætmogone violacea* as well as in *Oneirophanta mutabilis*, Théel, and *Lætmogone wyville thomsoni*, Théel, this variation is so great that scarcely any one individual resembles another completely. Many forms of *Elasipoda* appear to congregate in very great numbers on the deep-sea bottoms, walking together in large flocks. During the "Challenger" expedition it was not uncommon to procure at the same time and in the same locality a great many individuals of the same species, sometimes a hundred or more; and this very summer Mr. Murray has found several hundred individuals of *Lætmogone violacea* living together in the same place.

The *Elasipoda* are essentially deep-sea forms. With few exceptions all hitherto discovered genera and species of this order belong to

the oceanic abysses.* Only *Elpidia glacialis*, Théel, has as yet been observed living at comparatively small and moderate depths, about 40 to 100 fathoms, in the Sea of Kara, but the same species was also obtained not far from Greenland, during a Swedish expedition, at a depth of 950 fathoms. The Norwegian Arctic dredging expedition also procured from great depths many specimens larger than those from the Sea of Kara; and the “Challenger” expedition brought home an individual, dredged at Station 160, lat. 42° 42' S., long. 134° 10' E., south of Australia, in a depth of 2600 fathoms. From this it is manifest that while *Elpidia glacialis* is able to exist at a great variety of depths, it is really a deep sea form.

Only two forms (*Ilyodæmon maculatus*, Théel, and *Orphnurgus asper*, Théel) are known to live at a depth less than 500 fathoms, and a few from 500 to 1000 fathoms; the remainder, about thirty species, are found at depths ranging from 1000 to 2900 fathoms. The order Elasipoda seems to be represented in all oceans, and the largest, most peculiar, and most characteristic forms prefer the greatest depths. The number of deep-sea dredgings being small in comparison with the large area of ocean, it is as yet almost impossible to arrive at any exact idea of the distribution of genera and species. As a matter of fact, however, the genus *Elpidia*, for instance, has a very wide distribution, its species having been observed at almost all parts of the sea, from the Arctic Ocean to lat. 60° 52' S., long. 80° 20' E. south of Kerguelen Islands, and not very far from the antarctic circle, as well as in more scattered localities around the world. As to the distribution of species it has already been mentioned that *Elpidia glacialis* and *Lætmogone violacea* appear to be very widely distributed, and *Oneirophanta mutabilis* has also been procured by the “Challenger” expedition at seven different stations around the world, but not in the Atlantic Ocean.

Echinocucumis typica, Sars (*Ofversigt af Norges Echinodermmer* Christiania, 1861, pp. 102–108, pl. x. figs. 11–20, pl. xi. figs. 1–17), Station 7, 530 fathoms. Four specimens.

Thyone raphanus, Düb. and Koren (*Ofversigt af Skandinaviens Echinodermmer*; *Kongl. Sv. V. Akad. Handl.*, 1877, pp. 311–312, pl. xi. fig. 58–59, pl. v. figs. 49–55).

* As far as our present knowledge goes, no Elasipoda are found living at depths less than 40 fathoms.

Station 6, 530 fathoms. One specimen.

Station 7, 530 fathoms. Nine specimens.

All these individuals differ from the typical form described by Düben and Koren in their small size, the largest being only about 15 mm. in length, and 10 mm. in breadth, and some other unimportant differences also exist. The pedicels being scattered over the whole body, seem to be more numerous along the three ventral ambulacra, forming there, more or less conspicuous rows. Pedicels with a few small arcuate spicula, and a small irregular terminal plate. Tentacles with larger and smaller, straight or arcuate spicula, the ends of which are enlarged and perforated. Anus with fine, small, elongated, perforated plates resembling teeth.

Stichopus (?) *tizardi*, nov.

Station 6, 530 fathoms. Two rather incomplete specimens, and some fragments.

Station 4, 555 fathoms. Some fragments.

In consequence of the fragmentary condition of the specimens which have been at our disposal, it has been quite impossible to obtain an exact idea of their form, or to fix the genus to which they belong. The viscera having been ejected it could not be ascertained whether respiratory organs were present or not. The bottle in which the specimens were stored contained also the posterior part of an intestine with two respiratory trees, and it seems probable that these organs belong to the larger specimen. As they bear some resemblance to *Stichopus* I propose, for the present at least, to refer them to that genus.

Body elongated, the length of the larger specimen being about 130 mm. Bivium with some small retractile processes arranged in a row around its foremost part, and with a few larger ones scattered on the back. Trivium with small retractile pedicels. It is impossible to state how the processes and pedicels are arranged on the larger specimen, but the fragments plainly show that the bivium is provided with tubercles or processes all round the body, and that the pedicels are disposed in rows on the bivium. Mouth anterior ventral; anus posterior, terminal, subdorsal. Tentacles twenty of almost equal size, their terminal part rather large, with some retractile processes. Integument very thick and soft, with two kinds of calcareous deposits; small G-shaped spicula; and other bodies representing the form of a

cross or star, composed of four long, straight arms with the ends more or less enlarged, flattened and pierced with one large and a few small holes ; sometimes the enlarged ends of the arms are connected with one another, forming a more or less round, perforated plate ; the centre of the cross always with a large and straight tower or steeple, directed outwards from the body of the animal, and composed of four long, straight, parallel columns, held together by three to seven transverse bands. The pedicels and processes with numerous rather large, more or less arcuate spinous spicula, and the former with a rudimental perforated terminal plate.

Only one pyriform sac, rather slender and cylindrical, the length being about 35 mm. The madreporic canal dorsal, very small, with numerous small spicula, curved in the form of a C, and resembling those of the integument. Each of the powerful longitudinal muscles is double. Genital tubes dichotomously branched, arranged in two rather large clusters, one on each side of the dorsal mesenterium, each cluster being again divided into from five to seven smaller ones. The respiratory trees (if they really belong to these animals) are two, undivided, almost of equal size, about 45 mm. in length, and bearing along their whole length a great many small processes or branches. Colour in alcohol light grey ; terminal parts of the tentacles yellowish with some dark points.

Report on ECHINOIDEA. By Professor Alex. Agassiz.

I have examined the things and send you a list. There is nothing new, but I am very glad to have good specimens of *Phormosoma uranus* and *placenta*, which I had not seen, as well as good young specimens of *Echinocardium pennatifidum*, which are interesting.

<i>Dorocidaris papillata</i> , A. Ag.	St. 1	305 fms.
<i>Porocidaris purpurata</i> , W. Th.	St. 7	530 „
<i>Phormosoma uranus</i> , W. Th.	St. 4	555 „
„ <i>placenta</i> , W. Th.	St. 4	555 „
	and St. 2	530 „
<i>Echinus norvegicus</i> , D. & K.	St. 7	530 „
	St. 1	305 „
	St. 3	53 „
„ <i>acutus</i> , Lamk.	St. 3	53 „
„ <i>melo</i> , Lamk.	St. 3	53 „
<i>Echinocyamus pusillus</i> , Gray	St. 3	53 „

<i>Pourtalesia jeffreysii</i> , W. Th.	St. 8	540 fms.
<i>Spatangus purpurens</i> , Luke	St. 3	53 „
	young (?) St. 6	530 „
	(broken, possibly not the young)	
<i>Echinocardium flavescens</i> , A. Ag.	St. 3	53 „
„ <i>pennatifidum</i> , Norm.	St. 3	53 „
	with young specimens of the species.	

