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*L.M.B.C. REPORTS. No. III.*

THE THIRD VOLUME OF REPORTS  
UPON THE  
FAUNA OF LIVERPOOL BAY  
AND THE  
NEIGHBOURING SEAS,

WRITTEN BY THE MEMBERS OF THE  
LIVERPOOL MARINE BIOLOGY COMMITTEE,  
AND OTHER NATURALISTS,

AND EDITED BY

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*WITH TWENTY-THREE PLATES AND A CHART.*

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PRINTED FOR THE  
LIVERPOOL MARINE BIOLOGY COMMITTEE,  
UNIVERSITY COLLEGE, LIVERPOOL;

BY  
THOMAS DOBB & CO.,  
LIVERPOOL.

1892.



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## CORRECTIONS.

- In Third Annual Report &c., p. 27, line 6 from foot, for *Swammerdamii* read *vedlomensis*.
- Do. do. p. 37, line 8 from top, *D. bradyi* may = *D. spinosa*.
- In Third Report on Porifera, p. 228, line 8 from foot, the “prionorrhabs” belong to *Sycandra*.
- In Fourth Annual Report &c, p. 10 middle, delete *Sertularella tenella*.
- Do. do. p. 19, line 7 from foot, delete *Leda pernula*.
- Do. do. p. 29, line 4 from foot, delete *Chiton discrepans*.
- In Revised List of Marine Algae, Plates, for Pl. 34 read Pl. III.
- Do. p. 94, Footnote, read Vol. XXVIII.
- Do. p. 112, line 5 from top, for 29 read 22.
- Do. do. line 6 from foot, for 42 read 45.
- Do. p. 114, line 6 from top, for 39 read 40.
- Do. p. 122, line 14 from foot, for 90 read 89.
- Do. p. 125, add at end :—
- Fig. 10. Isolated central cell,  $\times 450$ .
- Fig. 11. Striation on walls of intercellular canal,  $\times 450$ .





## INTRODUCTION.

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THREE years elapsed between the publication of the first (1886) and of the second (1889) volumes of L.M.B.C. Reports, and now after a further interval of three years this third volume is issued. As in the case of vol. II, all the papers in the present volume have been read before the Liverpool Biological Society; and the L.M.B.C. have to thank the Council of that Society for the necessary permission to print off extra sheets of those papers in the "Transactions" which deal with the Fauna and Flora of Liverpool Bay. The duplication in the numbering of pages and plates, due to the fact that the reprints have been taken from separate volumes of Transactions, need not cause any difficulty or confusion if authors having occasion to quote from the work will kindly give the title of the article as well as of the volume: e.g., the new sponge described by Dr. Hanitsch as *Leucaltis impressa* may be referred to under "Fauna of Liverpool Bay, vol. III, Third Report on Porifera, p. 234."

The L.M.B.C. desire once more to place on record their grateful appreciation of the assistance and encouragement which they have received from various friends in Liverpool and the neighbourhood. The Liverpool Salvage Association have been especially helpful in placing at the service of the Committee their useful steamer the "Hyæna," thus facilitating the exploration of the more distant parts of the district.

The most notable event in the L.M.B.C. work of the last three years is the transfer of the Marine Biological Station from Puffin Island to the Isle of Man. The Puffin Island Station has been of great service to the Committee

during the past five years, and has been well worth the small annual expenditure required for its modest outfit; but it has been felt for the last year or so that a station at some place more readily accessible from Liverpool and with hotel or lodging accommodation obtainable on the spot, would enable their members to do more work, and also be of more use both to students and to investigators. Also it was becoming evident that after five years work upon the very limited ground presented by the shores of the small island the greater number of the plants and animals had been collected and examined, and that a change to a new locality with a rich fauna and a more extended line of coast would yield increased material for faunistic work; and so after a careful consideration of various sites, Port Erin at the South end of the Isle of Man, was chosen as the best available place. It is not necessary now to give any further details, as this is rather the closing of the Puffin Id. record than any account of the work at the new laboratory, and as a full description of the Port Erin Station and its surroundings will be given in the next L.M.B.C. annual report. It is sufficient to state that the new Biological Station was formally declared open for scientific work by His Excellency Spencer Walpole, Lieut.-Governor of the Isle of Man, on June 4th, and that since then it has been and is now occupied by several zoologists, while others are going across during August and September, so that there is every prospect that this first season will show a good record of work done.

In the introduction to the last volume of reports (June, 1889) it was stated that 1456 species of marine animals and plants had been recorded as the result of the L.M.B.C. investigations: with the additional species (229) referred to in the present volume the number is now brought up to 1685. Of these additions, 11 have not been previously

recorded in British seas, and 5 (*Halisarca rubra*, *Axinella mammillata*, *Leucaltis impressa*, *Dasychone herdmani* and *Rhodochorton seiriolanum*) are new to science.

A melancholy interest attaches to the Report upon the Testaceous Mollusca in the present volume. It was the last piece of work of the late Mr. F. Archer, who was a member of the Committee from the beginning, and has taken an active part in all the work. In addition to all more personal feeling of loss, his ready sympathy, kindly criticism, and sturdy common-sense will be greatly missed at the Biological meetings and on the collecting expeditions. Mr. Archer's place on the Committee has been filled up by the election, on June 3rd, of Mr. John Vicars, the Mayor of Bootle. The other reports scarcely call for any special explanation. It is a matter of regret that the state of Mr. T. J. Moore's health has not permitted him to finish his list of the Fishes of the district in time to be included in this volume.

It only remains for me to express again my cordial thanks to my friends and fellow-workers who have taken part with me in the various dredging expeditions and in the preparation of these reports. Thanks are especially due to our Hon. Treas. Mr. Isaac C. Thompson for the large share of his valuable time which he so ungrudgingly devotes to the management of our financial affairs.

W. A. HERDMAN.

UNIVERSITY COLLEGE,  
LIVERPOOL; JULY, 1892.



THIRD ANNUAL REPORT of the LIVERPOOL  
MARINE BIOLOGICAL STATION on  
PUFFIN ISLAND.

By W. A. HERDMAN, D.Sc., F.L.S., F.R.S.E.,

DERBY PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, LIVERPOOL; CHAIRMAN  
OF THE LIVERPOOL MARINE BIOLOGY COMMITTEE, AND DIRECTOR OF THE STATION.

[Read 13th December, 1889.]

DURING the past year the work of the Liverpool Marine Biology Committee has been carried on actively at Puffin Island and elsewhere in the district, and has resulted in an unusually large number of events and observations worthy of record in this annual report. The first of these reports was issued after the publication of vol. i. of the "Fauna of Liverpool Bay," and the greater part of it was devoted to an account of the establishment of our Biological Station on Puffin Island; while the second annual report was largely occupied by a description of the experiments with the submarine electric light, a method which we were the first in Europe to apply to purposes of biological investigation. On the present occasion I have to report, amongst other things, upon the further development of both of these schemes, viz. (1) the publication of vol. ii. of the "Fauna," chiefly as an outcome of the work carried on at the Puffin Island Station, and (2) the additional electric light experiments which were made during the five days cruise of the s.s. "Hyæna," at the Isle of Man last Easter, and which resulted in the capture of a large number of rare and interesting crustacea.

PUBLICATIONS.

The first volume of the "Fauna" was published in the summer of 1886, as an Appendix to vol. xl. of the

Proceedings of the Literary and Philosophical Society of Liverpool, and also as a separate volume.\* Later on in the same year the Liverpool Biological Society was founded, chiefly as a result of the L.M.B.C. investigations, and through the instrumentality of the members of that Committee, and it was then felt that this would in future be the proper scientific society before which to lay all reports upon the biology of the district. The various papers dealing with the investigations at Puffin Island and the results of the dredging expeditions have therefore been duly read before the Liverpool Biological Society during the last two sessions (1887-88 and 1888-89), and have been published in the "Proceedings" (vols. ii. and iii.).

The L.M.B.C. have now to thank the Council of the Biological Society for allowing extra copies of these reports to be printed, in order that they might be collected and issued as the second volume of the "Fauna of Liverpool Bay." This volume of 240 pages and 12 plates appeared in July, 1889, and contains sixteen articles, by ten authors, dealing with various groups, from Diatoms up to Seals and Cetaceans. It is proposed to continue this plan of publication, to communicate the papers in the first place to the Biological Society, and to issue successive volumes of collected reports upon the fauna and flora of the district as they are ready, probably at intervals of a few years.

The total number of species which we have recorded is now 1456, and of the additions in this last volume of the "Fauna" twenty-one have not been previously found in British seas, and nine (a Sponge, four Copepoda, two

\* "Fauna of Liverpool Bay," Report i. London: Longmans, Green and Co. 1886. 372 pp. and 12 pls.

Amphipoda, a Polyzoan, and an Ascidian) are new to science.

In the present paper I have to add fifty species, three of which are new to British seas and three new to science.

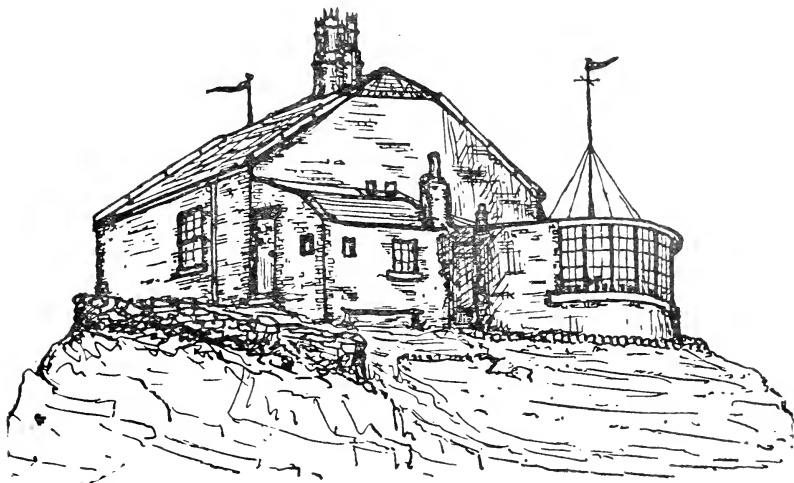


Fig. 1.—The Puffin Island Biological Station from the East.

#### STATION RECORD FOR THE YEAR.

During 1889 the following naturalists have worked at the Puffin Island Biological Station for longer or shorter periods:—

DATE.	NAME.	WORK.
1889.		
<i>Feb.</i>	I. C. Thompson, F.L.S., Liverpool .....	Copepoda.
—	R. J. Harvey Gibson, F.L.S., University College, Liverpool .....	Alge.
—	Prof. Herdman, University College, Liverpool...	Tunicata and Nudi- branchiata.
<i>April.</i>	R. J. H. Gibson, F.L.S., Liverpool .....	Alge.
—	Dr. R. Hanitsch, University College, Liverpool.	Sponges.
—	F. Villy, Owens College, Manchester .....	Vermes.
—	Dr. K. Meyer, Liverpool .....	General.
<i>May.</i>	Prof. Herdman, Liverpool .....	Tunicata and general.

<i>June.</i>	I. C. Thompson, F.L.S., Liverpool .....	Copepoda.
—	J. Vicars, Bootle .....	Land plants.
—	A. Leicester, Southport .....	Mollusca.
—	Dr. Stolterfoth, Chester .....	Diatoms.
—	Prof. Herdman, Liverpool .....	Tunicata and general.
—	W. S. McMillan, F.L.S., Maghull .....	Copepoda and Ostracoda.
—	Dr. R. Hanitsch, Liverpool .....	Sponges.
—	J. A. Clubb, Liverpool .....	Nudibranchiata.
—	W. J. Halls, Liverpool .....	Hydroida.
—	R. McMillan, Liverpool .....	General.
—	G. Swainson, F.L.S., Bolton .....	General.
—	A. F. Dumergue, Liverpool .....	General.
<i>July.</i>	I. C. Thompson, Liverpool.....	Copepoda.
—	J. Coventry, Liverpool .....	General.
—	Rev. W. Houghton, Wellington, Salop .....	General.
—	Prof. McNab, Dublin .....	Land plants.
—	R. J. H. Gibson, Liverpool.....	Land plants.
—	R. McMillan, Liverpool .....	General.
—	Prof. Herdman, Liverpool .....	Tunicata and Nudibranchiata.
<i>August.</i>	J. Hornell, Liverpool .....	Polychæta.
—	J. Agnew, Liverpool.....	General.
—	J. A. Clubb, University College, Liverpool .....	Nudibranchiata.
<i>Sept.</i>	W. Cobb, M.A., Oxford .....	General.

The small steam launch referred to in last year's report was exchanged in April, 1889, for a useful nine-ton sailing boat, the "Bonnie Doon," a half-decked, double-bowed cutter, built like the Isle of Man fishing boats; this has been in constant use during the summer, and has proved better suited to the peculiar requirements of the locality than any other vessel we have tried. The small punt obtained in November, 1888, has been most handy for light work, and is still in excellent condition.

The room opening off the kitchen on the north side of the house (room III. in plan) was considerably improved early in spring by the insertion of a larger window, so that it is now not only more pleasant as a sleeping room,



but can be used as a comfortable work room during severe weather, when the outside laboratory (with a stone floor) is too cold, and the wind is in such a direction that the stove cannot be used. The Committee propose that before next summer a simple fixed work-table running in front of the window, and a few shelves, should be put up in this room in order that it may be used regularly as an in-doors laboratory; while four or six wooden bunks erected against the wall in the adjoining room (No. II. in plan, fig. 2) would be a useful addition to the sleeping accommodation.

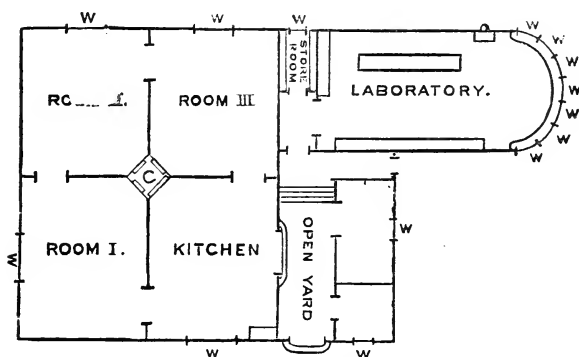


Fig. 2.—Plan of the Biological Station. W. W. windows; C. chimneys.

#### CONDITION OF THE SEA.

During the year, the curator (Mr. Alex. Rutherford) has continued to draw up and forward to Liverpool the weekly reports described last year, containing a careful record of the air and sea temperatures and other physical observations. From these tables it has now become possible to trace the distribution throughout the year, and the relations to temperature, of the remarkable Algæ, the appearance of which in such profusion as to cause "foul water," was first described in letters to *Nature*, in July,

1885, by Mr. Thompson from Puffin Island and the coast of North Wales, by Mr. Chadwick from Beaumaris, and by Mr. Shrubsole from Sheerness; and again, in 1886, in vol. i. of our "Fauna."\* This condition of the sea has since been met with by Prof. McIntosh† in St. Andrew's Bay, in 1887, and by the naturalists at the Plymouth Biological Station, in 1889.‡ In 1885 and 1886, in our neighbourhood, the "foul water" was caused by the presence of vast numbers of small gelatinous spherical bodies containing minute spicules. During the last few years, however, this form has not been observed here, its place being taken in early summer by gelatinous masses, which are found on examination to be composed almost entirely of Diatoms, chiefly *Coscinodiscus concinnus*.

From the adjoining series of quotations from the weekly reports, it is seen that the temperature of the sea was at its lowest (40° F.) early in February, and from that date the temperature rose gradually till it reached its highest point (61° F.) early in August, and then commenced to fall. The surface Algæ began to appear about the middle of May, when the temperature was 50° F., and continued to be present in great abundance for about six weeks, till near the end of June, and in less amount up to the 20th August, when they disappeared. After June, Medusæ, Ctenophora, Copepoda and other surface organisms were present in great abundance.

When these minute Algæ are present in quantity it is almost useless to tow-net, as the comparatively few other organisms present in the water become so entangled with the masses of Diatoms that it is almost impossible to separate them.

\* "Fauna of Liverpool Bay," vol. i., p. 315, 1886.

† Ann. and Mag. Nat. Hist., Aug. 1887, p. 97.

‡ Journ. Mar. Biol. Assoc., vol. i., No. 2, Oct. 1889, p. 114.

DATE.	TEMP. OF SEA.		TEMP. OF AIR.		CONDITION OF SEA.	
			max.	min.		
1889.						
Jan. 1	.....	45° F. ....	43°	33°	.....	Water clear.
— 7	.....	45.5°	50°	45°	.....	} <i>Sagitta</i> so abundant in all the surface tow-nettings both day and night, but especially the latter, as to obscure all else.
— 13	.....	42°	42°	34°	.....	
— 25	.....	41.5°	44°	39°	.....	
Feb. 7	.....	41°	35°	28°	.....	
— 11	.....	40°	34°	27°	.....	
— 17	.....	42.5°	52°	44°	.....	
— 27	.....	41°	39°	33°	.....	
Mar. 3	.....	41°	33°	29°	.....	Water becoming dirty ( <i>Coscinodiscus concinnus</i> ).
— 10	.....	42.5°	47°	35°	.....	<i>Sagitta</i> and <i>Calanus finmarchicus</i> abundant.
— 17	.....	43°	51°	39°	.....	Water very dirty. No use tow-netting.
Apr. 1	.....	45°	50°	37°	.....	Same condition continued for some time.
— 10	.....	44°	42°	36°	.....	Water clearing a little.
— 25	.....	45.5°	54°	35°	.....	Water still too dirty for tow-netting.
May 6	.....	48°	64°	48°	.....	Water clear again. Many larval Crustacea.
— 17	.....	50°	64°	45°	.....	Brown gelatinous matter appearing.
— 26	.....	52°	60°	49°	.....	Gelatinous matter in abundance.
June 13	.....	54°	60°	49°	.....	Gelatinous matter very thick.
— 21	.....	56.5°	68°	56°	.....	Water still full of gelatinous matter.
— 24	.....	57.5°	64°	55°	.....	First appearance of vivid phosphorescence at night.
— 26	.....	58°	65°	58°	.....	Medusæ in abundance.
July 3	.....	59°	62°	44°	.....	Small Medusæ in abundance.
— 23	.....	59.5°	63°	50°	.....	Medusæ still abundant.
Aug. 4	.....	61°	64°	50°	.....	Still some <i>Coscinodiscus concinnus</i> .
— 12	.....	60.5°	60°	49°	.....	Water very turbid.
— 28	.....	60°	61°	49°	.....	Water clear. Good tow-netting.
Sept. 4	.....	58°	62°	45°	.....	Ctenophora ( <i>Pleurobrachia</i> ) in great numbers.
— 17	.....	57°	60°	50°	.....	Ctenophora and <i>Sagitta</i> very numerous.
— 27	.....	55°	56°	47°	.....	Water very dirty. Tow-netting impracticable.
Oct. 4	.....	52°	57°	44°	.....	Tow-net choked with Ctenophora.
— 16	.....	50°	55°	.....	.....	Ctenophora still numerous; also <i>Sagitta</i> and larval Decapods. Shoals of Herring round the island.
— 24	.....	49°	49°	.....	.....	Water very dirty.

The Puffins (*Fratercula arctica*) returned to the island this year on the 10th of April, a week earlier than in 1888, and left on the 19th of August. Their number remains about the same.

#### ZONING OF THE SHORE.

About the middle of February, Mr. Thompson, Mr. Harvey Gibson and I visited the station for a few days, and we found that, notwithstanding the low temperature, work could be carried on both on the shore and in the laboratory. Mr. Thompson collected Copepoda, Amphipoda (including *Pleustes glaber*, new to Britain) and Isopoda; Mr. Gibson occupied himself with the Algæ, and I commenced detailed observations upon the zones of life on the shore (a subject which was referred to in the first of these reports), and arranged with the curator for the measurement of the exact distances of certain species of animals and plants vertically from high and low-water, and for the placing of permanent marks upon the shore at each end of the island so as to facilitate the taking of future observations and measurements.\*

The "zoning of the shore" is no new subject, but it is one which is full of interest and may be susceptible of some new developments. From the earliest times marine biologists have noticed that the depth has a great effect

\* These marks which have now been made upon the rocks are:—at the north end, near the laboratory, the average high-water mark (18 ft. tide) is shown by a red paint line labelled A.T., and low-water mark of the lowest springs (21 ft.) is shown by a blue line labelled L.S.; and at the south end, near the beach, high-water mark of the highest springs (21 ft.) is shown by a red line labelled 21, ditto of ordinary springs (19 ft.) by red line labelled 19, ditto of average tides (18 ft.) by red line labelled A.T., and ditto of smallest neaps (10 ft. 9 in.) by blue line labelled 10.9 on rock at both sides of beach. The accompanying new Chart of the Island and neighbourhood has been carefully prepared by Mr. Rutherford, the curator.

# PUFFIN ISLAND

AT LOW WATER SPRING TIDES.

By A. R.

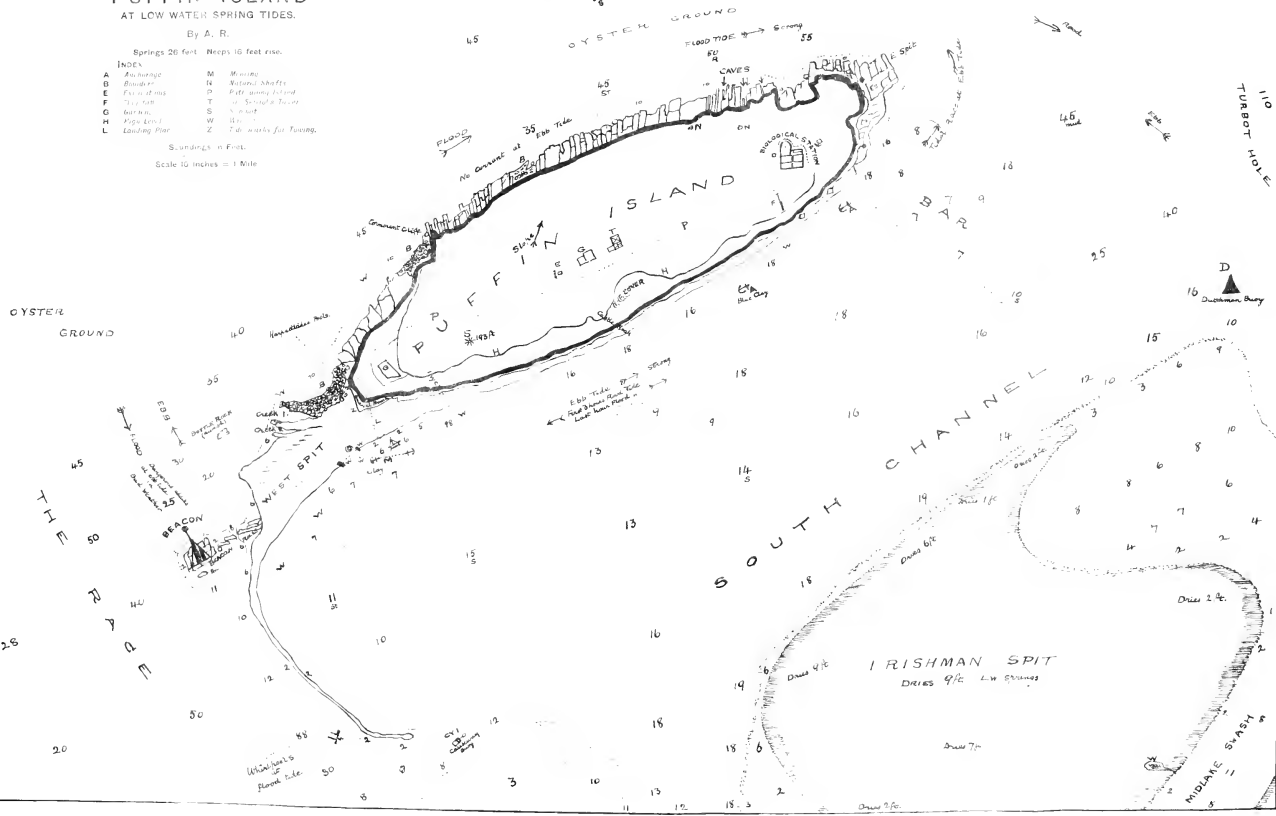
Springs 26 feet Neaps 16 feet rise.

## INDEX

A	Anchor	M	Mossy
B	Boat	N	Natural Shells
E	End of wall	O	Old building
F	Flag	S	Spring & Trench
G	Gate	T	Traverse
H	High	U	Unfinished
L	Leading Floor	W	Wall
		Z	Zoo

Soundings in Feet.

Scale 10 inches = 1 Mile



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upon the fauna and flora of a region; and Professor Edward Forbes, in his posthumous work on the "Natural History of the European Seas," pointed out that the sea bottom explored by the naturalist might be conveniently divided into four great zones, each inhabited by particular sets of animals. These are: (1) the *Littoral zone*, or the area between high and low-water marks. The animals and plants are here, of course, under very peculiar conditions, being for a part of their lives submerged in the sea, while for another part they are exposed to the air, to the sunlight, to extremes of heat and cold, to the washing of rain, or it may be to the pelting of snow. Next comes (2) the *Laminarian zone*, which extends from low-water mark downwards to a depth of ten or fifteen fathoms. This is pre-eminently the region of sea-weeds and of abundant animal life. Here, amongst the great tangled masses of the shiny brown *Laminaria* or oarweed, we find a profusion of nearly all forms of marine life, and here occur many of those instances of protective colouring and mimicry which prove such interesting problems to the evolutionist. This is the region the upper edge of which is just exposed at extreme low water of spring tides, and at such times it yields a rich harvest to the collector. Following the Laminarian zone comes (3) the *Coralline zone*, or region of zoophytes, formerly known as "corallines." This zone extends down, on an average, to a depth of thirty fathoms or so; and it is the region in which most of the scientific dredging is carried on around our coasts. It contains very few sea-weeds, but a large and varied assemblage of animals. Lastly comes (4) the zone of *Deep Sea Corals*, whose lower limit Forbes did not fix. To these regions must now be added the *Abyssal zone*, made known by the dredgings of the "Porcupine," "Challenger," and other scientific expeditions.

Long before the time of Forbes, however, the two distinguished French naturalists Audouin and Milne-Edwards,\* from their enthusiastic work as young men, among the rocks and islets of the Chausey Archipelago, and at other points along the coast of Normandy and Brittany, were able to distinguish five belts of life upon the shore:—(1) that of *Balani* (barnacles), only found on rocky coasts; (2) the zone of Fucoids, having limpets (*Patella*), whelks (*Purpura*, *Nassa*) and the common sea-anemone (*Actinia*) on rocks, sand-worms (*Arenicola*, *Terebella*) and sand-hoppers (*Talitrus*, *Orchestia*) on sandy shores, and certain other worms (*Nephtys*, *Sipunculus*) in mud; (3) the zone of “Corallines,” only exposed at low tide, having mussels (*Mytilus*), simple and compound ascidians, crabs (*Porcellana*), *Doris*, worms (*Serpula*, *Polynoë*) and sponges in rocky places, the molluscs *Venus* and *Solen* in sand, and the small *Rissoa* and *Cerithium* in mud; (4) the zone of *Laminaria*, having starfish, sea-anemones and the beautiful limpet *Helcion pellucidum* on rocks, and certain crustaceans on sandy ground; and (5) the lowest zone in which are found oysters (*Ostrea*), the sea-mouse (*Aphrodite*), the swimming crabs (*Portunus*) and the larger starfishes.

The well-known Scandinavian zoologists M. Sars† (in 1835) and Sven Lovén (more recently) directed their attention to the distribution of life around the Norwegian shores, and marked out four belts lying between high water mark and the Laminarian zone, viz:—(1) “regio Balanorum,” (2) “regio Patellarum,” with *Fucus vesiculosus* and *F. nodosus* in its upper part, and *F. serratus* and

\* See Ann. des Sc. Nat., 1re sér., t. xxi., p. 326, 1830; and Recherches pour Servir à l'Histoire Naturelle du Littoral de la France, 1832.

† Beskrivelser og Jagttagelser o. nogle mærk. eller. nye i Havet v. d. Bergenske Kyst lev. Dyr., Bergen, 1835.



*F. siliquosus* in its lower part, along with many shell fish; (3) "regio Corallinarum," with *Corallina officinalis*, many ascidians, sea-anemones, molluscs, worms and sponges; and (4) "regio Laminariarum," with nudibranchs, starfishes, ascidians, *Helcion*, *Caprella*, *Nymphon* and *Echini*. The close correspondence between this classification and that of the French observers is very remarkable.

Ten years later A. S. Örsted, in an important essay,\* showed that in the Strait of Öresund, near Copenhagen, three zones could be distinguished, both by the characteristic plants and the animals. To these he gave the names:—(1) "Regio Chlorospermearum," the belt of green sea weeds, extending from high water mark down to a depth of two to five fathoms, and corresponding to the "Regio Trochoideorum" amongst animals. The upper part of this zone is the subregion of the Oscillatorias, and the lower part the subregion of the Ulvas and Confervas. (2) is "Regio Melanospermearum," the belt of olive-brown sea-weeds, extending down to depths of seven or eight fathoms, and corresponding to the "Regio Gymnobranchiorum" amongst animals. Here also there are two subregions, an upper of Fucoids and *Zostera*, and a lower of *Laminaria*. (3) is "Regio Rhodospermearum," the belt of purple-red sea-weeds, extending from eight to twenty fathoms, and corresponding to the "Regio Buccinoideorum" amongst animals. As Vaillant has since pointed out, the somewhat abnormal conditions of marine life in the landlocked Strait of Öresund may account for the want of exact correspondence between these zones and those established on the more exposed coasts of France and Norway, but Örsted's first region evidently corresponds to the three upper zones of the French observers.

\* De Regionibus Marinis. Havniæ, 1844.

Edward Forbes\* himself, from his own work and a consideration of the observations of others, came to the conclusion that the subzones of his littoral zone (see above) are very well marked on the English coast, and can be distinguished by their characteristic plants and animals, as follows:—First two regions above half-tide mark (1) with *Fucus canaliculatus*, and the molluscs *Littorina rudis* and *L. neritoides*, and (2) with *Lichina*, *Patella*, *Balanus*, *Mytilus edulis* and incrusting nullipores; then a third and very prolific belt at half-tide (3) with *Chylocladia articulata* and *Fucus nodosus*, the molluscs *Purpura*, *Littorina littorea*, *Trochus umbilicatus*, and the common sea-anemone; then a fourth above low-water mark (4) with *Fucus serratus* and the molluscs *Littorina obtusata* and *Trochus cinerarius*, and finally, just at low-water mark a series of four very narrow bands most readily distinguished by their sea-weeds, (5) that of *Laurencia pinnatifida*, (6) *Conferva rupestris*, (7) *Chondrus crispus*, and (8) *Himanthalia lorea*; this last being the most constant, and being followed by the upper edge of the Laminarian zone, containing *Laminaria* on rocky coasts and *Zostera* on sandy.

Professor H. de Lacaze-Duthiers has defined on the shore at Roscoff, in Brittany, three zones, viz., (1) that of *Fucus*, (2) that of *Himanthalia*, and (3) that of *Sargassum*; and Professor Giard† has shown that special series of Compound Ascidiæ inhabit these definite belts.

About the same time Dr. Léon Vaillant‡ occupied himself with this subject in the same region, on the

\* "The Natural History of the European Seas," edited by Godwin-Austen. London, 1859, p. 93.

† Archives de Zoologie expér. et génér., t. i., 1872.

‡ Observ. faites à St. Malo s. l. zones litt. supér., Bull. Soc. Philomat., Paris, nouv. sér., t. vii., p. 144, 1870; and Remar. s. l. zones litt., Soc. de Biologie, Paris, 1872.

Brittany coast, and made some very interesting observations and experiments at St. Malo with the acorn-shell, *Balanus balanoides*, which is so commonly found at the extreme upper edge of the littoral zone on rocky coasts. Vaillant found that this marine animal, although it can only expand and obtain food when covered with water, is able to live so far above ordinary high-water mark as to remain dry for days at a time, amounting on an average to eighteen or nineteen-twentieths of its life; and he determined by experiment that it can live out of water for at least forty-four days at a time.

These observations are particularly interesting to me, as, before hearing in Paris last summer of Vaillant's work, I commenced some almost exactly similar observations at Hilbre Island, in 1885\* and at Puffin Island in 1887, from which I made out that the Polyzoan *Flustrella hispida*, which is found within a yard of ordinary high-water mark, must be exposed to the air during about five-sixths of its existence, and can only feed during the remaining one-sixth at and about the time of high tide. Probably respiration can be carried on to a certain extent both in the case of this animal and of Vaillant's *Balani* by a little air being let in periodically to oxygenate the small quantity of sea-water shut in with the body of the animal.

#### EXPERIMENTS ON HARPACTICIDÆ.

One of the first things one notices on examining the zones of life upon the shore at Puffin Island is that there are certain marine animals *above* high-water mark. There are some pools in the rocks which are only reached at high spring tides, or perhaps only by the spray from the waves during storms. These are overgrown with a common

\* See Liverpool *Daily Post*, 15th June, 1885.

grass-green seaweed, *Enteromorpha intestinalis*, and on this we find enormous quantities of Copepoda belonging to the genus *Harpacticus*. The condition of some of the pools suggested to me that these animals would probably be able to stand considerable variations in the salinity of the water, as in wet weather they are flooded with rain while in dry summers the pools become almost or completely dried up.

So, taking some sample tubes of salt water with *Enteromorpha* and *Harpacticus fulvus* from the pool, I added to one a third of its volume of fresh water, and continued every morning to add a little fresh water, until at the end of twelve days there were nineteen parts of fresh water to one part of the original sea-water and the fluid was no longer salt to the taste. The *Enteromorpha* appeared healthy, and the Copepoda had increased greatly in numbers and were very active. The young ones hatched in the nearly fresh water were all colourless, but the adults had not lost their original bright red tint.

A second sample tube of *Harpacticus*, *Enteromorpha* and sea-water from the pool was emptied into a shallow glass dish and allowed to evaporate slowly. The Copepoda in this case did not increase in numbers, but they did not die until the dish was almost dry and the salt had crystallised out round the edges. After evaporation had been going on for a few days, I noticed that the Copepoda had retreated into the interior of the *Enteromorpha* filaments, where their bright red bodies were distinctly visible on the green ground, and I think that under natural conditions they might in this way escape death when their pool became dried up, as the desiccation would not be so thorough in the damp atmosphere of the sea-shore as in the warm dry air of my laboratory. Mr. W. J. Halls is going to take this matter up and carry out some further experiments

with various species, and I have no doubt his results will be laid before us on some future occasion.

#### EXPERIMENTS ON MOLLUSCS.

Scattered over the rocks at Puffin Island, above high-water mark, and above any of the sea-weeds, in the region of the little incrusting *Lichina pygmaea*, the region which Vaillant has called the subterrestrial or zero zone, we find numerous specimens of the small periwinkle *Littorina rudis*, and it is difficult to see how this mollusc manages to live, and why it has migrated so far up the shore. It feeds upon the lichen, and is very sluggish in its habits, often remaining for days—perhaps months—without moving from the one spot. Like its relations further down the shore, it is a branchiferous mollusc fitted for breathing in water, and yet we find it living and apparently flourishing in the air: possibly it may be in process by becoming adapted to a terrestrial mode of life. We know that some of these molluscs can shut themselves up in their shells so tightly as not to allow any water to pass in or out. Gosse has told how *Purpura lapillus* is able in this way to withstand the action of fresh water for eighteen hours. This may help us to understand how it is that some marine molluscs upon the rocks are not injured by drenching showers of rain, but it will scarcely solve the difficulty in regard to the specimens of *Littorina* which stick to the dry rock for many days, unless they have become adapted to breath in air, and some experiments which I have made render it probable that this modification has taken place.