ASTEROIDEA dredged during the Cruise of the "Knight Errant" in
July and August 1880. By W. Percy Sladen, F.L.S., F.G.S.

The collection that forms the subject of the present report, although small numerically, is interesting in many respects. As might naturally be expected, the general facies of the whole is decidedly northern; and with the exception of two of the forms all have been previously recognised under similar conditions of habitat and association. Owing to the limited number of stations and the small number of starfishes obtained at each, I do not in the present instance feel justified in drawing from the study of this group of animals alone any definite generalisations upon the physical and faunatic conditions of the area surveyed. Of the five stations herein concerned, one is situated in the shallow water within the hundred fathom line, and all the forms there dredged are characteristic boreal and North British species; two stations occur in the "cold" area near to stations previously dredged by the "Porcupine,"—one being probably close to the most western extension of the area. The remaining two stations are in the "warm" area and near to the ridge that separates it from the cold area. One of the warm-area stations has furnished a very remarkable starfish, which constitutes the type of a new genus,—altogether distinct from any of its northern congeners; whilst from the second of these stations a recognised boreal species was dredged, which has not previously been found out of the cold area.

· With the exception of the new form, each of the species enumerated has been previously taken in the cold area. Upon this fact, however, too much importance should not be placed. As our knowledge of the distribution and adaptability of starfish life increases, there seems much danger of confusing cold-area forms (previously so called) with frigid abyssal forms of far distant localities, which certainly cannot

be regarded as belonging to the same geographical or isothermal area. It is not improbable that, when the Asteroidea of the “Porcupine” and “Lightning” cruises have all been critically examined and the results tabulated, in connection with the additional information furnished by the “Challenger” and other expeditions, that some modifications may be necessary in the asterid fauna-lists of the respective areas. Every series of specimens therefore is of especial interest and adds further weight and importance to previous observations.

My hearty thanks are due to Mr. John Murray for the opportunity of examining this collection, as well as for much information.

I. *List of the Species obtained.*

1. *Archaster tenuispinus* (Düben and Koren), Sars.

Station 8. August 17, 1880. Lat. $60^{\circ} 3' N.$, long. $5^{\circ} 51' W.$ Depth, 540 fathoms; bottom temperature, $29^{\circ} \cdot 2$ Fahr.; surface temperature, $56^{\circ} \cdot 5$ Fahr.; ooze. Three examples.

All fully grown individuals, $R < 5r$; in the largest, $R = 73$ millim., $r = 16 \cdot 5$ millim. These specimens present many of the characters of *A. echinulatus*, Perrier, which is perhaps only a locational variety of the northern species,—at any rate a representative form.

2. *Archaster bifrons*, Wyville Thomson. (*Archaster bifrons*, Wyv. Thom. (1873), *The Depths of the Sea*, p. 122, figs. 17 and 74).

Station 7. Aug. 12, 1880. Lat. $59^{\circ} 37' N.$, long. $7^{\circ} 19' W.$ Depth, 530 fathoms. Three examples.

This elegant and well marked form was named by Sir Wyville Thomson in his account of the “Porcupine” cruise in *The Depths of the Sea*; and two admirable woodcuts are there given, unaccompanied, however, by any description. As no diagnosis of this species has yet been published, the following summary of details will not be out of place:—

Archaster bifrons.—Radii five, elongate, moderately broad at the base, tapering continuously to a finely pointed extremity. Inter-brachial angles widely rounded. Minor radial proportion $23 \cdot 3$ per cent., $R = 90$ millim., $r = 21$ millim. $R > 4\frac{1}{4}r$. Radii 25 millim. broad at the base.

Paxillæ of the dorsal area minute, crowded, bearing 20 to 25

spinelets,—5 or 6 in the midst of each crown more robust than the rest.

Marginal plates large and conspicuous. Supero-marginal series about as broad as high, 33 in number from the interbrachial angle to the extremity, covered with granules which become subconical in form on the lateral half of the plate. Each supero-marginal plate bears a single, moderately long, conical, pointed spinelet standing on the rounded angle of the plate and directed outward almost horizontally. Sometimes this spinelet may be reduplicated on two or three plates near the middle of the ray. Infero-marginal plates correspondent with the superior series and similar in every respect, covered with similar sub-conical granules, and each with a similar and equal sized spinelet directed horizontally. The supero-marginal spines diminish in size towards the interbrachial angle and towards the extremity; and also the infero-marginal spines, but in a less degree. The largest spines are consequently about midway on the ray. Adambulacral plates form a straight or very faintly festooned margin to the furrow. Ambulacral spines rather elongate, 10 in a lineal series on the furrow-margin of the plate, slightly compressed, not tapering, extremities rounded, the middle spines largest; the others diminishing by gradation to either end of the series, the outermost spine being small and setiform. External to this inner row stands a single large, conical, sharply pointed spinelet, nearly as large and robust as the marginal spines. A few minute setiform spinelets stand at the base on the outer portion of the plate.

Interbrachial areas large. The ventral plates are small, numerous, regularly quadrate, and are divided into lineal series or columns by furrows which extend from the adambulacral plates to the marginal plates,—the breadth of the columns at their inner extremity corresponding with that of the adambulacral plates, but contracting as they proceed outward, in consequence of the diminution of the size of the plates. The ventral plates are covered with papilliform granules or spinelets, and each of those in the angle bears a single, moderately robust, conical pointed spinelet springing from the midst.

Anus distinct. Madreporiform body obscure, hidden by paxillæ; probably situated in the midst of a circular area of more widely spaced paxillæ which occurs in one of the interradia, rather nearer the margin than midway.

Terminal (ocular) plate very minute. Sucker-feet pointed. No sucker disk.

3. *Astropecten andromeda*, Müller and Troschel. (*Astropecten christi*, Düben and Koren,* *Öfvers. K. Vet.-Akad. Förhandl.*, 1844, p. 113).

Station 7. Aug. 12, 1880. Lat. 59° 37' N., long. 7° 19' W. Depth, 530 fathoms. A single example.

Müller and Troschel† described their species as sometimes furnished with small single spinelets on the supero-marginal plates; but no trace whatever of such are to be found in the specimen under notice. In this respect I can confirm the observations of Sars,‡ and Danielssen and Koren,§ and also the description given by Düben and Koren.|| In the “Knight Errant” specimen all the spinulous or papilliform appendages of the actinal surface are invested with a thick membranous tissue which is often more or less united at their bases, and in some parts coalescent even at their extremities, which are joined by web-like and fibrillar extensions. The appearance thus produced is accurately enough expressed by Düben and Koren’s “gelatinöst öfverdrag,”¶ and I have no doubt whatever as to the correctness of their description in this respect; although the character referred to has subsequently been called in question. Sars** states definitely that it did not occur in any of his specimens, and he considered that Düben and Koren had been deceived by the presence of foreign matter. Düben and Koren state that the character is not a constant one.

Remarks.—*Astropecten andromeda* has not previously been dredged out of the “cold” area. The present seems to be an instance of its occurrence within the limits of the “warm” area. It seems probable from this and other sources of information that some modifications will ultimately be required when drawing up a revision of the characteristic fauna-lists of the two areas.

* The date of the first publication of Düben and Koren’s name was incorrectly cited by Dujardin and Hupé (*Hist. Nat. Zooph. Echinodermes*, p. 420) as 1834,—a mistake which has subsequently been copied, and has led to an erroneous priority being accorded to Düben and Koren’s name. In 1846 Düben and Koren themselves acknowledged Müller and Troschel’s claim.

† *System der Asteriden*, 1842, p. 129.

‡ *Oversigt af Norges Echinodermmer*, p. 30.

§ *Nyt Mag. f. Naturvidensk.*, 1877, bd. xxiii. 3, p. 66.

|| *Kongl. Vet.-Akad. Handl. för År 1844* (1846), p. 250.

¶ *Loc. cit.*, p. 251.

** *Loc. cit.*, p. 31.

4. *Luidia sarsii*, Düben and Koren.

Station 3. Aug. 3 and 4, 1880. Lat. $59^{\circ} 12'$ N., long. $5^{\circ} 57'$ W. Depth, 53 fathoms. Seven examples.

5. *Porania pulvillus* (O. F. Müller), Norman.

Station 3. Aug. 3 and 4, 1880. Lat. $59^{\circ} 12'$ N., long. $5^{\circ} 57'$ W. Depth, 53 fathoms. A single example.

6. *Mimaster tizardi*, gen. et sp. nov.

Station 4. Aug. 10, 1880. Lat. $59^{\circ} 33'$ N., long. $7^{\circ} 14'$ W. Depth, 555 fathoms; bottom temperature, $45^{\circ} \cdot 4$ Fahr.; surface temperature, 57° Fahr.; mud. A single example.

Radii five, marginal contour stellato-pentagonal, interbrachial angles sub-acute, the radii tapering gradually to a fine extremity. The lesser radius is in the proportion of 45 per cent., $R = 120$ millim., $r = 54$ millim.; breadth of a ray at the base, 58 millim. Dorsal profile high and gibbous over the disk. Actinal surface convex.

Dorsal area covered with a great number of uniform small paxillæ, closely and equidistantly placed, presenting no definite order of arrangement. The paxillæ consist of a cylindrical pedicel nearly twice as high as broad, surmounted by a crown of 15 to 20 spinelets about equal in length to the pedicel, except where they have been abraded; and the spinelets radiate apart very slightly, which gives a compact appearance to the paxillæ. Papulæ in groups of 3 to 5 occur between neighbouring paxillæ.

Marginal plates, in ventral and dorsal series, small and sub-tubercular in appearance, 37 to 38 in each series between the interbrachial angle and the extremity of the ray. Each plate or boss is covered with a great number of small spinelets similar to those of the paxillæ, giving them a round, cushion-like appearance. The infero-marginal plates are the largest, transversely sub-oval in form,—the length increasing towards the interbrachial angle, and bear not less than 100 spinelets. The supero-marginal plates are smaller, usually round, and placed rather more aborally than the companion plate of the lower series, the pairs standing consequently slightly oblique. The ventral plates occupy a great space on the actinal surface, and extend up to the very extremity of the ray. Each plate bears a single paxilla, which is rather more robust than those on the dorsal surface, and carries rather fewer spinelets, which are somewhat longer and more widely expanded. In consequence of the size and arrangement

of the ventral plates, the ventral paxillæ are more widely spaced than the dorsal ones, and are disposed in regular lines which run from the adambulacral plate to the margin, the lines or columns being marked off by straight furrows or wrinkles in the membrane. As the paxillæ are equidistantly spaced in each of these transverse rows, equally regular and uniform longitudinal lines are also traceable along the ray. In the arm-angle 9 to 10 paxillæ stand in each transverse series, the same number being maintained until about the outer fifth of the furrow.

Each adambulacral plate stands on the furrow-margin as the terminal plate of one of the transverse series above mentioned ; and carries a group of 15-20 spinelets resembling a compressed paxilla, only rather more robust than those on the ventral plates. Two of the spinelets (sometimes three) larger than the rest, slightly flattened and tapering to a point, stand at the margin of the furrow. The succeeding spinelets are less robust, and pass in gradation to the group of outermost spinelets which are about equal in size to those of the ventral paxillæ. The 5 or 6 innermost adambulacral plates have much larger spinelets than the others. About 75 adambulacral plates may be counted along the furrow.

The united mouth-plates form a sharp angle inwardly, and a large elongately ovoid, sub-tubercular swelling is developed on their superficies,—the whole surface being covered with spinelets arranged in somewhat similar series to the ambulacral spinelets, standing perpendicular, 7 to 8 along each side of the mouth angle. The aboral portion of each plate is occupied by a compressed paxilliform group, similar to those on the adambulacral plates

Madreporiform body undistinguishable.

Remarks.—The appearance of this magnificent starfish suggests in a remarkable way the association of the prominent external characters of a *Solaster*, a *Pentagonaster* and an *Asterina*. It is entirely distinct from its northern congeners and in structural formula cannot be referred to any genus at present known. Judging from description alone it perhaps resembles most nearly the genus *Radiaster*, recently established by M. Perrier* from a specimen obtained by the U.S. Coast Survey Steamer “Blake” in the dredgings in the Gulf of Mexico and the Caribbean Sea. That *Mimaster* is clearly distinct, however, from

* *Bull. Mus. Comp. Zool.*, Harvard, vol ix. no. 1, p. 17.

that form will be readily seen on comparing the summary given above with that of M. Perrier.

I have great pleasure in naming this interesting species after Captain Tizard, R.N., under whose command the "Knight Errant" cruise was conducted,—an officer to whom science is much indebted for many services and contributions, amongst the foremost of which may be mentioned the important hydrographic investigations on board H.M.S. "Challenger."

7. *Cribrella oculata* (Linck), Forbes.

Station 3. Aug. 3 and 4, 1880. Lat. $59^{\circ} 12' N.$, long. $5^{\circ} 57' W.$ Depth, 53 fathoms. A single example.

8. *Crossaster papposus* (Linck), Müller and Troschel.

Station 3. Aug. 3 and 4, 1880. Lat. $59^{\circ} 12' N.$, long. $5^{\circ} 57' W.$ Depth, 53 fathoms. Two examples.

One large specimen having thirteen rays, $R = 122$ millim., $r = 45$ millim.; and the other a small one with twelve rays.

9. *Crossaster papposus*, var. *septentrionalis*, n.

Station 2. July 29, 1880. Lat. $60^{\circ} 29' N.$, long. $8^{\circ} 19' W.$ Depth, 375 fathoms; bottom temperature, 31° Fahr.; surface temperature, 53° Fahr.; mud. A single example.