I collected some specimens from the rocks above high-water mark, and after keeping them perfectly dry in a cardboard box in the laboratory for six days, during which time they showed no signs of life, I put ten of them into a

glass jar of *fresh* water. In this they remained day after day with the operculum or lid which closes the mouth of the shell tightly shut. At the end of the second day, I took one of the specimens out of the water, and on opening the shell found that the animal was alive and active inside. On the fourth day two specimens died, on the sixth day four more, and by the end of the eighth day all of them were dead. Whether this death was due merely to the prolonged immersion in the fresh water, or may have been caused by the water becoming slightly impure, was uncertain, so the experiment has been repeated several times since (see below, jar B).

It is easy to tell whether the *Littorinas* are alive or dead, as, so long as a specimen is alive, it remains tightly shut up in its shell, while whenever it dies the operculum opens and a part of the "foot" of the animal protrudes in the form of a white mass, which rapidly begins to decompose.

I next collected from the rocks a fresh set of specimens, which were placed as follows:—

(A) Ten specimens in a jar of clear sea-water, under muslin (see below, fig. 3).

(B) Ten specimens in a jar of fresh water.

(C) Ten specimens in an empty dry jar (*i.e.* in air).

(D) Twenty specimens in a slate and glass aquarium, half full of sea-water and open at the top.

The jar A (see fig. 3) was so arranged as to have a piece of coarse muslin (*m*) spread over a hoop just below the surface of the sea-water, the object being to allow the air to have free access while preventing the molluscs from coming to the surface of the water.

These four sets of specimens were examined every twelve hours for three days, and their positions and apparent

conditions carefully noted. The experiments were repeated several times, the general results being that:—

In the A jar, at the end of twelve hours all the specimens had crept up and were sticking to the under surface of the muslin; at the end of thirty-six hours, they had all fallen from the muslin, and were lying in various positions at the bottom of the jar; while at the end of the third day one or two were dead or dying, and most of the others seemed to be unwell. As the water in this jar had now gone bad, this experiment was not continued any further. Whether the sickly condition of the specimens in this jar was due merely to being kept immersed in sea-water for three days, or was caused by the water having become impure through the accidental (*i.e.* from some other, unknown, cause) death of one of the molluscs, it is impossible to say from a few experiments; but, at least, there is no doubt that the effect of putting closed up specimens of *Littorina rudis* into clean sea-water, out of which they cannot escape, is that they at once expand, become active, crawl as near as they can get to the surface of the water, and after remaining there for a time relax their hold and drop to the bottom.

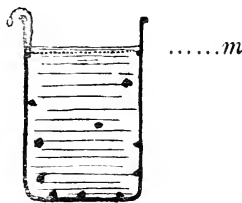


Fig. 3.—Experimental Jar containing *Littorina* kept in the water.

In B (fresh water), all the specimens remained during the three days lying at the bottom of the jar in a tightly closed up condition, but were apparently perfectly healthy at the end of that time. The jar was kept under

observation for some time longer; the molluscs only began to die on the thirteenth day—a marked contrast to jar A. Consequently these “marine” molluscs can live longer in fresh water than in sea-water.

In C some of the specimens remained, in the contracted state, where they were put; while others crawled slowly about on the sides of the jar, a piece of glass over the top prevented their escape. None died: apparently, then, they can live best in the air.

Of the twenty specimens in the aquarium (D) seven had crawled out of the water in fifteen minutes; at the end of twelve hours fifteen had crept up the slate sides out of the water, and at the end of twenty-four hours nineteen had emerged from the water, and had travelled to distances of from one to four feet from the aquarium over the stone floor and painted plaster walls of the laboratory. I marked pencil rings round the five which had crawled farthest at the end of the second day, and found they went no farther after that during the two months they were under observation.

This experiment has been repeated several times with the same general result. All the specimens of *Littorina rudis* put in a contracted state into an open aquarium become active, and in the course of a day or two find their way out of the water, and after crawling for a little distance come to rest and remain there indefinitely. I have not noticed any specimens crawling downwards again into the water, even after being for days in the air.

Next, I made some observations on the specimens at the shore under their natural conditions. The rocks at Puffin Island are reefs and masses of carboniferous limestone, broken up by the waves and worn into crevices and crannies of all sizes and shapes. The *Littorinas* above high-water mark on these rocks are, I find, almost



invariably in the hollows, either in rows along the lines of crevices, or singly at the bottom of the little rounded holes. They are never seen to move, they are attached to the dry rock, and with the exception of the dark coloured lichen *Lichina pygmaea* growing in patches, they have no visible means of subsistence.

It has been suggested that possibly they descend to the seaweed-covered rocks during the night and feed there; so to settle the matter as far as possible, I chose six fairly representative individuals, and without in the least disturbing them, I marked the shell and the hollow in which it was lying in such a way that it would be easy to detect any movement on the part of the mollusc. The first three were marked respectively with one, two, and three dots of red oil-paint on the shell, and one, two, and three rings round their hollows; while the remaining three

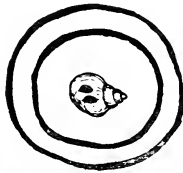


Fig 4.—Marked *Littorina* on the Rocks.

were similarly marked with blue paint (fig. 4). These marked molluscs were examined by myself at intervals of from six to nine hours for three days and nights (24th to 26th May), and during that time none of them changed their positions. After that they were watched for me by Mr. Rutherford until I returned to Puffin Island on the 7th June, when I found them unchanged. A second set of six molluscs, on the rocks at the north-east end, were marked with rings of paint as before by Mr. Rutherford, on 21st June, and were inspected every day, and remained in the same position until they were washed away on the

13th July by the spray from a heavy sea, caused by an easterly gale along with an unusually high spring tide. A new set were then marked (July 13th) higher up the rocks and remained unchanged in position till I saw them on my next visit on the 27th July, and Mr. Rutherford reported to me that they were still in the same spots, inside their little rings of paint, on the 13th August, when they had been exactly a month under observation.

Below the subterrestrial zone at Puffin Island we find the bands of life on the shore correspond very well with those recognised by Audouin and Milne-Edwards on the French coast, and by Edward Forbes in other parts of the British seas. We have (1) the region of *Balani* forming a well-marked line along the cliffs, (2) the area occupied by Limpets and *Littorina obtusata* on rocks covered with *Fucus nodosus*, *F. serratus*, and *F. vesiculosus*. In pools on this part of the shore is found *Corallina officinalis*. A little lower is the common sea-anemone (*Actinia mesembryanthemum*) in abundance, and under stones the annelids *Serpula* and *Spirorbis* and the Amphipod *Gammarus locusta*. At this point we have reached about six feet vertically below the highest Algæ on the rocks, and the first Hydroid Zoophytes are now found, *Diphasia pumila* on *Fucus* and *Laomedea* on the sides of stones, also *Membranipora pilosa* and *Chthamalus*. Then follow *Purpura*, *Anomia*, *Mytilus*, *Mucronella coccinea*, and various Zoophytes; then *Cancer pagurus* (small), *Alcyonidium gelatinosum*, and *Amphiura squamata*. We now reach the ten feet line vertically down from the top of the Algæ, and meet with *Halichondria panicea*, and *Porcellana platycheles* which extends from this point down to the Laminarian zone. Next is a very prolific zone, extending to low-water, in which occur *Alcyonium digitatum*, *Tealia crassicornis*, *Cribrella sanguinolenta*, *Asterias rubens*, *Serpula vermicularis*, *Sabellaria*

*alveolata*, *Littorina littorea*, *Doris pilosa*, *Doris proxima*, *Chiton cinereus*, and numerous very fine specimens of *Bugula turbinata*.

During a considerable part of April, Mr. Harvey Gibson, Dr. Hanitsch and Mr. F. Villy worked at the station. Mr. Gibson confined his attention to the Rhodophyceæ, and he informs me that since his last report, published in the "Fauna," vol. ii., he has found and identified seventeen species of Algæ, mainly parasitic forms, not previously known in the district. Dr. Hanitsch has continued his researches on the Sponges during the year, and reports six species additional to those recorded in the "Fauna." Of these three are new to science and will be figured and described in detail under the names, *Axinella mammillata*, n. sp., *Leucaltis impressa*, n. sp., and *Halisarca rubra*, n. sp., in the next report on Sponges by Dr. Hanitsch. The last species was obtained by dredging in deep water during the "Spindrift" expedition of July 20th, while the two first were collected on the rocks at Puffin Island in April.

#### "HYÆNA" EXPEDITION.

The Salvage Association have again this year afforded us the opportunity of making some investigations which could certainly not have been carried on without the use of the s.s. "Hyæna." The old gunboat left the Mersey on Thursday morning, the 18th of April, on her fifth scientific cruise, and was absent five days. The proposed course was to cross to Port Erin, at the south end of the Isle of Man, and then dredge southwards to Holyhead, through the deepest water to be found in this district; then to work along the coast of Anglesey to Puffin Island, and from that back to Liverpool. Besides the ordinary dredging and tow-netting operations, it was hoped that

two interesting new methods of collecting would be tried on this cruise. First, the submarine electric light, which gave such good results in the "Hyæna" expedition of the previous summer, was to be used as an attraction in the nets let down to the bottom at considerably greater depths than was the case in last year's experiments at Ramsey and Port Erin; and second, Mr. W. E. Hoyle's new tow-net (recently exhibited and described before the Biological Society of Liverpool\*), which can be opened and closed at any required depth, so as to ensure that the contents of the net were captured in a particular stratum of water, was to be taken, with the view of trying whether it could be worked successfully.

It has often been felt by naturalists when they brought up free-swimming animals (such as fishes, medusæ, or crustacea) from considerable depths that it was uncertain when and where these animals entered the net. This was the case with many of the animals collected during the "Challenger" expedition. They were obtained in a dredge net, which had been down to a depth of one, two, or say three thousand fathoms, but for all we know they may have been caught on the way down, or on the way up, and may not be found at the bottom at all. Consequently, many attempts have been made to construct a net which can be sent down closed to a particular depth, and then be opened and towed open for some distance, and then be closed again before being hauled up.

Two of these are—(1) the Turbyne tow-net, used at the Granton Marine Station, where there are two ropes, one of which, used for letting down and hauling up the net, forms a slip noose constricting the mouth of the bag; and (2) the very elaborate piece of apparatus invented by the Prince of Monaco, and shown lately at the Paris

\* See Proceedings, vol. iii., p. 100.

Exhibition, where the square mouth of the net is closed when required by a blind unrolled by the action of a descending weight.

Mr. Hoyle's net has been ingeniously devised to perform these same actions by means of a complex mechanism and two leaden "messengers," which are sent down the rope from the boat, the first to open the mouth of the net, and the second to close it. On account of the unfavourable weather, we were not able to give this net a fair trial on the "Hyæna" cruise; but later on, during the "Spindrift" expedition, it worked very satisfactorily.

The first day (April 18th) was spent in crossing to Port Erin, and after that the weather, although fine on land, became very unfavourable for marine work, and the programme had to be considerably altered. On Friday morning we steamed S.W. towards the deep water, but a strong wind was blowing, and after a haul of the dredge in twenty-seven fathoms, about five miles out, some bottom and surface tow-netting, a sounding in fifty fathoms, and then a further run to about nine miles from land, it was found that the heavy rolling of the vessel (even after the surface agitation had been considerably quieted down by the use of oil-bags hung over the windward bow) rendered dredging operations impossible out in the open sea; so the "Hyæna" was put about and returned to Port Erin, where tow-netting and other work was carried on in the bay.

The following day the wind was still stronger, so it was then decided to give up the Anglesey part of the cruise, and devote most of the remaining days to shore and shallow water work around the southern end of the Isle of Man. Accordingly, the rocks at Port Erin, Port St. Mary, Poyllvaish Bay, and Fleshwick Bay were explored on the third day, and many specimens collected. On the

north side of Fleshwick Bay there are some exquisite rock-pools lined with encrusting Nullipores and other seaweeds, and containing Sponges, Sea-anemones, Zoophytes, Polyzoa, Worms, Nudibranchs, and other animals. The rich green alga *Codium tormentosum* was obtained in these pools, but, although carefully searched for, no specimens of *Elysia viridis* were found upon it.

As the sea was still very rough, the early part of the fourth day was spent on board the "Hyæna," at anchor in Port Erin Bay. Tow-nets were let down, both on the surface and weighted so as to reach the bottom, and a small dredge with a long canvas net was taken out in a boat and used for obtaining samples of mud and sand to examine for small animals, such as Foraminifera, Copepoda and Ostracoda. The strong wind blowing was utilised by Captain Young, the representative of the Salvage Association, who suggested floating tow-nets across the bay with lifebuoys, and devised a sailing apparatus, consisting of an old lifebuoy rigged up with a mast and sail, and having a tow-net suspended from it, which was let out, carrying a long line, to leeward, and was then hauled in, the net keeping distended and working well during both the outward and the return journeys. Another surface net was even rigged up attached to a large kite, but this did not work satisfactorily. By these various means a large amount of material was collected and preserved for future examination. Mr. I. C. Thompson and Mr. W. S. McMillan, who are engaged in working out the Copepoda and Ostracoda of Liverpool Bay, have lately been getting some interesting species in mud and other deposits from Puffin Island and elsewhere, and they predict that it is from such sources that the most important additions to our fauna will be made in the future. Consequently, Mr. McMillan has devised a small dredging tow-net which will bring up

samples of the bottom deposits, and this was frequently in use during the cruise. A new species of Copepod, which was obtained in this manner from muddy sand dredged in Port Erin Bay at a depth of five fathoms, has been named *Jonesiella hyænæ*, in honour of the old gunboat.

In the afternoon the "Hyæna" made two runs from Port Erin southwards to the Calf, dredging homewards with the wind, and got two excellent hauls, which contained, amongst other things, the rare coral-like *Sarcodictyon*, the flat pentagonal starfish *Palmipes*, the remarkable parasitic sea-anemone *Adamsia*, which is always found in company with a particular hermit crab (*Pagurus prideauxii*), *Echinocyamus pusillus*, *Stichaster roseus*, *Porania pulvillus*, *Lyonsia norvegica*, *Ascidia venosa* (with *Leucothoe spinicarpa* in the branchial sac), a sponge (*Esperella floreum*) new to the district, and various rare crustacea and mollusca.

#### ELECTRIC LIGHT EXPERIMENTS.

After dark, on two consecutive nights, the electric light was used for a couple of hours in collecting bottom and surface free-swimming animals around the ship, in much the same way as during the previous summer's cruise.

The first application of this important method of collecting appears to have been made by the United States Fish Commission in 1884, on board the steamer "Albatross." On that occasion an arc lamp was merely suspended above the surface of the water, and it was found to attract Amphipods, Squids, and young fish to the surface. In the following year the same naturalists experimented further by lowering an Edison incandescent lamp into the water, with similar good results. The Fish Commission do not give any details in regard to the

animals collected, nor any comparison between the contents of illuminated and ordinary tow-nets worked at the same time.

The next submarine electric light experiments were those carried out by the L.M.B.C. in May, 1888, on board the "Hyæna," as detailed in last year's Report.\* Just a month later in that same summer (24th to 26th June, 1888) Prince Albert of Monaco† used on board his yacht "Hirondelle," a tow-net lit by a small Edison incandescent lamp (12 volts), supplied by a single Bunsen cell in which the nitric acid was replaced by chromic acid. The battery, which is let down into the sea along with the net, is hermetically sealed up in an iron case, while when the apparatus is used in great depths, the pressure is ingeniously equalised by a tube connecting the interior of the case with a strong indiarubber ball filled with air. This apparatus was tried in the neighbourhood of the Azores down to a depth of about twenty fathoms.

It may be useful to state here that the "Hyæna" is fitted up with the following electric light installation ‡:— A Gwynne vertical engine, of six nominal horse-power, running at 300-400 revolutions per minute, works a Phoenix compound-wound dynamo, with an effective output of 5,980 Watts (65 volts, 92 amperes) at 1,000 revolutions per minute. There are two Pilsen arc lamps of 3,000 nominal candle-power each, which can be used on deck or at mast head, or on the side of the ship; four Edison-Swan submarine incandescent lamps of 100 candle-power, and ten of sixteen candle-power each. The dynamo, being compounded, allows the arc and incandescent lamps to be

\* And in *Nature*, vol. xxxiii., June 7, 1888.

† *Comptes-rendus*, t. cvii., July 9, 1888.

‡ I am indebted to Captain F. Young of the Liverpool Salvage Association for this information in regard to the plant on board the "Hyæna."



run together with perfect ease by the use of a resistance of about 0·5 of an ohm in the arc-light circuit. The submarine lamps are fitted in strong circular annealed glass protectors, and can be lowered to any required depth in the water by means of a special waterproof flexible cable made of 260 strands of fine copper wire, covered with thick gutta percha and hemp. The arc lamps require from twenty-five to thirty amperes, and the submarine lamps 4·5 amperes, so that there is ample power when the whole installation is running.

This time the two large electric lamps, 3,000 candle-power each, were hoisted up into such a position as to illuminate the deck, and cast a bright light on the water for some distance on each side of the ship. Three submarine incandescent lamps of 100 candle-power each were then fitted in the mouths of tow-nets, and were let down, two of them to the bottom, at a depth of five fathoms, and the third to a foot or so below the surface of the sea. Each of these nets was put out twice, so that we got four bottom hauls and two surface hauls with the electric light tow-nets. Another tow-net without any lamp was let over the side of the "Hyæna," and lay in the brightly illuminated surface water. All these nets were stationary, but were kept fairly distended by the tide. At the same time Mr. I. C. Thompson was rowed round and round the ship, dragging an ordinary tow-net in the bright area, and this one haul, in addition to many higher Crustacea, yielded *Gastrosaccus spinifer*, *Siriella brooki*, and some very interesting varieties of *Atylus swammerdamii*, which Mr. A. O. Walker is now working out, and twenty species of Copepoda, including such rare forms as *Pseudocalanus armatus*, *Ectinosoma atlanticum*, *Zaus spinatus*, *Laophonte lamellifera*, *Dactylopus tenuiremis*, *D. tisboides*, *Cyclopina gracilis*, *Bradya typica*, *Euterpe gracilis*, and quantities of *Peltidium*

*depressum*. This last species is usually found attached to the surface of *Laminaria* and other Algæ at the bottom, and *Pseudocalanus armatus* has apparently only been found in British seas before at considerable depths in the Clyde estuary. Consequently their presence on the surface is remarkable, and was, no doubt, caused by the attraction of our powerful electric light.