An interesting variety was dredged at Station 2 in 375 fathoms, which on account of its well-marked character I consider desirable to recognise by name,—a course further justified by its constancy over a considerable area of distribution. In proposing this step, however, I wish to state clearly that I do not regard the form as specifically distinct from *Crossaster papposus*. The form is ten rayed, and accords in this and other particulars with a number of examples taken at different stations during the "Porcupine" cruise. The chief characters are persistent throughout the whole series of specimens that I have examined; several, however, are present in an extreme degree in the specimen under notice, of which the following may be taken as a brief description:—

Rays ten, short, broad at the base, and sharply tapering, radial proportions = $R < 2 r$; $R = 35$ millim., $r = 18$ millim. Dorsal surface of the disk gibbous, sloping rather quickly at the base of the rays. Paxillæ small, numerous, closely crowded, with 10 to 21 spinelets, which are more or less divergent from the pedicel. 15 to 17 paxillæ may be counted in a median interradyal line and about 10

across the base of a ray. Papulæ few, not more than 1 to 3 in a group.

Ambulacral spines : (1) furrow series, six on each plate near the mouth, five on the more outward plates, the aboral spine smallest ; (2) transverse series composed of eight spines. The two spines nearest the furrow are placed more aborally than the rest, which gives the line of base of each transverse series an aboral curve at the furrow side. The middle spines are longest, the outermost smallest ; all tapering to a fine point, robust at the base ; no webbing apparent. Mouth-plates with robust mouth-spines, and a prominent series of 9 to 10 secondary superficial spinelets, larger than the marginal mouth-spines. Interbrachial areas covered with small paxillæ, and rather crowded.

Remarks.—On comparing with the above form a typical *Crossaster papposus* of the same diameter, it will be found that in the latter the rays, which are 11 to 13 in number, are less tapering and relatively longer, the proportion being $R > 2.5 r$. The dorsal area of the disk is very little higher than the rays. The paxillæ are larger, fewer, more widely spaced, and bear a greater number of spinelets, usually about 40, which are arranged much more compactly and give the paxillæ a more rounded appearance,—often resembling that of a well-worn brush, the central spinelets being longest. The papulæ are more numerous, 5 to 10 or more. Ambulacral spinelets three in the inner or furrow series,—a fourth very minute one, placed aborally, being present near the mouth. Transverse combs of five spinelets, those near the furrow series longest ; line of base straight ; webbing at the base more or less present. All the spinelets are more delicate in character than in the variety. Mouth-plates with delicate spines ; secondary mouth-spines not more than two or three. Interbrachial areas quite naked or with only one or two small paxillæ.

This variety conforms in several respects with the admirable description given by Danielssen and Koren* of the form which they refer to the *Solaster affinis* of Brandt. The differences, however, are so marked that I cannot regard them as one and the same form ; and in none of the specimens which I have examined either from the “Porcupine” or the “Knight Errant” dredgings can I recognise an identity with the specimens described by the eminent Norwegian

* *Nyt Mag. f. Naturvidensk.*, 1877, bd. xxiii. 3, p. 57.

naturalists. Judging from the description above cited, it seems to me that our variety occupies an intermediate position between the typical form of *Crossaster papposus* and the *Solaster affinis* of Danielssen and Koren; and thus appears to me to strengthen the opinion elsewhere expressed,* that the latter form is probably a locational variation of the type of *C. papposus*.

10. *Asteracanthion rubens* (Linné), Müller and Troschel.

Station 3. August 3 and 4, 1880. Lat. $59^{\circ} 12' N.$, long. $5^{\circ} 57' W.$ Depth, 53 fathoms. Three examples; two of them being small.

The large specimen is remarkable for the elongation and attenuation of the radii, and for the comparative paucity and smallness of the dorsal spinelets. These are minute, conical, and almost hidden in the membrane. The margin of the dorsal area is bounded by a regular and prominent line of spinelets, and the median dorsal line is also more or less regular. The other spinelets are quite irregular in disposition and though moderately numerous are inconspicuous in consequence of their small size. The sides of the rays are deeper and more perpendicular than usual. Lateral spines, 2 or 3 in number, placed obliquely. No spines on the sides between these spines and the true dorsal series, and no spines between the lateral series and the ambulacral spines. Forficiform pedicellariæ very numerous on the ambulacral spines, especially in the inner portion of the furrow, also on the sides of the ray; smaller and less numerous on the dorsal area. Forcipiform pedicellariæ comparatively scanty, a few at the base of the marginal dorsal spines, and a greater number at the base of the lateral spines; a few irregularly distributed over the dorsal area. This specimen in some respects simulates the habit of *A. glaciale* in a striking manner.

11. *Asteracanthion mülleri*, Sars.

Station 3. Aug. 3 and 4, 1880. Lat. $59^{\circ} 12' N.$, long. $5^{\circ} 57' W.$ Depth, 53 fathoms. A single example.

II. Station-Lists.

The following lists will show at a glance the association of the species at each of the stations.

* Duncan and Sladen, *A Memoir on the Echinodermata of the Arctic Sea to the West of Greenland*, London, 1881, p. 39.

Station 2. July 29, 1880. Lat. 60° 29' N., long. 8° 19' W. Depth, 375 fathoms. Bottom temperature, 31° Fahr.; surface temperature, 53° Fahr.; mud.

Crossaster papposus, var. *septentrionalis*.

Station 3. Aug. 3 and 4, 1880. Lat. 59° 12' N., long. 5° 57' W. Depth, 53 fathoms; off the island of North Rona.

Luidia sarsii.

Crossaster papposus.

Porania pulvillus.

Asteracanthion rubens.

Cribrella oculata.

Asteracanthion mülleri.

Station 4. Aug. 10, 1880. Lat. 59° 33' N., long. 7° 14' W. Depth, 555 fathoms; bottom temperature, 45°·4 Fahr.; surface temperature, 57° Fahr.; mud.

Mimaster tizardi.

Station 7. Aug. 12, 1880. Lat. 59° 37' N., long. 7° 19' W. Depth, 530 fathoms.

Archaster bifrons.

Astropecten andromeda.

Station 8. Aug. 17, 1880. Lat. 60° 3' N., long. 5° 51' W. Depth, 540 fathoms. Bottom temperature, 29°·2 Fahr.; surface temperature, 56°·5 Fahr.; ooze.

Archaster tenuispinus.

Report on OPHIUROIDEA. By Professor Theodore Lyman.

I have examined the “Knight Errant” Ophiuroidea. They are as follows:—

<i>Ophioglypha aurantiaca</i> , VII.	St. 6	530 fms.
„ <i>signata</i> , VII.	St. 8	540 „
<i>Ophiactis abyssicola</i> , Ljn.	St. 2	375 „
	St. 7	530 „
<i>Ophioconia nigra</i> , Mull. & Tr.	St. 3	53 „
<i>Ophiopholis aculeata</i> , Gray	St. 3	53 „
<i>Ophiothrix pentaphyllum</i> , Ljn.	St. 3	53 „
<i>Ophioscolex glacialis</i> , Mull. & Tr.	St. 2	375 „
<i>Ophiacantha tridentata</i> , Ljn.	St. 5	515 „

It is curious that they did not get things like *Ophiacantha spinulosa*, and several common species of *Ophioglypha*, and that they did get new things, viz., *Ophioglypha aurantiaca* and *O. signata*. The latter, however, stands pretty near the common *O. affinis*.

Report on the SPONGES. By Professor Franz Eilhard Schulze.

Station No. 2, July 29, 1880 ; 275 fathoms.

(1) Two medium-sized specimens of *Tisiphonia agariciformis*, Wyville Thomson (*Depths of the Sea*, p. 74).

(2) An irregularly triangular flattened disc about 15 square centimetres in area and 2·5 mm. thick, flexible, and of the consistency of leather. One edge is irregularly torn, the two others are rounded off smoothly : the latter evidently represent the free margin in its normal condition. The surface on both sides exhibits a system of round pit-like depressions about 1 mm. broad, between which is left a level reticulate lattice-like network of trabeculæ, which also have a thickness of 1 mm. Large numbers of short siliceous spicules occur, pointed at one end and blunt at the other ; they are united into a loose skeleton of tri- or quadri-lateral meshes by an extremely small amount of horny substance, and are all of the same form and size. Thus the sponge under notice is a *Reniera* (in the broad sense of the word). The species was hitherto unknown.

(3) A coarsely woven mass of siliceous spicules made up of long rod-like and abundant smaller quinque- and sex-radiate forms ; it was probably derived from a *Holtenia*.

Station No. 3 ; 53 fathoms.

Tetilla Cranium, Müll.

Station No. 7 ; 530 fathoms. A packet of long tuft spicules from a Hexactinellid, most probably a *Holtenia*.

Station No. 8 ; 540 fathoms. Several examples of *Stylorhiza stipitata*, Oscar Schmidt (*Sponges of the Gulf of Mexico*, p. 79), a species identical with *Polymastia stipitata*, Carter (*Annals of Nat. Hist.*, 1876, ser. 4, vol. xviii. p. 393.)

Besides adults, young forms also occur, which exhibit a roundish head.

Report on the FORAMINIFERA. By Henry B. Brady, F.R.S.

This Report was received by the late Sir C. Wyville Thomson,
in November 1880.

Sea-bottoms.—Specimens of the sea-bottom from five localities have been examined and the Foraminifera determined. Particulars

as to locality, physical conditions and the like, are given in the following summary. The letters A, B, C, D, E correspond to the headings of the columns in the distribution-table, and are otherwise used for reference.

- A. "STATION 1.—July 27 ; lat. $60^{\circ} 4' N.$, long. $7^{\circ} 37' W.$; depth 305 fathoms ; bottom temperature, 47.1° Fahr. ; surface temperature, 54.8° ."

Greyish-brown sandy mud, leaving but little residue after washing, and that chiefly hard silicious sand, with larger dark-coloured fragments. But few Foraminifera, principally of large coarse types such as *Anomalina coronata*, *Truncatulina refulgens*, and *Tr. lobatula* and *Uvigerina pygmæa*.

- B. "STATION 2.—July 29 ; lat. $60^{\circ} 29' N.$, long. $8^{\circ} 19' W.$; depth, 375 fathoms ; bottom temperature, 31.0° Fahr. ; surface temperature, 53.0° ."

Brownish sandy mud, with a good many small fragments of rock of darker colour. Foraminifera by no means abundant—the most conspicuous genera being *Globigerina*, *Polystomella*, *Nonionina*, and *Cassidulina*. One or two specimens of the interesting sessile species *Rupertia stabilis* were found in this gathering. A considerable proportion of the *Globigerinæ* were of the small arctic variety, *Gl. borealis*.

- C. "STATION 4.—August 10 ; lat. $59^{\circ} 33' N.$, long. $7^{\circ} 14' W.$; depth, 555 fathoms ; bottom temperature, 45.4° Fahr. ; surface temperature, 57.0° ."

Grey *Globigerina*-ooze, leaving very little residue after washing. The residue composed almost entirely of the shells of Foraminifera, chiefly of *Globigerina bulloides* and *Gl. inflata*.

- D. "STATIONS 6 and 7.—August 12 ; lat. $59^{\circ} 37' N.$, long. $7^{\circ} 19' W.$; depth, 530 fathoms ; bottom temperature, 45.9° Fahr. ; surface temperature, 56.6° ."

Globigerina-ooze very rich in arenaceous types of Rhizopoda, notably *Astrorhiza*, *Rhabdammina*, and *Marsipella*, with occasional examples of *Saccammia* and *Storthosphæra*. Of the hyaline species, *Rotalia orbicularis*, by no

means a common form, alone requires notice—the specimens being not only plentiful but unusually fine.

E. "STATION 8.—August 17; lat. 60° 3' N., long. 5° 51' W.; depth, 540 fathoms; bottom temperature, 29·2° Fahr.; surface temperature, 56·5°."

Muddy sand. Of arenaceous Rhizopoda, *Reophax sabulosa* and *R. scoriurus* are the most remarkable. The former is a large rare species, only previously known by specimens from one of the "Porcupine" stations. The latter is cosmopolitan, but in this particular dredging is particularly abundant. Of the calcareous types, *Cornuspira* claims attention from the gigantic size of some of the specimens, and *Lagena* from the long list of species found; *Pullenia sphaeroides* and *Cassidulina lævigata* are also prominent forms. A large proportion of the *Globigerinæ* are of the small northern thick-shelled variety.

Detailed lists of the Foraminifera from the several localities are furnished in the following table. It will be seen from the temperatures recorded in the foregoing summary that the columns headed A, C, and D represent the Rhizopod-fauna of a warm sea-bottom, B and E of a cold area.

A comparison of the Rhizopod-fauna of the cold sea-bottom, represented by column E, with that of the warmer area typified by C and D, suggests some interesting facts in connection with the distribution of species. The larger arenaceous types pertaining to the family *Astrorhizidæ*, such as *Astrorhiza*, *Saccammmina*, *Storthosphæra*, *Rhabdammina*, *Jaculella*, *Marsipella*, and *Hyperammmina*, are for the most part conspicuously absent from the colder portion of the channel, and appear to be partially replaced by the weaker forms of *Lituolidæ*. The genus *Bulimina* in its typical condition affects the warm area; whilst in the cold, the starved transition varieties which constitute the sub-genera *Bolivina* and *Virgulina* abound. The genus *Lagena* is represented in the cold region by a list of fifteen species; in the warm by only eight. The little thick-shelled *Globigerina borealis*, so far as we know, is confined to the cold area, and, as has been stated, the gigantic *Cornuspira striolata* is similarly limited in distribution. How far these facts may indicate general laws can only be determined by further investigation, and on the comparison of a larger series of soundings than are at present available.