All the nets were, on this occasion, used in water lighted up, the surface nets being in the 6,000 candle-power glare, while the bottom nets were further from this bright light, but had each their own smaller lamps. All gave, so far as we yet know, practically similar results, which are markedly different from both the bottom and the surface gatherings taken at the same place during the previous day. The electric light gatherings contain chiefly Schizopoda, Cumacea and Amphipoda, and the Cumacea, chiefly adult males of *Iphinoe trispinosa*, with their long slender red bodies and active movements, are the most marked feature; they are very abundant, and form a conspicuous characteristic in the gathering whenever it is transferred from a net into a glass jar. In none of the daylight tow-nettings, either bottom or surface, I think, was a single cumacean obtained, while every gathering on the two nights when we had the electric light going contained Cumacea in abundance. There can be little doubt that those captured in the surface nets had been attracted from the bottom by our brilliant deck lights, which had been shining for fully half an hour before the nets were put over.

On the fifth day the "Hyæna" started in the morning from Port Erin, and arrived at Liverpool soon after midnight. A little dredging and tow-netting was done on the way. One good haul was obtained from a stony and shelly bottom at about fifteen miles south-east of the

Chicken Rock (depth thirty fathoms), which yielded large numbers of polyzoa. These have been examined by Mr. Lomas, who tells me that they include *Cellaria fistulosa* (very abundant) and *C. sinuosa* (new to "Fauna"), *Cellepora dichotoma*, *Stomatopora major* and *S. johnstoni*, *Tubulipora lobulata* and *T. flabellaris*, and a number of common forms.

At this spot also, it being the deepest water on our homeward track, we let the electric lamp down to the bottom in a tow-net (see fig. on page 40) twice, and got gatherings, consisting mainly of Copepoda, Sagitta, Amphipoda, Zoëas, and other larval forms.

That free-swimming Crustaceans are attracted to a stationary net by the electric light may now, after our experiments of 1888 and on this last cruise, be considered established beyond doubt; and that the illuminated tow-net can be used in at least moderately deep water was evident to all who saw the success with which the net was worked on board the "Hyæna" in thirty fathoms.

The submarine electric light is, therefore, an important addition to the collecting methods of the marine biologist, and one which ought certainly to come into extensive use in the future. It is, of course, only very rarely that a vessel like the "Hyæna," so fitted up that the electric light can be turned on readily at any time to illuminate a series of nets, is placed at the use of the biologists, and to fit out a boat specially with an engine and dynamo and a set of lamps, would be a very expensive matter. I thought at one time that storage batteries might serve the biologist's purpose, but on making inquiries in Liverpool we found that for even a day's work a considerable number of batteries would have to be taken, and the expense would be too great. The plan of sending a primary battery down in the net, as in the case of the

Prince of Monaco's experiments, seems on the whole—if it gives a bright enough light and works satisfactorily—to be the simplest and most economical method, and the one which it would be best to adopt where no vessel already provided with an electric installation is available.

As to the practical application of this method to fisheries, although there can be no doubt that the electric light acts powerfully in attracting many free-swimming animals, and especially Crustacea, there is no very good evidence that it attracts marine fishes. More experiments are required before the matter can be considered as settled, but I am inclined at present to agree with the opinion which has been expressed by some of the American investigators, that the method is of more value to the scientific biologist than to the practical fisherman.

#### ADDITIONAL COPEPODA.

While collecting near low water mark on the south spit at Puffin Island, one evening in summer, I found attached to a colony of *Lepralia*, under a stone, a beautiful little discoid pink and white Copepod, which Mr. Thompson has since identified as *Artotrogus orbicularis*, Boeck, a species never previously found in British seas. Ninety-four species of Copepoda in all have now been recorded from our district, of these thirteen are new to Britain and four (*Lichomolgus sabellæ*, *Hersilioides puffini*, *Cymbasoma herdmani*, and *Jonesiella hyanæ*) new to science. Mr. Thompson tells me that since the publication of his last report ("Fauna," vol. ii., containing Reports ii. and iii. and Appendix), he has found the three following species (new to our lists) in addition to the *Artotrogus* mentioned above, all from the examination of mud and other deposits: *Amygone longimana*, *Delavalia palustris* and *Artotrogus*

*magniceps*. Another notable point in regard to the Copepoda is that at Puffin Island on the night of May 17th, *Cyclopina littoralis*, one of the rarer species, and usually found singly, appeared in a shoal, and numerous specimens were captured.

#### “SPINDRIFT” EXPEDITION IN JUNE.

This year the Government Grant Committee of the Royal Society placed £50 at the disposal of the L.M.B.C. for the purpose of hiring vessels and men in carrying on the exploration of Liverpool Bay by dredging expeditions. The steam-tug “Spindrift” was accordingly chartered on two occasions from the Liverpool Tug Company for single day expeditions. Such exploring trips are very important, and every one of them adds considerably to our knowledge of the district. Unfortunately, however, they are so expensive that in the present state of our funds we cannot afford to have more than one or two in each season. If tug companies or owners of small steamers would lend us a vessel occasionally for a single day or a week-end, it would materially aid our work and advance the scientific knowledge of Liverpool Bay.

The first of these expeditions was on Saturday, the 8th June, which proved one of the finest days of the summer for work at sea. A number of members of the Committee and other naturalists went down to the Menai Straits on the previous day, and the “Spindrift” arrived off Puffin Island at five a.m. on 8th June, and, after taking some of the party on board from the Biological Station and others from Beaumaris, steamed to the “Turbot Hole,” off the N.E. end of the island, and commenced the work of the day. We then proceeded along the north coast of Anglesey, round Point Lynas, as far as Porthwen Bay, and dredging was carried on with varying success

until about nine p.m., when, after a final haul in the Turbot Hole, the biologists were again landed on Puffin Island. The following is a summary of the observations made on this expedition :—

(A) Turbot Hole, off Puffin Island, sixteen fathoms; two good hauls :—*Cucumaria planci*, *Thyonidium drummondii*, Zoophytes, and many other things.

(B) West of "Little Mouse," round Point Lynas, nineteen fathoms, gravel, shells and sand; one haul :—*Hydractinia*, Sponges, *Dentalium* and *Echinocyamus*.

(C) Off Porthwen Bay, seventeen fathoms; one haul :—*Pecten varius*, *Fissurella græca*, *Cypræa europea*, *Antedon*, *Sabellaria*, *Phascolosoma vulgare* (*Syrinx harveyi*), *Dentalium entale*, and Ascidians (*Ascidia plebeia*, *Styela grossularia*, and *Polycarpa pomaria*).

(D) Same, two miles off shore, twenty to twenty-two fathoms; two hauls :—*Garveia nutans*, *Antennularia ramosa*, *Antedon rosaceus*, *Fissurella græca*, *Murex erinaceus*, *Natica*, *Nucula* and *Cellepora*.

(E) Off Point Lynas; in first haul lost large dredge, then one haul with small dredge :—*Spatangus purpureus* in sand.

(F) Off Dulas Island, thirteen to fifteen fathoms, sand and shells :—*Solaster papposa*, Sponges and Ascidians.

(G) Same, further off land, twenty fathoms :—*Spatangus purpureus* in abundance.

(H) Off middle of Red Wharf Bay, twenty fathoms :—*Spatangus*.

(I) Turbot Hole, sixteen fathoms; one haul :—Same results as before.

These hauls yielded many interesting Crustacea to Mr. Walker. Some of the best of these were obtained by placing the sand and gravel brought up in the dredge in dishes of sea water, when many Amphipods swam out.

*Galathea nexa*, *Crangon nanus*, *Mysis inermis*, *Cuma edwardsii* (with ova), *Atylus uncinatus* (new to Britain), *Autonoe longipes*, *Lilljeborgia pallida*, *Podocerus ocus*, *Dryope irrorata*, and *Unciola planipes* were all added to our lists on this occasion.

Most of the material collected during this expedition, coming as it did too late for insertion in the detailed reports which make up vol. ii. of the "Fauna," has not yet been distributed to our workers. Miss L. R. Thornely, who has kindly undertaken to sort out the collection into groups and identify the Hydroida, tells me that we have now collected twenty-nine species of Zoophytes, from the immediate neighbourhood of Puffin Island, including a number of forms not previously known from that part of our district; and Mr. Halls, who is working in the zoological laboratory at the Zoophytes collected off the south end of the Isle of Man, reports that he has identified fourteen species, and is now examining a mass of new material.

For a couple of days after the "Spindrift" expedition of 8th June, most of the dredging party stayed on Puffin Island, and a great deal of investigation was carried on, there being twelve biologists at work, the largest number since the opening of the station. Mr. J. Vicars devoted the time entirely to collecting and identifying the land plants of the island, and added considerably to the list drawn up by Mr. Dutton (Chester) and Dr. C. H. Hurst (Manchester) in 1888;\* Mr. Alf. Leicester collected land Mollusca, and succeeded in obtaining sixteen species, upon which he has submitted a short report to the Biological Society; while the rest of the party were at work either on the shore or in the laboratory. A large number of

\* This list, still further augmented by Mr. Harvey Gibson and Professor McNab, is published as Appendix (A) of this report.

Polyzoa have been collected during the year at Puffin Island, and Mr. Lomas reports to me that these include *Valkeria uva*, *Cellepora armata* and *C. dichotoma*, and many other commoner forms.

“SPINDRIFT” EXPEDITION IN JULY.

On Saturday, the 20th July, a most unfortunate day as far as weather was concerned, the “Spindrift” arrived at Holyhead, at five a.m., and took on board the party of biologists who had gone down by train from Liverpool the previous afternoon. The object on this occasion was to explore the deep water lying south of the Isle of Man, and which the bad weather at Easter had prevented us from reaching during the “Hyæna” expedition.



Fig. 5.—The L.M.B.C. District.

We got on the right ground this time, and had several hauls in from forty to sixty fathoms; but it rained hard and blew all day, and there was a heavy southerly swell,



and finally the trawl and the chief dredge were rendered useless by dragging over the rough bottom, so the work had to be given up earlier in the afternoon than usual. Consequently I feel that this region between the Isle of Man and Holyhead has not yet been sufficiently investigated, and that it is very desirable that we should have at least another day's work there, in favourable weather, with a powerful tug such as the "Spindrift" or the "Gamecock."

Amongst the rarer species obtained from over fifty fathoms during this trip were: *Cynthia tessellata*, *Amphiura ballii*, *Palmipes membranaceus*, *Balanus porcatus*, and a new species of Sponge (*Halisarca rubra*, n. sp.), encrusting the shell of *Mytilus*, which will be described and figured by Dr. Hanitsch in a future report. Mr. Walker informs me that so far as the Crustacea are concerned this trip was disappointing, the only addition to the "Fauna" being *Hippolyte spinus*. *Euonyx chelata*, a rare Amphipod, once before taken at Puffin Island, was however found abundantly on *Echinus sphæra*.

#### DEEP-SEA TOW-NET.

On this occasion Mr. Hoyle's deep-sea tow-net was used down to a depth of thirty fathoms. The closing apparatus worked without a hitch, save once, when a small piece of rope which was drifting in the water became twisted round the line and thus prevented the descent of the messengers. The possibility of such an occurrence had always been foreseen, but it is not sufficiently serious to militate against the use of the apparatus in shallow water. The operation does not take long, and if one haul should fail it is easy to make another. In the exploration of great depths, however, the case is different. The period occupied in

letting out and hauling in the line, taken in conjunction with the time required for dragging the net, is then so great that it becomes imperative to remove every possible risk of losing an observation. Furthermore, the time occupied by the messengers themselves in descending the line is a not unimportant factor in the case.

The Committee\* appointed by the British Association to investigate this matter were so much impressed by these considerations that it was resolved to attempt the construction of a piece of apparatus which should bring about the opening and closing of the net by means of an electric current, transmitted along wires passing down the interior of the line by which the net is drawn. This plan has so far succeeded that Mr. Hoyle has already constructed a provisional model. The lock (a piece of brass near the mouth of the net) contains an electro-magnet the armature of which actuates an escapement which the first time contact is made liberates the opening rod, and the second time the closing rod of the net. Such an arrangement is obviously instantaneous in its action, and not liable to interference from external causes. It is hoped that this electric tow-net will be ready for use soon, so that we may be able to experiment with it during next season's expeditions.

#### HIGHER CRUSTACEA, &c.

During the summer a good deal of shore collecting and of dredging with a small canvas dredge has been carried on by Mr. A. O. Walker, in Colwyn Bay and off the Little Orme's Head, resulting in the addition of the following species:—*Mysis inermis* and *M. ornata*, *Lamprops fas-*

\* Consisting of Prof. Schäfer, Prof. Herdman and Mr. Hoyle (Secretary). See Report of the Committee, read at the Newcastle-upon-Tyne meeting, 1889, from which some of the particulars given above are taken.

*ciatus*, *Danaia dubia*, *Atylus falcatus*, *Microprotopus maculatus* and *Corophium bonellii*. Mr. Walker also reports that in dredging on sand and mud in two and a half fathoms, at Colwyn Bay, in November, he came across a great number of females and one or two immature males of *Diastylis bradyi*, and a single adult male of *D. spinosa*, and he suggests that possibly the so-called immature males of *D. bradyi* may really be the females of *D. spinosa*. The pretty little Amphipod *Megaluropus agilis*, first described by Dr. Norman only last June, is now found to be not uncommon in Colwyn Bay. Mr. Walker informs me that the collections of Crustacea we have made this year exceed in bulk those of any previous year, and although they are not yet half worked out they have yielded a considerable number of novelties.

Towards the end of July, Mr. I. C. Thompson, the late Professor W. R. McNab, of Dublin, Mr. R. J. H. Gibson and I were at Puffin Island for a few days. Professor McNab and Mr. Gibson worked partly at the Algæ and partly at the land plants; while I occupied myself with further observations on the distribution of the animals over the littoral zone. At this time there were considerable numbers of two species of Pycnogonids on the under sides of stones. The one (*Nymphon* sp.) is of a straw-yellow colour, and is found adhering to Sertularian Zoophytes which are of the same tint; while the other species (*Phoxichilus spinosus*) is red and affects *Tubularia*, and a sea-weed (*Chylocladia articulata*) having also a dull red tint.

We have found the following Nudibranchs during the year at Puffin Island:—*Doris tuberculata*, *D. proxima*, *Goniodoris nodosa*, *Ancula cristata*, *Tritonia plebeia*, *Eolis viridis*, and the spawn of *Tergipes despecta*. No specimens of *Dendronotus arborescens* have yet been seen, so very

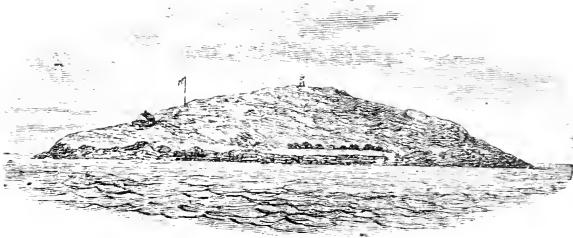
probably the attempt described in last year's report to transplant this species from Hilbre Island to Puffin has failed. The nudibranchs at Puffin Island along with those at Hilbre have afforded material to Mr. Clubb and myself for a number of anatomical observations during the year, as well as for those theoretical conclusions in regard to the usefulness of the branched and highly-coloured processes from the body as protecting or warning marks, which I discussed in my Presidential Address to the Biological Society. This theory in regard to the function of these structures, and of the colouring of the nudibranchs generally, has been arrived at independently this summer by the investigators at three separate biological stations, viz.—Professor Giard's laboratory at Wimereux, our own at Puffin Island, and, a little later, at the Plymouth laboratory.

I am now carrying on some experiments at the museum tanks for the purpose of determining to what extent the different kinds of nudibranchs are eaten by various coast fishes, such as the blenny, sole, plaice, turbot, conger, wrasse, &c.; and whether the conspicuously coloured forms with stinging threads, such as *Eolis*, are refused, while the protectively coloured harmless forms, such as *Tritonia* and *Doto* are eaten when visible. The experiments are being carefully recorded, and the results will be discussed in a future report.

Towards the end of autumn the L.M.B. Committee decided to close the biological station for the winter. The considerable distance, the numerous winter engagements in town, and the uncertain weather, have rendered it impracticable for our workers, with a very few exceptions, to visit Puffin Island at this season, and as it was found that even when at the station comparatively little could be

done on the shore, or out in the boat in the short, cold winter days, it seemed wise to economise time, money and energy by shutting up the laboratory from October till April. Consequently, the boats have been placed in safety in the Menai Straits, the apparatus and specimens have been brought up to University College, the curator has obtained a situation for the winter in Liverpool, and the station has been securely locked up. It is proposed to re-open the establishment at the beginning of either April or May, according to the weather and the wishes of our workers, and I have no doubt that next summer all the various lines of investigation now started will be followed up with a renewed enthusiasm which will more than make up for the loss of the winter observations.

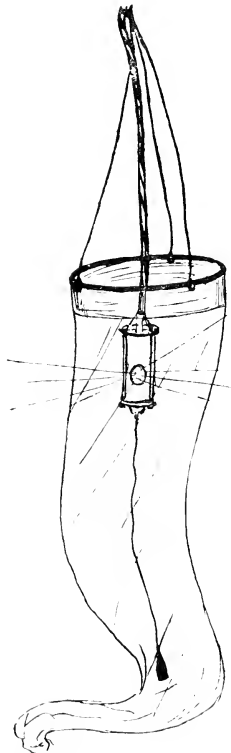
A catalogue of the land plants which have been recorded, the usual list of subscribers to the L.M.B.C. funds and the Hon. Treasurer's balance sheet for the year are appended.