	A	B	C	D	E
<i>Biloculina ringens</i> (Lamk.) . . .	×			×	
<i>depressa</i> , D'Orb.				×	
<i>comata</i> , Brady				×	
<i>elongata</i> , D'Orb.		×		×	
<i>Planispirina contraria</i> (D'Orb.) . . .					×
<i>Miliolina seminulum</i> (Linn.)	×	×		×	×
<i>trigonula</i> (Lamk.), var.				×	
<i>tricarinata</i> (D'Orb.	×			×	×
<i>celata</i> (Costa)	×		×	×	
<i>Cornuspira striolata</i> , nov.					×
<i>carinata</i> (Costa)				×	
<i>involvens</i> , Reuss				×	×
<i>crassisepta</i> , nov.				×	
<i>Psammospæra fusca</i> , F. E. Schulze . .					×
<i>Saccamina spherica</i> , M. Sars				×	
<i>Astrorhiza arenaria</i> , Norman				×	
<i>Storthospæra albida</i> , F. E. Schulze . .				×	
<i>Rhadamina abyssorum</i> , M. Sars . . .	×			×	
<i>discreta</i> , Brady				×	
<i>cornuta</i> , Brady				×	
<i>Jaculella obtusa</i> , nov.				×	
<i>Marsipella elongata</i> , Norman				×	
<i>cylindrica</i> , nov.				×	
<i>Hyperammia elongata</i> , Brady				×	×
<i>ramosa</i> , Brady				×	×
<i>Reophax difflugiformis</i> , Brady			×	×	×
<i>scorpiurus</i> , de Montfort			×		×
<i>adunca</i> , nov.				×	
<i>guttifera</i> , Brady					×
<i>sabulosa</i> , Brady					×
<i>Haplophragmium canariense</i> (D'Orb.)				×	×
<i>subglobosum</i> (M. Sars)					×
<i>scitulum</i> , Brady				×	
<i>simplex</i> , Reuss				×	
<i>tenuimargo</i> , nov.				×	
<i>Placopsilina vesicularis</i> , Brady . . .					×
<i>Trochamina squamata</i> , P. & J. . . .					×
<i>charoides</i> , J. & P.				×	
<i>Webbina clavata</i> , J. & P.				×	
<i>Cyclammia cancellata</i> , Brady				×	
<i>Thurammia papillata</i> , Brady					×
<i>Textularia sagittula</i> , DeFrance . . .	×				
<i>trochus</i> (D'Orb.)					×
<i>aspera</i> , nov.				×	
<i>Verneuilina pygmæa</i> (Egger)				×	
<i>Gaudryina pupoides</i> , D'Orb.			×	×	
<i>Valvulina fusca</i> (Will.)				×	
<i>Bulimina marginata</i> , D'Orb.			×	×	
<i>pyrula</i> , D'Orb.				×	
<i>subteres</i> , Brady				×	×
<i>Virgulina Schreibersiana</i> , Czjzek . .					×
<i>squamosa</i> , D'Orb.				×	×
<i>Bolivina punctata</i> , D'Orb				×	×
<i>dilatata</i> , Reuss					×
<i>pygmæa</i> , Brady				×	×
<i>canariensis</i> (Costa)					×
<i>Cassidulina lævigata</i> , D'Orb. . . .	×	×	×	×	×
<i>crassa</i> , D'Orb.	×		×	×	×
<i>Lagena globosa</i> (Montagu)	×				
<i>lævis</i> (Montagu)					×
<i>apiculata</i> , Reuss		×			×

	A	B	D	C	E
<i>Lagena acuta</i> , (Reuss) . . .				x	x
<i>gracillima</i> (Seg.) . . .		x		x	x
<i>marginata</i> , W. & J. . . .				x	
<i>orbignyana</i> , Seg.				x	x
<i>distoma</i> , P. & J.				x	x
<i>striata</i> (D'Orb.)				x	x
<i>semistriata</i> , Will.					x
<i>sulcata</i> (W. & J.)				x	x
<i>pulchella</i> , Brady					x
<i>lineata</i> (Will.)					x
<i>melo</i> (D'Orb.)					x
<i>squamosa</i> (Montagu)		x	x	x	x
<i>lagenoides</i> , Will.					x
<i>hispidula</i> , Reuss					x
<i>Nodosaria</i> (G.) <i>laevigata</i> , D'Orb. . .			x	x	
(G.) <i>rotundata</i> , Reuss				x	
<i>simplex</i> , Silv.				x	
<i>scalaris</i> (Batsch.)	x		x	x	x
(D.) <i>communis</i> , D'Orb.			x		
(D.) <i>soluta</i> , Reuss					x
(D.) <i>pauperata</i> , D'Orb.					x
<i>Vaginulina linearis</i> (Montagu) . . .		x			x
<i>spinigera</i> , Brady				x	
<i>Marginulina glabra</i> , D'Orb.					x
<i>costata</i> (Batsch.)					x
<i>Cristellaria rotulata</i> , Lamk.	x		x	x	x
<i>cultrata</i> (de Montfort)				x	
<i>reniformis</i> , D'Orb.				x	
<i>Polymorphina lactea</i> (W. & J.) . . .	x			x	x
<i>Uvigerina pygmaea</i> , D'Orb.	x		x	x	
<i>angulosa</i> , Will.	x	x	x		x
<i>Globigerina bulloides</i> , D'Orb. . . .	x	x	x	x	x
<i>inflata</i> , D'Orb.	x	x	x	x	x
<i>bulloides</i> , var. <i>borealis</i>	x	x			x
(Orbulina) <i>universa</i> , D'Orb. . . .	x	x	x	x	x
<i>Hastigerina pelagica</i> (D'Orb.) . . .			x	x	
<i>Pullenia sphaeroides</i> (D'Orb.) . . .			x	x	x
<i>quingueloba</i> , Reuss	x		x	x	
<i>Sphaeroidina bulloides</i> , D'Orb. . . .	x			x	
<i>Spirillina vivipara</i> , Ehrenb.					x
<i>Patellina corrugata</i> , Will.					x
<i>Planorbulina ariminensis</i> (D'Orb.) .	x			x	
(<i>Truncatulina</i>) <i>lobatula</i>					
(W. & J.)	x	x	x	x	x
(<i>Tr.</i>) <i>refulgens</i> (de Mont.) . . .	x	x			
(<i>Tr.</i>) <i>variabilis</i> , D'Orb.	x	x			
(<i>Anomalina</i>) <i>coronata</i> , P. & J. . .	x				
<i>Rupertia stabilis</i> , Wallich.		x			
<i>Pulvinulina repanda</i> (F. & M.) . . .	x				
<i>karsteni</i> (Reuss)	x	x			
<i>menardii</i> (D'Orb.)	x				x
<i>canariensis</i> (D'Orb.)		x	x		
<i>scitula</i> , nov.			x	x	x
<i>melchioriana</i> (D'Orb.)	x			x	x
<i>Rotalia orbicularis</i> , D'Orb.			x	x	x
<i>Nonionina stelligera</i> , D'Orb.	x	x			
<i>scapha</i> (F. & M.)	x	x			
<i>turgida</i> (Will.)	x		x	x	x
<i>umbilicatula</i> (Montagu)	x	x	x		x
<i>Polystomella striato-punctata</i> (F. & M.)	x	x		x	x
<i>Operculina ammonoides</i> (Gron.) . .			x	x	

The following notes refer to species mentioned in the foregoing table, which are either new to science or otherwise present points of interest :—

Planispirina contraria (*Biloculina contraria*, d'Orbigny).—Dr. Steinmann (*Neues Jahrb. für Min.*, 1881, vol. i. p. 37, pl. 2), describes in detail the structure of the shell in this species, and shows sufficient grounds for separating it from the genus *Biloculina*. In point of fact, it is an intermediate sub-type, more nearly resembling *Hauerina* than *Biloculina*, but differing from the former in two important particulars, namely, the alar extension of the chamber-walls over the lateral surfaces of the test, which imparts to the shell a laminated structure like that of a nummulite, and the simple arched orifice instead of a cribrate aperture. On the basis of the former of these characters Dr. Steinmann proposes for it the generic term *Nummoloculina*.