*Applications to be allowed to work at the Biological Station, or for Specimens (living or preserved) for Museums, Laboratory Work, and Aquaria, should be addressed to Professor Herdman, University College, Liverpool.*

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*Subscriptions and Donations should be sent to Mr. I. C. Thompson, F.L.S., 19, Waverley Road, Liverpool.*



Tow-net with Electric Light.

## APPENDIX A.

## FIRST LIST of PLANTS on PUFFIN ISLAND.

[I have compiled this list from the records in the station "Journal" commenced by Mr. F. V. Dutton (Chester), 24th July, 1888, continued by Dr. C. Herbert Hurst (Manchester), and added to by Mr. J. Vicars (Bootle), Mr. R. J. Harvey Gibson (Liverpool), and the late Professor McNab (Dublin). The nomenclature and arrangement are those of Bentham and Hooker's Handbook --W. A. H.]

## DICOTYLEDONS.

## I. THALAMIFLORÆ.

## RANUNCULACEÆ.

*Ranunculus repens*, L., Creeping R.

## CRUCIFERÆ.

*Cochlearia officinalis*, L., Scurvy-grass.

## VIOLARIÆ.

*Viola canina*, L., Dog violet.

## CARYOPHYLLACEÆ.

*Sagina procumbens* (*apetala*), L., Pearlwort.

*Cerastium* sp.

*Spergularia rubra* (*salina*), Pers., Sandspurry.

## GERANIACEÆ.

*Geranium molle*, L., Dove's-foot G.

*Erodium maritimum*, L'H., Sea E.

## II. CALYCIFLORÆ.

## LEGUMINOSÆ.

*Trifolium repens*, L., White clover.

*Lotus corniculatus*, L., Bird's-foot trefoil.

## ROSACEÆ.

*Prunus communis*, Hud., Blackthorn.

*Rubus fruticosus*, L., Bramble.

*Potentilla reptans*, L., Cinquefoil.

## CRASSULACEÆ.

*Sedum acre*, L., Biting sedum.

## UMBELLIFERÆ.

*Crithmum maritimum*, L., Samphire.

*Daucus carota*, L., Carrot.

*Conium maculatum*, L., Hemlock.

## ARALIACEÆ.

*Hedera helix*, L., Ivy.

## III. MONOPETALÆ.

## CAPRIFOLIACEÆ.

*Sambucus nigra*, L., Elder.

## RUBIACEÆ.

*Galium verum*, L., Ladies' bedstraw.

## DIPSACACEÆ.

*Dipsacus sylvestris*, L., Teasel.

## COMPOSITÆ.

*Bellis perennis*, L., Daisy.

*Inula* sp.

*Senecio jacobæa*, L., Ragwort.

*Arctium lappa*, L., Burdock.

*Carduus lanceolatus*, L., Spear thistle.

*Carduus arvensis*, Curt., Creeping thistle.

*Carduus pycnocephalus*, L., Slender thistle.

*Carlina vulgaris*, L., Common carline.

*Leontodon* sp., Hawkbit.

*Sonchus* sp., Sow thistle.

*Taraxacum dens-leonis*, Desf., Dandelion.

*Hieracium* sp., Hawkweed.

## PRIMULACEÆ.

*Anagallis arvensis*, L., Common pimpernel.

## OLEACEÆ.

*Ligustrum vulgare*, L., Privet.



## BORAGINEÆ.

- Myosotis collina*, Hoffm., Early Forget-me-not.  
*Myosotis arvensis*, Hoffm., Field Forget-me-not.  
*Myosotis versicolor*, Pers. (?)  
*Lycopsis arvensis*, L., Bugloss.

## SOLANACEÆ.

- Hyocyamus niger*, L., Henbane.

## SCROPHULARINEÆ.

- Verbascum thapsus*, L., Great mullein.  
*Scrophularia nodosa*, L., Figwort.  
*Veronica* sp., Speedwell.  
*Veronica chamædryis*, L., Germander speedwell

## LABIATÆ.

- Ballota nigra*, L., Black horehound.  
*Calamintha* sp.  
*Nepeta glechoma*, Benth., Ground ivy.  
*Prunella vulgaris*, L., Self-heal.  
*Teucrium scorodonia*, L., Wood sage.

## PLUMBAGINEÆ.

- Armeria vulgaris*, Willd., Common Thrift.

## PLANTAGINEÆ.

- Plantago media*, L., Hoary Plantain.  
*Plantago lanceolata*, L., Ribwort P.  
*Plantago coronopus*, L., Buck's-horn P.  
*Plantago maritima*, L., Sea P.

## IV. MONOCHLAMYDÆ.

## CHENOPODIACEÆ.

- Chenopodium album*, L., White Goosefoot.  
*Chenopodium rubrum*, L., Red Goosefoot.  
*Beta maritima*, L., Common Beet.

## POLYGONACEÆ.

- Rumex crispus*, L., Curled Dock.  
*Rumex acetosa*, L., Sorrel.  
*Rumex acetosella*, L. Sheep sorrel.

## URTICACEÆ.

*Urtica dioica*, L., Common Nettle.

*Urtica urens*, L., Small Nettle.

*Parietaria officinalis*, L., Pellitory.

## MONOCOTYLEDONS.

## AROIDEÆ.

*Arum maculatum*, L., Cuckoo-pint.

## ORCHIDACEÆ.

*Orchis maculata*, L., Spotted Orchis.

## IRIDEÆ.

*Iris fetidissima*, L., Fetid Iris.

## LILIACEÆ.

*Scilla nutans*, Sm., Bluebell squill.

## GRAMINEÆ.

*Holcus lanatus*, L., Common H.

*Arrhenatherum avenaceum*, Beauv., False-oat.

*Festuca ovina*, L., Sheep's fescue.

*Poa (Sclerochloa) maritima*, Huds., Sea poa.

*Aira præcox*, L., Early Aira.

*Bromus arvensis (mollis)*, L.

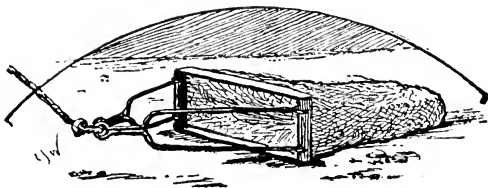
## CRYPTOGAMS.

## FILICES.

*Asplenium ruta-muraria*, L., Wall-rue.

*Asplenium marinum*, L., Sea-spleenwort.

*Aspidium filix-mas*, Sw., Male Fern.



## APPENDIX B.

## SUBSCRIPTIONS and DONATIONS.

	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
Banks, Prof. W. Mitchell, 28, Rodney-st.	2	2	0	—		
Bickersteth, Dr., 2, Rodney-street .....	2	2	0	—		
Booth, Alfred, 14, Castle-street .....	—			5	0	0
Brook, George, 19, Greenhill Gardens, Edinburgh .....	1	1	0	—		
Brown, Prof. J. Campbell, University College, Liverpool.....	1	1	0	—		
Brown, J. Harvie, Dunipace House, Larbert, N.B. ....	0	10	0	1	0	0
Burton, Major, Fryars, Beaumaris .....	2	2	0	—		
Caine, Nath., 10, Orange-court, Castle-st.	1	1	0	—		
Caton, Dr., 31, Rodney-street .....	—			1	1	0
Chadwick, H. C., 2, Beech-road, Chorlton- cum-Hardy, Manchester.....	0	5	0	—		
Clemence, S., Chester .....	1	1	0	—		
Comber, Thomas, Leighton, Parkgate.....	1	1	0	—		
Coventry, Joseph, 24, Linnet-lane .....	1	1	0	—		
Davidson, Dr., 2, Gambier-terrace .....	1	1	0	—		
Denny, Prof., Firth College, Sheffield.....	1	0	0	—		
Derby, Earl of, Knowsley .....	5	0	0	—		
Drysdale, Dr., 36A, Rodney-street ... ..	1	1	0	—		
Fritsch, Dr. Anton, Prague .....	—			3	0	0
Gair, H. W., Smithdown-road, Wavertree	2	2	0	—		
Gamble, Col. David, Windlehurst, St. Helens .....	2	0	0	—		
Gaskell, Holbrook, J.P., Woolton Wood, Much Woolton .....	1	1	0	—		
Gaskell, E. H., North Hill, Highgate, London .....	—			3	3	0
Gibson, R. J. Harvey, 16, Sydenham-avenue	1	1	0	—		

	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
Gifford, J., Whitehouse-terrace, Edinburgh	1	0	0	—		
Glynn, Dr., 62, Rodney-street .....	1	1	0	—		
Halhed, W. B., Sunnyside, Prince's Park.	1	1	0	—		
Halls, W. J., 35, Lord-street .. .....	1	1	0	—		
Henderson, W. G., Liverpool Union Bank	1	1	0	—		
Herdman, Prof., Univ. College, Liverpool.	2	2	0	—		
Higgin, Thos., Ethersall, Roby .. .....	1	1	0	—		
Holder, Thos., 1, Clarendon Buildings, Tithebarn-street .. .....	1	1	0	—		
Holland, Walter, Mossley Hill-road .....	2	2	0	—		
Holt, George, J.P., Sudley, Mossley Hill...	1	0	0	5	0	0
Hornby, T. D., The late, Olive Mount, Wavertree .. .....	1	1	0	—		
“Hyæna”—collected on board..... . . . .	—			3	8	6
Johnstone, Rev. Geo., M.A., 41, Bentley-rd.	0	5	0	—		
Jones, Chas. W., Field House, Wavertree	5	0	0	—		
Jones, J. Birdsall, 10, St. George's-crescent	1	1	0	1	1	0
Leicester, Alfred, 24, Aughton-rd., Birkdale	1	1	0	—		
Macfie, Robert, Airds.. .. .. .	1	0	0	—		
Marshall, Prof. A. Milnes, Owens College, Manchester .. .....	1	1	0	—		
McMillan, W. S., 17, Temple-street .....	2	2	0	—		
McMillan, R., 20, Aubrey-street .. .....	0	15	0	—		
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LIVERPOOL, 31st December, 1889.

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HON. TREASURER.

*Audited and found correct,*

ALFRED LEICESTER.

# REPORT on the LAND MOLLUSCA of PUFFIN ISLAND.

BY ALFRED LEICESTER.

[Read 13th December, 1889.]

IN presenting this report on the land Mollusca of Puffin Island, I may remark that on account of the small size of the island the numbers to record cannot possibly be large, or the species very varied, still what species have been found are well represented. The collections were made in the autumn of 1887 and summer of 1889. Further time devoted to the search in the future may result in the discovery of a few additional forms, but it is not to be expected that many such will be found. So far two families only are represented, viz. Limacidæ by one species, and Helicidæ by fifteen species.

I have not yet made a very careful search on the mainland of Anglesey, around Penmon Point, or on the Great Orme's Head, but most of the species found on the island have also representatives on the mainland; whilst one noticeable form found commonly on the Great Orme's Head does not occur on the island, viz. *Cyclostoma elegans*, the only operculated land shell. It seems strange that not even a dead specimen should have been found on Puffin Island considering its proximity to the land, and this being so, it would appear that no communication can have existed for a long period, or else such a striking form would surely have left some trace.

The nomenclature I have used is that of Forbes and Hanley's "British Mollusca."

**GASTROPODA.**

## PULMONATA.

Family: LIMACIDÆ.

*Limax agrestis*, Müll.

Very common, especially after rain. No other slugs have been observed.

Family: HELICIDÆ.

*Vitrina pellucida*, Müll.

Only a few specimens found.

*Zonites cellarius*, Müll.

Fairly common, some good ones. No other *Zonites* found on the island, but another species, *Z. alliarius*, Mill., was obtained on the Great Orme's Head, when one specimen only was found.

*Helix aspersa*, Müll.

It is a strange fact that this common shell should only be represented by dead specimens, not even a single living one having been found on the island. The quantity of dead ones is very large, showing that the species must have been very common formerly. Most were found at the mouths of the rabbit holes. Both on Anglesey and the Great Orme's Head living specimens are found.

*Helix nemoralis*, L.

By far the most common land shell on the island, and some are very good examples. The Conchological Society of Great Britain and Ireland are now making each differently banded shell a distinct variety, which is to my mind a great mistake. The number of bands and colouring of this shell is certainly too slender ground to go upon in forming named varieties. Some shells have only one band



half way round and two bands on the remainder. Many of the living shells are weathered to a greater or less extent, which may be accounted for by the very exposed situation of the island.

*Helix hispida*, L.

A few specimens found, also a good one on the Great Orme's Head.

*Helix caperata*, Mont.

Fairly common. This shell is also found on the Great Orme's Head.

*Helix rotundata*, Müll.

Very common, some specimens being rather large.

*Helix pulchella*, Müll.

Not very frequent.

*Helix umbilicata*, Mont.

On the first visit only one specimen was found, but since a fairly good number have been taken.

*Bulimus acutus*, Müll.

Very common. Some of the specimens are very strongly marked and are good examples of the species. They abound in the cliffs all round the island. This shell is very local in its distribution and variable in its markings.

*Bulimus obscurus*, Müll.

Only one dead specimen found on the island, but several on the Great Orme's Head.

*Pupa umbilicata*, Drap.

Also very freely distributed all round the island; there are, however, a good many dead specimens. No other *Pupa* noticed on Puffin Island or on the Great Orme's Head.

*Clausilia nigricans*, Mat. and Rack.

Very common, and the specimens large.

*Zua lubrica*, Müll.

Only one specimen, found by Mr. Gregory; no doubt there are more, but so far they have escaped notice.

PNEUMONOCHELYDA.

Family: CYCLOSTOMATIDÆ.

*Cyclostoma elegans*, Müll.

This beautiful shell was found to be fairly common on the Great Orme's Head, and so far as I have read I have not noticed it recorded as having been found previously in this district.

THIRD REPORT upon the NUDIBRANCHIATA  
of the L.M.B.C. DISTRICT.

By W. A. HERDMAN, D.Sc., F.L.S.,

PROFESSOR OF NATURAL HISTORY; AND

J. A. CLUBB,

ASSISTANT IN THE NATURAL HISTORY DEPARTMENT, UNIVERSITY COLLEGE,  
LIVERPOOL.

With Plates VI., VII., VIII., IX.

[Read May 9th, 1890.]

SINCE the last Report, published a year ago\*, a large number of Nudibranchs have been collected at Puffin Island, Hilbre Island, and in other parts of the district; and although no species previously unrecorded have been found, new localities have been added for some of the rarer species, and a number of additional observations upon habits and variations have been made. We have continued some of the anatomical and histological investigations on the structure of the cerata commenced last year, and have instituted a comparison between the conditions of the various dorso-lateral ridges and processes in the different genera. We also record here some experiments made in the fish tanks of the Liverpool Aquarium with the object of testing the theory proposed by one of us that the chief function of the cerata or dorsal papillæ is, according to their condition, to contribute to the inconspicuous and protective appearance of the animal or, in other cases, to render it conspicuous and warn predaceous animals of some special offensive property.

\* Proc. Biol. Soc., L'pool, vol. iii., p. 225.

This report is divided into three parts:—(1) the systematic account of the species, (2) some remarks upon the epipodial nature of the cerata, and (3) an account of the experiments with fishes. The usual tabular view of the distribution of the recorded species throughout the district, brought up to date, will be found on p. 146.

PART I. SYSTEMATIC ACCOUNT OF THE SPECIES.

NUDIBRANCHIATA.

A. PYGOBRANCHIA (= HOLOHEPATICA).

Family DORIDÆ.\*

*Archidoris tuberculata*, Cuvier.

We have several times lately found this common species lying in hollows of large sponges (*Halichondria panicea*), the Nudibranch being in such cases very completely hidden from observation. Garstang † has recently noticed this protective resemblance in specimens found at Plymouth, and Giard ‡ has referred to it in discussing the Nudibranchs at Wimereux, on the coast of Normandy. In 1888 we described § a remarkable specimen which was so coloured as to resemble exactly the lining of the rock-pool in which it lived.

*Lamellidoris bilamellata*, Linnæus.

This is the commonest species of Dorid in the Mersey, and although richly coloured with yellow and brown, so

\* We consider the form "Doridæ" preferable to "Dorididæ" as it avoids confusion with the family Dorididæ formed for the genus *Doridium*.

† Jour. Mar. Biol. Assoc., vol. i. no. 2, p. 174.

‡ Bull. Sci. de la France, &c., t. xix., p. 492. Giard had also pointed out some years before (Arch. Zool. expér., t. ii., 1873, p. 487) that this and a few other species sometimes resemble the compound ascidians upon which they live.

§ Proc. Biol. Soc., L'pool, vol. iii., p. 13.

as to be a striking object in a white dish or a vessel of clear water, it is quite inconspicuous on the dark purple-brown rocks spotted with patches of adhering mud, sand, small algæ and zoophytes found in this neighbourhood. We were much impressed with this on a recent visit (March, 1890) to Hilbre Island when we found that a reef of rock we were exploring had a number of specimens of this species scattered over it which were not at first noticed because of the perfect manner in which their colours blended with those of the surroundings.\*

*Lamellidoris proxima*, Ald. and Hanc.

We have taken this again at Puffin Island and Hilbre Island, and Dr. Hanitsch found it at Port Erin, Isle of Man, in April, 1890.

*Acanthodoris pilosa*, O. F. Müller.

Found again at Hilbre Island, March, 1890—colour dark grey. Transverse sections of this species bring out very clearly that the large papillæ on the dorsal surface are much more prominent on the sides than along the middle line of the back (Pl. VI. fig. 5).

#### Family POLYCERIDÆ.

*Goniodoris nodosa*, Montagu.

Found at Port Erin, Isle of Man, in April, 1890, by Dr. Hanitsch. We have made use of specimens of this species for an enquiry into the condition of the epipodial ridges (Pl. VI. fig. 6) which will be discussed below.

*Polycera quadrilineata*, O. F. Müller.