My friend, the Rev. A. M. Norman, placed in my hands, long ago, some specimens dredged in the Farøe Channel, which were in the collection of the late Edward Waller. These belong to a closely allied species, and have been regarded as somewhat anomalous *Hauerinæ*. More recently, Professor Seguenza of Messina has had the goodness to send me examples of his *Planispirina communis* (*Mem. R. Accad. Lincei*, 1879–80, vol. vi. p. 310, pl. xvii. fig. 18), and I find them to be quite indistinguishable from Mr. Waller's unnamed form; in both the laminated structure is even more apparent than in *Pl. contraria*. Under these circumstances Professor Seguenza's generic term takes precedence of the more appropriate one suggested by Dr. Steinmann. The "Challenger" species described as *Hauerina exigua* (*Quart. Jour. Micr. Sci.*, vol. xix. n. s. p. 267) must be referred to the same genus; and there is still another more aberrant modification amongst the "Challenger" gatherings, to which the MS. name *Pl. sigmoidea* has been applied.

Cornuspira striolata, nov., resembles the typical *C. foliacea* in general characters, but the last convolution widens rapidly, spreading out and imparting to the test a contour very similar to that of the wide "bonnet-shaped" varieties of *Peneroplis*. The specimens sometimes attain extraordinary dimensions, the largest hitherto found being one from Station E, which mea-

sures more than an inch in diameter (1·2 inch or 31 mm.); a second, somewhat thicker proportionately, measures ·45 inch, or nearly 12 mm. Both of these have a surface ornament of fine, raised, closely-set striæ, parallel to the direction of growth, not absolutely straight and continuous, but taking a slightly waved and irregular course.

Cornuspira involvens, Reuss.—The specimens from both localities are somewhat doubtful; they have fewer convolutions than usual, and it is just possible they may be the tubes of minute annelids.

Cornuspira crassisepta, nov.—Convolution very narrow and numerous, especially near the centre, as in *C. involvens*; but the peripheral edge is nearly square instead of rounded, and the spiral septal wall is thick, and marked externally by a raised limbate line. Diameter $\frac{1}{4\frac{1}{5}}$ inch, or 0·56 mm.

This is the isomorph in the porcellanous series, of a somewhat rare perforate form, *Spirillina limbata*.

Rhabdammina cornuta, Brady.—This is the species previously described under the name *Astrorhiza cornuta* (*Quart. Jour. Micr. Sci.*, vol. xix. n.s. p. 43, pl. iv. figs. 14, 15), but the structure of the test accords better with the firmly-cemented shell of *Rhabdammina* than with the thick, loose, sandy investment of *Astrorhiza*, and its position has been changed accordingly.

Jaculella obtusa, nov.—Test long, cylindrical, nearly straight, consisting of a tapering tube, commencing in a small bulbous chamber, and gradually increasing in size to the opposite extremity, which is broad and open. Texture coarsely arenaceous, hard and firmly cemented; exterior rough. Length, $\frac{1}{3}$ inch, or 8·0 mm.

It is possible that this may be only a variety of *Jaculella acuta*, from which it differs chiefly in having a small inflated primordial chamber instead of terminating in a point, and in its generally more slender contour. Of all arenaceous Foraminifera *Jaculella* appears to have the hardest and most firmly cemented test; at any rate, it is the one of which it is most difficult to obtain a satisfactory section by ordinary methods.

Marsipella cylindrica, nov.—Amongst the Arenacea found in the material from D., are a number of delicate cylindrical tubes, of

nearly even diameter, built up of short sponge-spicules laid side by side, and forming irregular, more or less interlacing tiers. The largest specimen is about a quarter of an inch (6 mm.) in length, and $\frac{1}{150}$ inch (0.17 mm.) in diameter, but such pieces can only be regarded as fragments of an organism that may be developed almost indefinitely. The species is manifestly closely related to *Marsipella elongata*, with which it is found associated. Similar fragments occur in one or more of the “Porcupine” dredgings, and less characteristic specimens at two of the “Challenger” stations.

Reophax difflugiformis, Brady.—There seemed a possibility that this species might turn out to be only the primordial chamber of *R. scorpiurus*, but as it exists in abundance in one of the dredgings (D) in which no specimen of the latter has been found, it is evident that it holds an independent position.

Reophax adunca, nov.—Test moniliform, consisting of a crooked line of inflated segments, irregular in size, but of nearly equal diameter. External constrictions between the segments comparatively slight; walls thin, rough externally. Length indefinite, specimens seldom found with either end entire; those which have been measured are about $\frac{1}{12}$ inch or 2 mm.

Reophax sabulosa.—This is the *Reophax rudis* of a previous paper (*Quart. Jour. Micr. Sci.*, vol. xxi. n. s. p. 49). The specific term *rudis* being preoccupied by a distinct form, figured by Costa as a *Nodosaria*, an alteration of name becomes necessary.

Haplophragmium tenuimargo, nov.—Test elongate, crosier-shaped, much compressed; lateral edges very thin. Spiral chambers few and small; linear segments about six in number, broad, slightly convex; septation obscure; aperture simple, irregular in form, terminal; texture coarse, surface extremely rough. Length of largest specimen, $\frac{1}{10}$ inch or 2.5 mm.

This is a somewhat rare species. Specimens have been met with at five of the “Challenger” stations in various parts of the world, at depths varying from 1000 to 3950 fathoms, but never more than one or two specimens from a locality.

Textularia aspera, nov.—An obscure few-chambered Textularian, with a loosely-made arenaceous test, not uncommon in some of

the "Porcupine" dredgings, and often found parasitic upon *Rhabdammina*, occurs in the material from Station D. In localities where it is abundant, some of the specimens generally present triserial or Verneuline characters. As it does not appear to have been described, I have given it the provisional name, *T. aspera*.

Cristellaria reniformis, D'Orbigny. — Under this species are included a group of large, flat, more or less carinate *Cristellariæ*, common at moderate depths in the North Atlantic, presenting every variety of contour from *Cristellaria compressa*, D'Orb., to *C. reniformis*, D'Orb. (*For. Foss. Vien.*, Pl. III. figs. 32, 33 and 41, 42).

Globigerina bulloides, var. *borealis*, nov.—In the fear of introducing unnecessary names, I have been unwilling to employ a distinctive term for the small thick-shelled *Globigerinæ* common in cold areas, if not peculiar to them; and they have been treated hitherto as starved examples of the species to which they seemed most nearly related from a morphological point of view, namely, *Globigerina bulloides* and *Gl. Dutertrei*. They are, however, very uniform in character, and the more they are studied the more distinct and easily recognised they become. It seems desirable, therefore, that their peculiarities should be embodied in a specific, or at any rate in a varietal, definition.

The test is of smaller dimensions than *G. Dutertrei*, the longer diameter of fully-grown specimens being about 3 mm. (that of the D'Orbignian species is 5 mm.), and it has fewer chambers, almost invariably four in the final convolution. The shell-wall is relatively much thicker and the aperture less conspicuous, but the habit of growth in other respects is very similar. Compared with *Globigerina bulloides*, the shell is more compactly built, its segments are less inflated and globular, and it has no umbilical vestibule. Under the name of "*Globigerina bulloides*, arctic variety," it is figured in the *Ann. and Mag. Nat. Hist.* ser. 5, vol. i. pl. 21, fig. 10.