Dr. Hanitsch obtained some specimens at Port Erin, Isle of Man, in April, 1890. We have found this species an important transition form, in the condition of the

\* In this connection see the experiments on fishes given on p. 152, and the remarks on colour on p. 162.

dorsal ridges and epipodial processes, between *Goniodoris* and *Ancula*.† The anterior part of the body in the region of the rhinophore shows in transverse section (Pl. VI. fig. 7, *e.p.*) a prominent lateral ridge which becomes considerably lower as it is traced back (Pl. VI. fig. 8, right side), and then rises again at the sides of the branchiæ (Pl. VI. fig. 8, left side, and fig. 9) and immediately behind them to form prominent cerata comparable with those of *Ancula* (Pl. VI. fig. 10). These posteriorly placed cerata of *Polycera* contain numerous large glands (Pl. VII. figs. 3 and 4) which we shall have to refer to again in connection with *Ancula* (p. 136).

*Ancula cristata*, Alder.

This species was found by Dr. Hanitsch at Port Erin, in April, 1890, and we took it in extraordinary profusion at Hilbre Island in March, 1890. On one reef of rocks especially, a little way above low water mark, there must have been many thousands of specimens present. For yards it was impossible to walk without treading on them and handfuls were readily collected by scraping the specimens together from the mud-covered rocks. Many of these were kept alive and used for the experiments with fishes at the Aquarium described below.

The variation in size and colouring of this species at Hilbre is very great, and the larger specimens are almost invariably white, light grey or almost colourless, while the smaller ones are more or less conspicuously ornamented with bright yellow. This species is very slimy, and a number of specimens put together in a bottle very soon form a

†Garstang (*loc. cit.* p. 181) has already pointed out that the cerata of an allied form, *Italia aspersa*, are plainly homologous with the ridges of *Goniodoris* &c., and the epipodial folds of *Doris*; and has expressed his belief that their homologues are to be found in *Tritonia*, *Lomanotus* and *Eolis*. See also, Herdman, *Quart. Journ. Mier. Sci.*, vol. xxxi., p. 42.

reticulum of mucus with mud and entangled foreign bodies in which they remain hidden. In the natural state the mucus seems chiefly on the foot and especially at its posterior end, each individual having a slimy string attached to the end of the tail by which it is anchored. This no doubt accounts for the manner in which the animal is able to live on exposed rocks in the wash of the tide. We have several times watched specimens of *Ancula* in a few inches of water when there was a strong tide running past the rocks and waves dashing on them and noticed that they were swayed backwards and forwards in the water but were securely anchored by their tails.

Transverse sections through the body show that at least three different sets of glands connected with the integument are present. First there are the mucus-secreting goblet cells in the ectoderm which are abundant over the whole surface (Pl. VII. figs. 5 and 6, *g.c.*); then there are the distinct glands in the foot (Pl. VII. fig. 5, *f.g.l.*) which are large and extend for a considerable way into the mesoderm; and finally there are special glands which are placed chiefly on the side of the body in its posterior part (Pl. VII. fig. 6, *gl'*), and in large masses occupying the apices of the cerata (Pl. VII. fig. 8, *gl'*).

The foot glands are multicellular pyriform masses opening by narrow ducts on the surface of the foot (Pl. VII. figs. 5 and 6, *f.g.l.*). The cells are distinctly nucleated and granular, and stain deeply with picrocarmine. The special glands on the sides of the body and tail consist of large single cells of spherical or pyriform shape which are generally aggregated into clumps. These cells are distinctly nucleated, but the nucleus is sometimes displaced to one side and the greater part of the cell is occupied by a clear or faintly granular secretion (Pl. VII. fig. 6, *gl'*). Ducts are not so obvious as in the case of the

foot glands. At the apices of the cerata the glands are much more distinctly arranged in ovate or pyriform masses (Pl. VII. figs. 7, 8, 9) and there are usually distinct ducts (Pl. VII. fig. 9, *gl'*). The cells are smaller, are invariably filled with a clear secretion, and the nucleus is displaced to the side. We find that the cerata are occupied by large blood spaces (the ceratal sinuses, Pl. VII. figs. 7 and 8, *b.s.*) exactly like those of the cerata of *Dendronotus arborescens*.\*

*Ancula* is not protectively coloured; and as it has no cnidophorous sacs, its bright white and yellow colouring and conspicuous appearance on dark rocks seemed for a time inexplicable. From our experiments we have come to the conclusion that it is distasteful to fishes (see below, p. 155), and possibly it is the secretion of these large compound glands at the apices of the cerata which is of an offensive nature.

In *Polycera quadrilineata* (Pl. VII. figs. 3 and 4) the cerata terminating the lateral ridges on the body, which we regard as representing the cerata of *Ancula*, contain numerous glands. These are simple pyriform sacs filled with large polygonal granular cells which stain deep crimson with picrocarmine (Pl. VII. fig. 3, *gl*). These glands open between the ectoderm cells by long narrow tubular ducts (Pl. VII. fig. 4).

In *Ancula* the large glands in the cerata are somewhat different from those of *Polycera quadrilineata*. The masses are not so regularly placed and shaped, and the cells are not so granular, but seem to a large extent filled up with a clear secretion, while the nucleus is displaced to one side of the cell. And whereas in *Polycera* the glands extend nearly all over both sides of the cerata, there being

\* Compare our last report, Proc. Biol. Soc., L'pool, vol. iii., Pl. xii. fig. 2.



only a narrow basal tract free from them, (Pl. VI. fig. 9), in *Ancula* they are confined to the terminal one-third or so of the cerata. Possibly these glands, both in *Polycera* and *Ancula*, correspond to those found in a similar position in *Aplysia* (Pl. VII. fig. 1), viz., along the edges of the epipodia. In *Aplysia punctata*, however, these epipodial glands are smaller and not so conspicuous, those of the under surface of the mantle edge being relatively larger and more numerous (Pl. VII. fig. 2).

## B. CERATONOTA (= CLADOHEPATICA.)

### Family DOTONIDÆ.

*Doto coronata*, Gmelin.

Dredged in Turbot Hole, off Puffin Island, August, 1889.

With the view of determining the structure of the cerata, and especially the meaning of the little pigmented projections which give them their turretted appearance (Pl. IX. fig. 1), we have made a number of serial sections both longitudinal and transverse. The hepatic cæca in the cerata are very large and are branched and swollen, so that usually several large hepatic cavities are found cut in each section (Pl. IX. fig. 1).\* Between the hepatic cæca and the ectoderm we find almost a continuous layer of gland cells which stain deeply with picrocarmine and are arranged in elongated clumps lying parallel with the ectoderm and usually two or three cells thick (Pl. IX. fig. 3, *gl.*). On the pigmented projections the columnar ectoderm is found to become rapidly cubical and then almost squamous (Pl. IX. figs. 2 and 4, *k*), while the dome-shaped cavity below the thin ectoderm is nearly filled up

\* For the general relations of the hepatic cæca in the cerata to the parts of the liver in the body see Herdman, Quart. Jour. Microsc. Sci., vol. xxxi., p. 51, and pl. ix.

with gland cells amongst which are found one or more small cavities.

Vayssière\* has described in *Doto cinerea*, and briefly referred to in *D. coronata*, the presence of remarkable large unicellular glands on the papillæ of the cerata which he considers as offensive organs comparable with the cnidocysts of the Eolididæ. Vayssière finds that these cells when mature are able on slight pressure to emit a delicate tube filled with a finely granular fluid, which escapes from a slit in the end of the tube, and may be regarded as a poison serving to defend the *Doto* against enemies.†

Our figures (Pl. IX. figs. 2, 3 and 4) are of course taken from preserved specimens, where no doubt there has been a certain amount of contraction, but the sections certainly give us the impression that the large cells are arranged in distinct masses or glands containing a central cavity (Pl. IX. figs. 2 and 4) and opening to the exterior at the apex of the little papilla where the epithelium becomes low. From Vayssière's figure ‡ it appears that in *Doto cinerea* the epithelium remains columnar all over the summit of the papilla. We do not find in our specimens any trace of the "urticating cells" filled with minute fusiform spicules found by Vayssière in *Doto cinerea*.

#### Family EOLIDIDÆ.

*Facelina (Acanthopsole) coronata*, Forbes.

We find that in this species, which we have been investigating since the last report, the apex of the hepatic cæcum in the cerata is connected with the cnidophorous sac by a long narrow tube very much as in *Facelina drummondii* (see Pl. IX. fig. 8). The cnidophorous sac

\* Ann. du Mus. d'Hist. Nat. de Marseille, t. iii., mem. 4, p. 104, 1888.

† loc. cit., p. 105.

‡ loc. cit., pl. vii. fig. 133.

narrows gradually at its lower end and passes over into the connecting tube which is bent upon itself in a sigmoid curve. Fig. 6 shows a section in which hepatic cæcum (*h.c.*), connecting tube (*c.d.*) and cnidophorous sac (*c.s.*) occur together all cut transversely. The large cells or cnidocysts in which the thread-cells lie (fig. 6, *c.s.*) are distinctly nucleated and contain each a very large number of cnida. They get much smaller at the upper and lower ends of the sac and pass gradually into the ordinary ectoderm cells on the one hand and the cubical or low columnar cells of the connecting duct on the other.

The cnida are of elongated fusiform shape and are slightly curved\* (fig. 7). None were seen in the exploded state. At the junction of the connecting tube with the apex of the hepatic cæcum the cubical epithelium passes gradually into the glandular hepatic cells, and there appears to be no distinct sphincter present. Figure 5 shows the very narrow opening of the hepatic cæcum into the lateral branch of the liver (*l.l.*) leading to the posterior end of the stomach.

*Facelina (Acanthopsote) drummondi*, Thompson.

A number of specimens were found at Hilbre Island on September 9th, 1889, at extreme low water.

The remarkably long curved connecting duct between the cnidophorous sac and the hepatic cæcum in this species is shown in Pl. IX. fig. 8, *c.d.* Pl. IX. fig. 9 shows the

\* These are evidently the forms described by Vayssière as the reniform nematocysts (Ann. du Mus. d'Hist. Nat. de Marseille, Zool. t. iii., Mém. 4, p. 40, 1888); we have not found the second kind described as oviform. Bergh, in his recently published admirable account of the Cladohepatic Nudibranchs (Zoolog. Jahrbüch., Bd. v. 1890), seems to consider it still doubtful whether more than the one kind of cnida is really produced in the cnidophorous sac, but Vayssière's figures show very distinctly, in the case of *Coryphella landsburgi* at least, unbroken cnidocysts containing two distinct kinds of cnida, large reniform and small pyriform.

appearance of the hepatic cæcum in the living condition, and fig. 10 shows some of the pigmented yellow (*a*) and red (*b*) liver cells set free.

*Coryphella rufibranchialis*, Johnst.

This species is considered to be a synonym of *Coryphella landsburgi* by Trinchese, Vayssière and others, but we are convinced of its distinctness. In *C. rufibranchialis* the white zone on the cerata is very wide, and the cnida differ from those of *C. landsburgi* (see Pl. VIII. figs 2 and 9.) It has been added to the Fauna of Puffin Island by Mr. Thompson who collected three specimens on the south spit in April, 1890.

As this is a common species in this neighbourhood, and we have been able to examine a number of very fine specimens, we give the following notes taken from the animal in the living condition :—

The body is white and less translucent than in *Facelina coronata* and many other Eolids ; it is more solid and fleshy-looking. The front of the foot is prolonged laterally to form a pair of conspicuous curved processes. The tail is very long and tapers to a fine point. The largest specimens we have taken at Hilbre Island during the last year measure 4·5 cm. in length.

The dorsal tentacles are of the same white colour as the body. They are tapering and are not laminated, but are irregularly corrugated along their edges. There is a little opaque white pigment scattered over their tips.

The oral tentacles are of the same form, length, and colour as the dorsal tentacles. In one of our specimens we found the left oral tentacle bifurcating into a pair of long slender divergent branches with very sharp points.

The cerata are large and awkward looking, and the animal has a habit of erecting them in a bristling manner and of waving them about energetically with a somewhat jerky

motion. The colour of the hepatic cæca in the cerata is from a bright brick-red to vermilion and is quite opaque; while the surrounding integument ("sheath" of Alder and Hancock) is colourless and transparent. There is a ring of opaque white pigment on the surface near the apex (Pl. VIII. fig. 1, *pyg.*) The cerata are placed indistinctly in rows which are placed very close together and are 18 to 20 in number. There are about 6 cerata in each row, the smallest being as usual on the outside. Some of the smaller cerata have little or no colour, and in one of our specimens we found one of the largest cerata near the middle of the body to be perfectly clear and colourless—apparently the hepatic cæcum was absent.

The hepatic cæca in this species are very distinctly lobulated (Pl. VIII. figs 1, 3, 4 and 5). In some cases it might be said that short branches are present, thus leading in the direction of the distinctly branched cæca of *Doto*. Figure 3 shows one of the cerata of *Coryphella rufibranchialis* in longitudinal section and exhibits the well marked lateral lobes or short branches of the cæcum, while fig. 5 shows the condition, and arrangement of the red (*v*) and yellow (*y*) pigmented masses, in part of a slightly squeezed living specimen.

The broad ring of superficial pigment near the tip of the cerata hides the greater part of the cnidophorous sac (Pl. VIII. fig. 1, *pyg.*) allowing only the apex and the wide base to be seen. The sac is large and of elongated pyriform shape, and has a very muscular wall. The cnidocysts are long and narrow and rather numerous. They nearly meet in the centre of the sac (Pl. VIII. fig. 4, *c.c.*) The connecting tube between the cnidophorous sac and the hepatic cæcum is so short as to be reduced to a mere opening (see Pl. VIII. fig. 1, surface view, and fig. 4, section), on the edges of which the smaller basal cnidocysts

are seen to pass gradually over into the hepatic cells. The cnida, which are very numerous, are large and of nearly globular form (fig. 2) like those of *Facelina drummondi*, and the thread is coiled transversely to the longer axis of the cell.

*Coryphella lands'burgi*, Ald. and Hanc.

We found four specimens of this rare species at the north end of Hilbre Island, on March 21st, 1890. This is apparently the first time it has been taken in the district since the two original specimens recorded by Byerley in 1849 and 1853.\* Our specimens were obtained at extreme low water of a twenty foot tide, and at least two of them were attached to *Flustra foliacea*.

The length of the largest specimen when extended was 1.5 cm.; and the colouring was very brilliant, the body and tail and the tentacles, both oral and dorsal, as well as the surface layer of the cerata being of a bright lilac, or from that to a violet tint, while the central part of the cerata varied from a bright brick red to a vermilion colour, very much as in the case of *Coryphella rubibranchialis*. Under a low power the characteristic lilac colouring is seen to be in a granular condition, and is due to a large number of rounded pigment cells scattered closely over the surface layer of the mesoderm (Pl. VIII. fig. 10).

The cerata are arranged in groups. Commencing at the anterior end there are first four rows closely placed, then two rows, then four sets of single rows having six cerata in each row. The larger cerata are long and tapering. Near the tip of each is found an incomplete ring of opaque white pigment placed upon the surface and obscuring the median portion of the endoporous sac (Pl. VIII. fig. 7, *py*). There is also a little opaque white pigment

\* See our first Report in vol. i. of "Fauna," p. 274.

scattered over the tips of the dorsal and oral tentacles. The eyes are very distinct, and are placed some way behind the bases of the dorsal tentacles. Sections however show that they are sessile upon the cerebral ganglia.

The cnidophorous sac is pyriform in outline, the upper end being pointed while the lower wider end communicates with the apex of the hepatic cæcum by a short straight tube (Pl. VIII. fig. 7). The wall of the cnidophorous sac is unusually muscular, and while one of the animals was under observation in the living condition we saw a large number of the cnida expelled with force from the terminal opening (Pl. VIII. fig. 8.) in the exploded or evaginated condition. The cnida are large (measuring 0·028 mm. in length and 0·01 mm. in breadth) and are of an ellipsoidal shape (Pl. VIII. fig. 9).\* The thread is distinctly seen to be coiled along the axis of the cell and not transversely to it as in *Facelina drummondi* and other species. When evaginated the thread is seen to be provided with numerous long sharp spines placed alternately so as to give rise to a zig-zag appearance (Pl. VIII. fig. 9).

*Galvina picta*, Ald. and Hanc.

We collected half a dozen specimens of this species at Hilbre on September 9th, 1889, and several on March 21st, 1890; and Mr. A. O. Walker dredged a specimen in Colwyn Bay in February, 1890. It appears to be becoming more common in the district.

Figure 11 on Plate IX. shows a transverse section through the tip of one of the cerata of this species. On the inner side of the large ectoderm cells is found a thin layer of connective tissue (*mes.*), then an irregular series of blood sinuses, then another thin layer of connective tissue, and then, occupying the centre of the section, is

\* Described by Vayssière as reniform (loc. cit., p. 78.)

the cnidophorous sac (*c.s.*) with its wall formed of large cnidocysts (invaginated ectoderm cells) packed full of cnida. The sac is rather long, the cnidocysts are very distinct and not numerous, and the cnida are of elongated rod-like form with the thread coiled transversely to the long axis of the cell.

*Cratena concinna*, Ald. and Hanc.

We obtained this species for the first time during the recent cruise of the "Hyæna" (May, 1890). It was recorded many years ago by Collingwood, from the neighbourhood of the Mersey. We dredged three specimens off Lleinïog in the Menai Straits, between Puffin Island and Beaumaris, from a depth of six fathoms.

The colour of the hepatic cæca in the cerata differed a little in these specimens, being in one much redder and in the others browner. Under a low power of the microscope the colour seems very much yellower than it does to the eye. It is coarsely granular, and in some of the cerata the cæca are much lobed.

*Cratena viridis*, Forbes.

We found one specimen of this rare species amongst zoophytes dredged from the Turbot-hole near Puffin Island in August, 1889, and took one specimen at Hilbre Island on March 21st, 1890. The latter is the first that has been recorded from the neighbourhood of the Mersey, and the species was only known previously from the other parts of our district by one specimen from the Isle of Man and one from Puffin Island. We also dredged a specimen in Rhoscolyn Bay, Anglesey, during the recent cruise of the "Hyæna" (May, 1890). The following notes were taken from the Hilbre Island specimen in the living condition:—

The length of the body is 4·5 mm. The dorsal and oral tentacles are rather short and colourless, and have slightly irregular edges. There are ten closely placed rows of



cerata which are short and stout in form. The hepatic cæca under a low power of the microscope are seen to be irregularly speckled with green and black pigment, while at the apex the cnidophorous sac forms a large opaque yellowish mass. This apical colouring is not superficial as in the case of *Coryphella landsburgi*, *C. rubibranchialis*, and other species, but is apparently in the wall of the sac itself. There is, however, a little opaque white sprinkled down the anterior surfaces of the cerata. One of the larger cerata was found to be bifurcated at its tip, and provided with two distinct cnidophorous sacs. Curiously enough the single specimen from Puffin Island, which we recorded last year, showed exactly the same abnormality.\*

The cnidophorous sac (Pl. IX. fig. 12) is flask shaped, and communicates with the hepatic cæcum by a very short tube. Several masses of gland cells (*gl.*) are placed around the junction.

The table on the following page shows the distribution of the species of Nudibranchs recorded up to now in the four regions of our district which have been sufficiently investigated. The first column includes Hilbre Island, while the third takes in the Menai Straits and the coast of Anglesey: we separate Puffin Island from the preceding region merely because it may be convenient for those working at the Biological Station to know what species have been found on the shore. Fifteen species have now been obtained at Puffin Island.

\* Proc. Biol. Soc., Liverpool, vol. iii., p. 234.

NUDIBRANCHIATA.	Estuary of the Mersey.	Isle of Man.	North Wales.	Puffin Island.
<i>Archidoris tuberculata</i> .....	×	×	×	×
<i>A. johnstoni</i> .....	×	...	...	...
<i>A. flammea</i> .....	...	×	...	...
<i>Lamellidoris bilamellata</i> .....	×	...	...	...
<i>L. depressa</i> .....	×	...	...	...
<i>L. proxima</i> .....	×	×	...	×
<i>Acanthodoris pilosa</i> .....	×	...	...	×
<i>A. quadrangulata</i> .....	×	...	...	...
<i>Goniodoris nodosa</i> .....	...	×	×	×
<i>G. castanea</i> .....	...	×	...	...
<i>Triopa claviger</i> .....	...	×	...	...
<i>Polycera lessoni</i> .....	×	...	...	...
do., var. <i>ocellata</i> .....	×	...	...	×
<i>P. quadrilineata</i> .....	...	×	...	...
<i>Ancula cristata</i> .....	×	×	...	...
<i>Tritonia hombergi</i> .....	×	×	...	...
<i>T. plebeia</i> .....	×	...	...	×
<i>Dendronotus arborescens</i> .....	×	×	×	...
<i>Doto coronata</i> .....	×	×	...	×
<i>D. fragilis</i> .....	...	×	...	×
<i>Janus cristatus</i> .....	×	...	×	...
<i>J. hyalinus</i> .....	×	...	...	...
<i>Eolidia papillosa</i> .....	×	×	×	×
<i>Eolidiella glauca</i> .....	...	...	×	...
<i>Facelina coronata</i> .....	×	...	...	×
<i>F. drummondii</i> .....	×	...	×	...
<i>Coryphella lineata</i> .....	...	×	...	...
<i>C. gracilis</i> .....	...	...	×	×
<i>C. landsburgi</i> .....	×	...	...	...
<i>C. rubibranchialis</i> .....	×	...	...	×
<i>Cratena concinna</i> .....	×	...	×	...
<i>C. olivacea</i> .....	×	...	...	...
<i>C. anæna</i> .....	...	×	...	...
<i>C. aurantiaca</i> .....	×	...	...	...
<i>C. arenicola</i> .....	...	...	×	...
<i>C. viridis</i> .....	×	×	×	×
<i>Cuthona nana</i> .....	×	...	...	×
<i>Galrina picta</i> .....	×	×	×	×
<i>G. tricolor</i> <sup>o</sup> .....	...	×	×	...
<i>Tergipes despecta</i> .....	×	...	×	...
<i>T. erigua</i> .....	×	...	×	...
<i>Embletonia pallida</i> .....	×	...	...	...
<i>Fiona marina</i> .....	×	...	×	...

## Part II. EPIPODIAL NATURE OF THE CERATA.

In a paper\* laid by one of us before the British Association last September, it was suggested that all the various projections from the sides and back of Nudibranchs known as cerata are to be regarded as epipodial papillæ, or outgrowths from a more or less distinct epipodial ridge. And Garstang † has independently arrived at the same conclusion in his recent Report upon the Nudibranchs of Plymouth Sound.

Pelsener has lately drawn attention ‡ to the presence and condition of the epipodia in *Trochus* and other Rhipidoglossate Gastropods, but he does not consider these structures as being homologous with the large epipodial flaps of *Aplysia* and other Opisthobranchs and Pteropods. For these latter he uses the term parapodia, introduced by von Jhering, and open to the objection that it is already appropriated by a totally different structure in another group of animals. But the condition of the parts in *Trochus* is so very similar to that found in *Polycera* and *Idalia*, and the dorso-lateral processes of the two latter forms are so clearly comparable with the large lateral flaps of *Aplysia*, that we are inclined to regard all these projections as being homologous structures, entitled to be considered as epipodial in their nature.

We now give figures of a series of transverse sections (Pl. VI.) for the purpose of showing the condition of the epipodial structures in a number of different forms of Nudibranchs.

The typical epipodia are seen in *Elysia* (Pl. VI. fig. 1)

\* Herdman on the Struct. and Functions of the Cerata, &c., Brit. Assoc. Report, 1889 (abstract only), and published in full in Quart. Journ. Microsc. Science, vol. xxxi., p. 41.

† Journ. Mar. Biol. Assoc., vol. i. no. 2., p. 181.

‡ Sur l' épipodium des Mollusques, Bull. Sci., 1888, p. 182.

or in *Aplysia* (fig. 2,) in a well developed state, and a transverse section through the latter mollusc at about the junction of the anterior and middle thirds of the body shows that the epipodia are folds of the lateral integument, extending upwards and inwards (Pl. VI. fig. 3, *e.p.*) so as to cover over the greater part of the dorsal surface.

It is generally believed\* that the fold of integument over-hanging the foot in *Doris* should be regarded not as a mantle edge but as an epipodial ridge. Figures 4 and 5 show transverse sections through *Doris pilosa*, and the lateral ridges (*e.p.*) above the foot are seen to be large, to have the same general relations as the epipodial folds of *Aplysia*, and to bear on their surface a number of prominent papillæ. When we examine next a transverse section of *Goniodoris nodosa* (Pl. VI. fig. 6) we find that the lateral ridges have assumed a more dorsal position, and have slightly projecting nodules or papillæ at intervals along their course. In *Polycera* (Pl. VI. figs. 7, 8, 9) we find the same lateral ridge has become more prominent, bears more distinct papillæ throughout its course, and rises up at its posterior end alongside the median dorsal branchiæ to form a pair or more of large simple or bifurcating processes which are entitled to the name of cerata (Pl. VI. fig. 9).†

In the genus *Idulia* a similar epipodial ridge is present bearing numerous slender cerata, especially in its posterior part, alongside the branchiæ; and even in *Egirus punctilucens*, where the back and sides of the body bear numerous tubercles, there is a row of larger projections distinctly visible on each side, which probably represents the epipodial ridge of other forms (Pl. VI. fig. 11, *e.p.*).

\* E.g., see Lankester, *Eny. Brit.*, 9th ed., vol. xvi., Art. Mollusca, p. 655.

† Parieto-cerata, Herdman, *loc. cit.*, *Quart. Jour. Mic. Sc.*, p. 42.

In *Ancula cristata* the lateral ridge has almost disappeared as a ridge, but it is evident that the five pairs of large simple cerata placed at the sides of the branchiæ (fig. 10) correspond to the similar structures seen in *Polycera* and *Idulia*. Then in *Triopa claviger* (fig. 12) the cerata have become more numerous (seven pairs), are directed more laterally, and extend from the head nearly to the posterior end of the body.

In passing next to the family Tritoniidæ we find that the cerata become branched in an arborescent manner, but on comparing sections of *Goniadoris* (fig. 6) or *Polycera* (fig. 9) with those of *Candiella plebeia* (fig. 13) it is impossible to doubt that one is dealing with the same series of projections. *Cabrilla occidentalis*, which has been lately described and figured by Fewkes,\* presents an interesting intermediate condition between *Triopa* and *Tritonia*. *Cabrilla* is evidently referable to the Doridæ; it has short laminated rhinophores and a posteriorly-placed circle of branchiæ, but is possessed of six or seven pairs of laterally-placed cerata which are branched at their ends, and are evidently comparable with the parieto-cerata of *Tritonia* and *Dendronotus*. In *Dendronotus* the large parieto-cerata become very complicated in form (fig. 14), but are evidently merely a further development of the smaller but similar processes of *Candiella* or *Tritonia*.

Finally, in the great group Cladohepatica we find large and conspicuous hepato-cerata (Pl. VI. figs 15 and 16), as in *Doto*, *Eolis*, and *Proctonotus*, but we must regard these as being merely cerata, originally like those of the Doridæ and Tritoniidæ, which have been invaded by the hepatic cæca and have afterwards become enlarged and modified

\* Zoological Excursions, I. New Invertebrata from California: Boston, 89, p. 44.

in various ways. In *Doto* (fig. 15) there is a single row of cerata on each side of the body, but each member of the row is lobed. In most species of *Eolis* (fig. 16) there are several rows of cerata on each side, or in other words each of the lobed cerata of *Doto* is represented by a group of simple cerata in *Eolis* (see Pl. VI. figs. 15 and 16).

Consequently we think there are grounds for considering all these dorso-lateral projections, whether they be ridges or parieto-cerata or hepato-cerata, simple or branched, as being epipodial in their nature.

### Part III. EXPERIMENTS WITH FISHES.

With the view of testing the theory that the remarkable shapes and colours of Nudibranchs are either of a protective or of a warning nature,\* and are definitely related to their edibility or the reverse, we arranged some experiments on the feeding of Fishes with Nudibranchs, which were carried out in the Aquarium of the Liverpool Free Public Museum, with the kind co-operation of the Curator, Mr. T. J. Moore, and some of his assistants.

Most of the experiments were made in three large fish tanks, which may be called A, B, and C. A and B are rectangular slate and plate-glass wall-tanks lit from the top, measuring  $7\frac{1}{2}$  feet long,  $5\frac{1}{4}$  feet wide, and  $3\frac{1}{4}$  feet high, and containing each about 700 gallons of sea water and some rock-work. A has a gravel bottom, and contains about twenty very healthy and active adult shannies (*Blenius pholis*, obtained from the Menai Straits); while B has a sandy floor and is devoted to flat fish—it contains a considerable number of soles (*Solea vulgaris*) and plaice

\* See Herdman, Opening Address, in Trans. Biol. Soc., Liverpool, vol. iv., p. 16; and Quart. Journ. Microsc. Sci., vol. xxxi., p. 41, April, 1890.

(*Pleuronectes platessa*), a few small thornback rays (*Raja clavata*), turbot (*Rhombus marinus*), and one brill (*Rhombus laevis*), and on one occasion had some young cod (*Gadus morrhua*). The average size of these flat fish is six or seven inches in length, and there are over sixty of them altogether in the tank.

C is an octagonal centre or table tank with a sandy bottom, measuring 4 feet 6 inches in diameter and 17 inches in depth, and holding about 100 gallons of water. It contains various small fishes, viz., bullhead (*Cottus bubalis*), wrasse or goldsinny (*Ctenolabrus rupestris*), pogge (*Agonus cataphractus*), gemmeous dragonet (*Callionymus lyra*), five-bearded rockling (*Motella mustela*), viper weever (*Trachinus vipera*), and young cod (*Gadus morrhua*).

All these fishes were in a thoroughly healthy condition, and some of them had been living undisturbed in their tanks for periods varying up to four years. The water in the tanks is kept aerated, and in constant circulation by a water engine. The fish are usually fed upon mussels, cockles, and occasionally worms, which are thrown in at the top of the tank and allowed to sink slowly through the water. Such food matters are usually seen at once and eagerly pounced upon and eaten during their descent. We adopted the same plan in putting most of the nudibranchs into the tanks; and as, in anticipation of the visit to the Aquarium in the afternoon, the fishes were not fed on the days we intended to experiment with them, they had been fasting for about twenty-four hours, and so may be regarded as being unusually eager to seize any object dropped into the water. At the beginning, and again at the end of each day's experiments, we threw a couple of cockles or mussels into the tank, and found that they were at once caught and bolted in the usual manner.

- I. October 29th, 1889. [A supply of healthy average-sized specimens of *Lamellidoris bilamellata* was obtained from the rocks at New Brighton. Mr. Moore, the curator; Mr. R. Paden, assistant; and Woods, the Aquarium attendant, were present. Notes were taken by Professor Herdman.]

A. Shanny Tank :—

- Doris*\* 1.—Seized when falling by a fish and taken at once to dark corner.
- 2.—Seized and at once rejected; seized by another fish and at once rejected; seized by a third and rejected, then allowed to lie on bottom.
- 3.—Seized and rejected by two fish in rapid succession, then seized by third and taken to dark corner.
- 4.—Seized and rejected by first fish, taken to dark corner by second.
- 5.—Seized and rejected by three fish in rapid succession, and then left.

B. Flat Fish Tank :—

- Doris* 1.—Seized and rejected in rapid succession by a turbot, a sole, another sole, and a plaice, and then left lying on sand.

C. Table Tank :—

- Doris* 1.—Seized and rejected by a wrasse, tried again by same and again rejected, then left.
- 2.—Seized and rejected by a *Cottus* and by a dragonet in rapid succession and then left.

\* In the account of these experiments we shall use the old well-known generic names *Doris* and *Eolis* instead of *Lamellidoris*, *Coryphella*, &c.



Finally, another *Doris* was dropped gently into a fourth tank containing a conger eel so as to fall in front of its nose, but although the fish passed close to the nudibranch several times while under observation it apparently took no notice of it, and certainly made no attempt to seize it.

From these nine experiments there can be but little doubt that *Doris bilamellata* is distasteful to these eight kinds of fish. This was an unexpected result, as the *Doris* has no stinging apparatus, and certainly seems to be protectively coloured. The distastefulness may be due either to the spicules in the skin or to the abundant mucus covering the body.

II. February 21st, 1890. [We brought a large supply of *Ancula cristata*, and a few specimens of *Dendronotus arborescens*, *Coryphella rufibranchialis*, and *Galvina picta*, which we had collected at Hilbre Island the previous evening. Mr. Moore, Mr. R. Paden, and Woods were present. Notes were taken by Professor Herdman.]

Mr. Moore and Professor Herdman each eat an *Ancula*. The specimen was placed alive upon the tongue. No stinging or other disagreeable sensation was perceived. It was then chewed slowly and swallowed. The taste was pleasant, and distinctly like that of an oyster.

*Ancula cristata*.

A. Shanny Tank:—

- Ancula* 1.—Seized and rejected by a fish and then bolted suddenly by a second.
- 2.—Seized when falling and rejected by ten fish in rapid succession.
- 3.—Seized when falling and swallowed by a fish.

- 4.—Seized and rapidly rejected by five fish in succession.
- 5.—Seized and rapidly rejected by four fish in succession.

B. Flat Fish Tank :—

- Ancula*
- 1.—Seized and rejected by a young cod and six plaice in rapid succession.
  - 2.—Seized and rejected by seven plaice in rapid succession and left lying on sand.
  - 3.—Seized and rejected by four plaice in rapid succession and left lying on sand.

The fish were then tried with some cockles, which, when thrown in, were eagerly pounced upon and eaten. Then four specimens of *Ancula* were thrown in together and were tried and rejected by two young cod and three plaice.

C. Table Tank :—

- Ancula*
- 1.—Touched by a young cod but not taken, then tried and rejected by goldsinny.
  - 2.—Touched and rejected several times by cod.
  - 3.—Touched and rejected by first cod, bolted suddenly by second.

The shannies at once take an object into the mouth even though they reject it again immediately, but the young cod usually approach it very closely and appear to smell it or feel it with the lips and then turn away from it, or else suddenly bolt it, in which case it does not reappear. The shanny seems to test the edibility inside its mouth, the cod outside.

Some crabs (*Hyas araneus*) in two small tanks were then tried with specimens of *Ancula* with the following results :—

- Ancula* 1.—Seized at once by crab but eaten very slowly.  
 Pulled to pieces by third maxillipedes, and  
 apparently only some parts eaten.
- 2.—Taken no notice of.
- 3.—Taken up by chela, then dropped and left.
- 4.—Apparently not noticed by crabs.

The three last specimens of *Ancula* were found alive and fully expanded next day, and crawled about the two crab tanks undisturbed for some time.

Finally a few specimens of *Ancula* were taken to the anemone tank and allowed to drop upon the fully expanded tentacles of a white and a pink *Actinoloba dianthus*; they were not swallowed in either case, but after lying for some time were allowed to fall off the tentacles.

In all, then, *Ancula* was rejected by fifty-three animals and taken by four. These experiments gave us the distinct impression that *Ancula* was distasteful to the animals tried, although we did not at that time understand why and had expected to get a contrary result.

*Dendronotus arborescens.*

A. Shanny Tank:—

*Dendronotus* 1.—Seized at once by shanny and carried off to back of tank. Shortly afterwards two shannies were found fighting over it, each having hold of an end, as they do with a large worm, finally they each ate a part of the *Dendronotus*.

B. Flat Fish Tank:—

*Dendronotus* 1.—Tried and rejected by brill and young cod. Then seized by plaice and kept in mouth for a long time, during which it was pursued by other fish.

## C. Table Tank :—

*Dendronotus* 1.—Touched and left by a young cod, taken partly into mouth and rejected by two bullheads (*Cottus*) four or five times.