Pulvinulina scitula, nov.—A variety of *Pulvinulina canariensis*, differing from the typical form in its relatively small size and compact habit of growth. The margin is rounded instead of

sharp, and the peripheral ends of the chambers are only slightly convex instead of standing out prominently as in *P. canariensis*. Notwithstanding its small minute dimensions, it generally attracts attention by its glistening white appearance. Longer diameter, $\frac{1}{100}$ inch or 0.25 mm.

With one or two exceptions all these species, though some have been undescribed hitherto, occur in the material obtained on the “Challenger” and “Porcupine” expeditions, so that figures, as well as further details respecting their history and distribution, may be left until the publication of the “Challenger” report on Foraminifera. It may just be mentioned that the empty silicious tests of one of the *Phæodaria* (the form with Mr Murray’s manuscript name *Challengeria naresi*) were found in the material from D and E.

Surface Forms.—There has not been time for the complete investigation of the gatherings made by the tow-net, and the following notes on the surface fauna are based upon the examination of about thirty mountings made by Mr Murray. As these are from material taken on nine different days, between July 27 and August 12, at various depths, from the actual surface down to 35 fathoms, and vary but little in the Foraminifera they contain, they are probably sufficiently representative.

The *Globigerinæ* are all referable to *Gl. bulloides*, *Gl. inflata*, and *Gl. (Orbulina) universa*; the specimens are small and thin-shelled, and those of *Globigerina* (proper) are non-spinous. The *Orbulinæ*, on the other hand, are sometimes armed with very short delicate spines. No specimens of *Globigerina borealis* occur in any of the surface mountings, and no *Pulvinulinæ*. The absence of the latter is in no way remarkable, for none of the species known to be pelagic are present in any considerable number in the dredged material; but that the small northern variety of *Globigerina*, which is tolerably abundant as a bottom species in three out of the five localities, should not be an equally prominent constituent of the surface fauna is a noteworthy fact.

Report on the Gas Contents of a number of Samples of Sea Water.
By Professor Dittmar, F.R.S.

The waters were left at my laboratory by Mr. Murray in the month of August.

In obedience to instructions received they were boiled out, the gases collected, measured, and analysed ; care being taken to use the same methods as had served for corresponding work done in connection with the "Challenger" expedition.

The samples were contained in bottles of about one litre's capacity, provided with well-fitting glass stoppers. The bottles were almost full to the top ; the empty air-space amounting to only 7 c.c. or thereabouts. The samples stood in my laboratory for some weeks before I received my orders as to what I should do to them ; but they were carefully protected against direct sun-light, or elevation of temperature by other causes, and the stoppers never lifted before the contents were taken out to be worked up. Hence the dissolved gases are not likely to have changed much either qualitatively or quantitatively during the storage of the waters ; the less so as the percentage of oxygen in the gas minus carbonic acid was in all cases found to be little different from what (according to my analyses of the "Challenger" water-gases) is generally met with in surface waters.

The boiling-out of the gases was effected by means of Jackobsen's apparatus, the flask of which held 740 c.c. of water. The flask in each case was charged by means of a long necked wide funnel going to the bottom of the flask ; through this funnel water was run in until about 100 c.c. of water had run over the edge of the flask. This 100 c.c. of water, which was allowed to go to waste, could be assumed to include all that portion which was, to more than the absolutely unavoidable extent, affected by contact with the atmosphere of the laboratory. In regard to the rest of the work I may content myself with referring to my report on the "Challenger" gases.

Labels.

I. "Bottom Water No. 31 ; 11th August 1880. Depth, 515 fathoms."

II. “Bottom Water, No. 33 ; 17th August 1880. Depth, 540 fathoms.”

III. “Bottom Water, No. 26 ; 4th August, 1880. Depth, 460 fathoms. Rona-Faroe.”

IV. “Bottom Water ; sounding No. 11 ; 28th July 1880. Depth, 270 fathoms.”

V. “Bottom Water ; 27th July 1880, Depth, 560 fathoms.”

Supplementary label :—“This bottle was broken.”

In the following statement of the results, Vo means the volume in cubic centimetres (reduced to 0° C., and 760 millimetres, and absolute dryness), of the total gas extracted from one litre of water. vo means the volume in cubic centimetres of the nitrogen and oxygen contained in those Vo c.c. of total gas, similarly reduced. So that Vo – vo represents the carbonic acid (in cubic centimetres and reduced as above) per litre of water.

	I.	II.	III.	IV.	V.
Vo,	24·49	25·47	18·77	20·08	22·12
vo,	13·92	14·80	13·74	15·95	14·40
Per cents. of CO ₂ in Vo,	43·16	41·88	26·80	20·59	34·88
Per cents. of O ₂ in vo, .	32·01	32·28	34·23	35·55*	32·88

* This number is *very* high ; possibly it may be infected with an unobserved error. Unfortunately there was not enough of material to repeat either the boiling out or the analysis of the gas resulting from the one boiling.

(Signed)

W. DITTMAR.

Note.—The percentages of CO₂ are rather high. The percentages of oxygen (in the gas freed from CO₂) are decidedly higher than those obtained for the “Challenger” waters from similar depths.

The high percentage of oxygen is owing probably to the relatively low values of the temperatures at which the waters originally absorbed their air, and the relative absence at their respective situations of decaying organic matter.

May 11, 1882.

W. D.

Rocks of North Rona collected in August 1880 on the North-east Spur of the Island. By Prof. A. Renard and John Murray.

1. Amphibolic rock with a more or less schistose structure, fine grained, breaking in elongated fragments following the plane in which the crystals of hornblende are arranged. It contains especially black brilliant hornblende with the cleavages of $124^{\circ} 30'$. Also quartz and some grains of feldspar.

2. A rolled fragment of sandstone (Cambrian?), red, fine grained, passing to arkose. This rock is essentially composed of fragments of quartz more or less rounded, of particles of hornblende, of epidote, of mica, and of more or less altered feldspar.

3. Gneiss composed of lamellæ of muscovite, plagioclase, orthoclase, and quartz.

4. Granitite containing plagioclase, orthoclase, quartz, and biotite.

5. Amphibolic rock, almost entirely formed of an aggregation of crystals of black hornblende, whose dimensions are from 0·5 to 1 centimetre, and show prismatic cleavage. Associated with the hornblende are granular quartz, lamellæ of biotite, and orthoclase.

7. Rolled pebbles of a clastic rock (Cambrian?) composed of fragments of quartz, more or less rounded, and red orthoclase.

8. Gneissic rock formed of quartz, orthoclase, lamellæ of biotite, and rather large crystals of hornblende.

2. Notice of the Solar Eclipse of the 17th May, with Remarks on the Calculation. By Mr. Edward Sang.

The eclipse of the 31st December 1880 was not seen here, and thus we lost the opportunity of comparing the computed with the observed times.

In the daily papers at that time expression was given to a feeling of dissatisfaction that any computation should have been added to that recorded in the *Nautical Almanac*. And therefore, while laying before the Society the results at which I have arrived in regard to the coming eclipse, it may be proper for me to explain how such an investigation comes to be needed.