The general impression we received was that *Dendronotus* was more acceptable to the fish than *Ancula*, but that they were incommoded by the size. Our specimens were large ones, over two inches in length, and none of the fishes tried seemed able to get the whole of the *Dendronotus* comfortably into the mouth at once; several took half the body into the mouth and swam about with the other half hanging out. This was well seen in the case of the shannies who each eat half of the specimen, and of the plaice which carried about its prey for a considerable time, during which it was actively pursued by the others. That specimen was in all probability eaten by one or more of the plaice, as we could find no trace of it some little time afterwards. The rejection by *Cottus* may be accounted for by the awkward size of the morsel. The two fish had each at least two tries at it, taking it half into the mouth, giving it a shake, sending it out, and then going at it again as if to get a better hold.

*Eolis.*

## A. Shanny Tank :—

*Eolis* 1. — (*Coryphella rufibranchialis*) — Seized by largest shanny, who at once shook it vigorously and kept moving its jaws and ejecting the cerata in groups of three or four, and finally put out the rest of the body. Then tried and rejected by four or five other fish in rapid succession, and then by the large shanny again, then by several others, and finally left lying at the bottom of the tank. The large shanny who first tried it was noticed

going about for some time afterwards (5 p.m.) with the mouth held open, but was all right again next morning.

C. Table Tank :—

*Eolis* 2.—(*Galvina picta*)—Touched or tried and rejected at once by cod, bullhead, and weever. The cod came very near it or touched it with its snout several times afterwards, but never took it into the mouth.

*Eolis* is undoubtedly distasteful. The cnida on the tips of the cerata probably sting the lips, &c., of the fish.

As it had occurred to us that the natural conditions would be more nearly reproduced if the nudibranchs were not dropped into the tank, on the following day, February 22nd, a few specimens of *Ancula* were placed upon pieces of stone and lowered cautiously into tanks A and B in such a way as not to attract the attention of the fish. The nudibranchs reached the rockwork safely, and were seen crawling over various parts of the tanks for several days untouched by the fish (shannies and flat fish). Woods (the Aquarium attendant) tells us that the fish sometimes went close to the *Ancula* and looked at them but never attempted to touch them. The nudibranchs were last seen about a week after being put into the tanks. They then disappeared, but may possibly have retreated into the back part of the tank, or have crawled up out of the water as *Ancula* is very liable to do when kept in captivity.

III. March 22nd, 1890. [We brought to the Aquarium specimens of *Dendronotus*, *Eolis*, and *Doris*, which we had collected at Hilbre Island on the previous afternoon. Mr. Moore, Mr. Chard, assistant, and Woods were present—Professor Herdman taking notes.]

*Dendronotus arborescens.*

## A. Shanny Tank :—

*Dendronotus* 1.—Seized at once by the large shanny and kept in mouth, half the nudibranch projecting. This shanny was pursued by others, one of which caught the projecting end of the prey, and in the ensuing struggle tore half the body off and eat it. The large shanny at once retreated with the remainder to the back of the tank; came out shortly afterwards with the *Dendronotus* still in mouth, and was again pursued and retreated to the back, appearing again soon without the nudibranch.

## C. Table Tank :—

*Dendronotus* 1.—Pounced upon at once by three bullheads which made rapid dabs at it successively, until one secured it and carried it off to a quiet place where he seized it in his mouth and rejected it nine times in succession, each time taking it half into the mouth and keeping it there for some seconds, then spitting it out and at once pouncing upon it again. Finally the now somewhat mangled remains of the *Dendronotus* were taken out and put into tank A, where one of the shannies at once seized and swallowed it. The *Dendronotus* was large. It was larger than the head of the *Cottus*, and caused the mouth cavity to bulge out greatly when half taken in. The general impression was that the *Cottus* found the *Dendronotus* desirable food but an uncomfortably large mouthful and was trying to worry it to pieces.

*Eolis.*

## A. Shanny Tank :—

- Eolis* 1.—(*Coryphella rufibranchialis*).—Tried and at once rejected by three fish in rapid succession, then seized by the large shanny and carried behind the rock-work ; immediately numerous red cerata were seen scattered through the water in that neighbourhood, showing that the *Eolis* had been forcibly ejected in pieces. The cerata floated about for some time in the water, but were not touched by any of the fish.
- 2.—(*Fucelina coronata*).—Pounced upon by several fish together—one secured it and at once rejected it, and then seized the white body and managed to bite it across, setting free the dorsal portion with all the cerata. It then retired to the back of the tank, and the cerata were left floating about in the water untouched.

*Doris bilamellata.*

## A. Shanny Tank :—

- Doris* 1.—Tried and rejected by two fish, then seized by large shanny and carried off to back of tank.

## B. Flat fish Tank :—

- Doris* 2.—Several fish darted at the nudibranch, but a large sole suddenly slipped up vertically between them and bolted it.
- 3.—Tried and rejected by six or eight plaice, and finally left on the sand.
- 4 to 6.—These three specimens were gently lowered into the tank by a net, so as to reach a shelf of the rock-work without attracting attention. They soon began to expand and move. One plaice

swam up and looked or smelled at them but did not touch them.

The action of the large sole in bolting *Doris* No. 2 above may possibly be explained as a result of the habits of competition for their food. Three or four other fish were darting at the nudibranch and the sole took the only possible course by which it could secure the prey; it made a rapid movement upwards between the snouts of its competitors and swallowed the *Doris* entire; there was evidently no time for examination.

These experiments are manifestly incomplete and must be largely added to in the future, but we believe it may be useful to publish them at this stage, especially as we would be glad of suggestions from any other biologists working on the same lines.\* Our general impression is that the order of edibility of the nudibranchs offered to the fishes is:—*Deudronotus*, *Doris*, *Ancula*, and *Eolis*: *Eolis* being the most distasteful form, *Ancula* next, *Doris* less so, and *Deudronotus* edible, but from its size offering difficulties to the rather small fishes which we tried.

We have used altogether fifty-three nudibranchs, offered to twelve different kinds of fish and other voracious animals, and we have recorded over a hundred and thirty distinct transactions between the fishes and the nudi-

\* Mr. Bateson's interesting paper on "The Sense-organs and Perceptions of Fishes," in the last number of the Jour. Mar. Biol. Assoc., dated April, 1890, which however only reached Liverpool on May 14th, has appeared since our paper was read (May 9th) and just as we are passing it for press. In regard to the sole being one of those fishes which hunt for their food and recognise it by the sense of smell alone, we would remark that the specimens in the Aquarium here certainly seem to perceive their food as the plaice do by sight, the two kinds of fish often darting together at a food morsel—and, as has just been shown above, the sole being sometimes more alert than its competitors. Possibly these soles have changed their habits like the rockling described (p. 238) by Mr. Bateson.



branches. Our nudibranchs were all alive, healthy, and good-sized specimens; and our fish were probably the right kind, being nearly all shore fishes, found in the immediate neighbourhood of where the nudibranchs live. But still the conditions were, of course, to a certain extent artificial, and that must be taken into account in drawing conclusions. Dropping the nudibranchs into the tank from above is unnatural, and may give rise to a misleading result, especially where the fish are accustomed to have their food thrown in from above, and *only receive edible food*.

Then again, at least some of the fish—those that have been some time in captivity, have been educated to compete with one another for the food masses. When *anything* is thrown in—a bit of white shell will do—there is at once a rush made upon the falling object, and no time is allowed for inspection or consideration. I would account for the seizing of *Eolis* by the shannies (very active, voracious, and apparently impulsive fishes), even when the prey is evidently distasteful and has brilliant warning colours, as a result of this acquired habit of competition, and of pouncing upon anything thrown into the tank; several times when a morsel was suddenly bolted, it seemed to be because another fish was coming up to seize it. Still there is a marked difference between the manner in which they take a cockle and, say, an *Ancula*. The cockle is taken right in and swallowed at once, while the distasteful nudibranch, even if seized, is usually only partly taken into the mouth, in some cases it is seen to be held by the very front of the jaws, and is then ejected with force.

*Ancula* has been a particularly interesting case. Starting with the general opinion that *Ancula* is a perfectly defenceless soft-bodied animal, we were astonished to find

that it was present on the rocks at Hilbre Island in great abundance, in very prominent and exposed situations, and that its colouring was not protective but rendered it conspicuous. Our experiments at the Aquarium next showed us that this nudibranch is distasteful to fishes and other shore animals, but for a time we did not understand why. Lately, however, we have found that besides the abundant mucous glands scattered over the integument, *Ancula* possesses special large glands,\* occupying the apices of the cerata and opening on the exterior. These glands are placed just where an offensive organ would be most useful, and where the stinging cells are found in *Eolis*, and it seems probable that their secretion has an acrid or some other objectionable property.

The protective colouring of *Doris bilamellata*† may be accounted for in one or both of two ways:—(a.) It may serve to protect from certain other shore animals which we have not yet tried, and to which the spicules and mucus of the *Doris* are not objectionable, and (b) it may save the animal from being tried by fishes, &c., not sufficiently aware of its (to them) distasteful nature.‡ It is obvious that if an animal is not thoroughly objectionable, and has not yet become conspicuous with warning colours, it will be better for it to be protectively coloured. *Eolis* is a most distasteful form and has conspicuous colours of a warning

\* See this Report, p. 135 and Pl. vii. fig. 9, *gl'*.

† See this Report, p. 133.

‡ A very similar case seems to be that of the two British species of *Hermæa* as described by Garstang (loc. cit., p. 191). *H. bifida* has its conspicuous hepatic ramifications exceedingly like the branches of the red seaweeds of the genus *Griffithsia* amongst which the animal lives. *H. dendritica* is coloured bright green so as to resemble *Codium tormentosum* on which it lives. Both species are protectively coloured and have no stinging cells like those of *Eolis*, but they seem to possess the power of emitting, when irritated, an offensive fluid.

nature. *Ancula* is also distasteful and is conspicuously coloured. *Doris* is less distasteful and is still protectively coloured; while *Dendronotus*, which we believe to be edible, is very effectually concealed amongst the seaweeds it lives on by its large branched cerata and red-brown colours.

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#### EXPLANATION OF THE PLATES.

Where not otherwise stated, the drawings were made from serial sections prepared by hardening in Kleinenberg's picric acid and graduated alcohols, staining in picocarmine, embedding in paraffin and cutting with the rocking microtome.

#### Reference Letters.

*ap.* opening of cnidophorous sac to exterior; *br.* branchiæ; *b.s.* blood sinus; *c.* cnida; *c.e.* cnidocysts; *c.s.* cnidophorous sac; *c.d.* connecting duct between cnidophorous sac and hepatic cæcum; *cer.* cerata; *d.* duct of gland; *e.p.* epipodial ridges, folds, or processes; *ec.* ectoderm; *f.* foot; *f.gl.* foot glands; *g.e.* goblet-like mucus-secreting cell; *gl, gl'* glands; *h.c.* hepatic cæcum; *k.* knob on papillæ of cerata of *Doto*; *l.l.* lateral duct of liver leading from hepatic cæca; *m.* mantle; *m.p.* metapodium; *mes.* mesodermal tissue; *m.f.* muscle fibres; *m.l.* median duct of liver in body; *o.t.* ovotestis; *p.p.* propodium; *pg.* pigment; *rh.* rhinophores; *r.* red pigment; *t.* tentacles; *y.* yellow pigment.

S. 1.	=	Swift's 1 in. obj., oc. 2,	magnifying about	45 diam.
S. $\frac{1}{4}$ .	=	„ $\frac{1}{4}$ „ „ „ „	230 „	
S. $\frac{1}{6}$ .	=	„ $\frac{1}{6}$ „ „ „ „	330 „	
Z. $\frac{1}{12}$ .	=	Zeiss's $\frac{1}{12}$ (oil immers.), oc. 2, „ „	505 „	

## PLATE VI.

Comparative views of the condition of the Epipodia as seen in transverse sections of various Opisthobranchiate Mollusca.

- Fig. 1. Sketch of *Elysia* from the dorsal surface to show the epipodia (*e.p.*)  $\times 2$ .
- Fig. 2. Sketch of *Aplysia* from the left side to show the epipodia (*e.p.*), nat. size.
- Fig. 3. Outline of transverse section of *Aplysia*, one-third along the body from the front, to show the relations of the epipodia (*e.p.*), mantle (*m*) and foot (*f*). Zeiss a\*, 10.
- Fig. 4. T.S. (transverse section) of *Acanthodoris pilosa*, through the rhinophores (*rh.*) showing the epipodial ridge and large papillæ. S.1. reduced.
- Fig. 5. Another section of the same, about middle of body, showing the distinctly lateral arrangement of the papillæ. S.1. reduced.
- Fig. 6. T.S. of *Goniodoris nodosa*, one-third along body from the front (ten sections behind rhinophores), to show the lateral epipodial ridges (*e.p.*). S.1.
- Fig. 7. T.S. of *Polycera quadrilineata* (60th sect. from front) showing the lateral ridges at the sides of the rhinophores. S.1. Compare with fig. 4.
- Fig. 8. Another of same (150th sect. from front, about middle of body) showing the prominent ridges (right side) and processes (left side) containing glands, placed at the sides of the branchiæ. S.1.

- Fig. 9. Another of same (60th sect. from posterior end, about three-fourths along body) showing the large epipodial processes (or "cerata") containing glands. S.1.
- Fig. 10. T.S. of *Ancula cristata*, showing the large cerata (*e.p.*) alongside the branchiæ (*br.*) S.1. Compare with fig. 8.
- Fig. 11. T.S. of *Egirus punctilucens*, showing the row of large lateral papillæ (*e.p.*) representing the epipodia. S.1.
- Fig. 12. T.S. of *Triopa claviger*, showing the lateral cerata and dorsal papillæ. S.1. Compare with fig. 11.
- Fig. 13. T.S. of *Tritonia plebeia*, about middle, showing the branched cerata. S. 1.
- Fig. 14. T.S. of *Dendronotus arborescens*, about middle, showing the large branched parieto-cerata, S. 1., reduced.
- Fig. 15. T.S. of *Doto coronata*, about middle, showing the large lobed hepato-cerata. S. 1.
- Fig. 16. T.S. of *Eolis*, showing the clumps of simple hepato-cerata representing epipodia. S.1.

PLATE VII.

Figs. 1 and 2. *Aplysia punctata*.

Figs. 3 and 4. *Polycera quadrilineata*.

Figs. 5 to 9. *Ancula cristata*.

- Fig. 1. Section of the edge of the epipodium of *Aplysia punctata* to show the glands (*gl.*) S. 4.
- Fig. 2. Section of the mantle edge of *Aplysia* to show the very numerous large glands opening on the lower surface (*gl.*) S. 4.
- Fig. 3. Vertical section of one of the cerata at the posterior end of the epipodial ridge of *Polycera*

*quadrilineata*, to show the abundance of glands (*gl.*). S. 1.

- Fig. 4. Small piece of edge of same more highly magnified to show the structure of the glands (*gl.*). S.  $\frac{1}{2}$ .
- Fig. 5. Transverse section through *Ancula cristata*, near posterior end of body, to show the foot glands (*f. gl.*) and the special lateral glands (*gl'*). S. 1.
- Fig. 6. Part of edge of foot of same more highly magnified to show the structure of the glands. S.  $\frac{1}{2}$ .
- Fig. 7. Transverse section of one of the cerata of *Ancula*, showing the ceratal blood sinus (*b.s.*) and the glands (*gl'*). S. 1.
- Fig. 8. Longitudinal section of one of the cerata of *Ancula*, showing the ceratal blood sinus (*b.s.*) and the glands (*gl'*). S. 1.
- Fig. 9. Part of the edge of same near tip, showing the structure of the glands (*gl'*). S.  $\frac{1}{2}$ .

#### PLATE VIII.

Figs. 1 to 6. *Coryphella rufibranchialis*.

Figs. 7 to 10. *Coryphella landsburgi*.

- Fig. 1. Tip of one of the cerata of *C. rufibranchialis*, drawn from the living specimen, showing the very broad superficial zone of opaque white pigment (*pg.*) which covers the greater part of the cnidophorous sac (*c.s.*). S. 1.
- Fig. 2. Five cnida of *C. rufibranchialis*, discharged from living specimen. S.  $\frac{1}{2}$ .
- Fig. 3. Part of a longitudinal section (not quite median) of cerata of *C. rufibranchialis*, showing the lobulated condition of the hepatic cæcum (*h.c.*) S. 1.
- Fig. 4. Longitudinal section of apex of cerata of *C. rufibranchialis*, showing the cnidophorous sac (*c.s.*)

and its connection with the hepatic cæcum (*h.c.*) S.  $\frac{1}{4}$ .

- Fig. 5. Part of the edge of one of the cerata of *C. rufibranchialis*, drawn from the living specimen, slightly squeezed, to show the colours of the hepatic cæcum. *y.* indicates the generally distributed yellow granules, *r.* the masses of red pigment, and *cl.* the groups of clear globules. S.  $\frac{1}{4}$ .
- Fig. 6. The contents of the hepatic cæcum when squeezed out of the living specimen: *a*, vesicle containing yellow granules; *b*, vesicle containing red granules; *c*, clear oil-like globules. Z.  $\frac{1}{12}$ .
- Fig. 7. Tip of one of the cerata of *C. landsburgi*, drawn from the living specimen, showing the superficial zone of opaque white pigment (*pg.*) surrounding the middle of the cnidophorous sac (*c.s.*). S. 1.,
- Fig. 8. Apex of cnidophorous sac of *C. landsburgi*, slightly squeezed while alive and emitting cnida (*c.*) S.  $\frac{1}{3}$ .
- Fig. 9. Group of cnida of *C. landsburgi*. S.  $\frac{1}{3}$  (the two lower ones enlarged, Z.  $\frac{1}{12}$ ).
- Fig. 10. The subepithelial layer of the integument in surface view, drawn from the living specimen, showing the violet-coloured pigment corpuscles (*pg.*) to which the colour of the body is due. S.  $\frac{1}{3}$ .

PLATE IX.

Figs. 1 to 4. *Doto coronata*.

Figs. 5 to 7. *Facelina coronata*.

Figs. 8 to 10. *Facelina drummondii*.

Fig. 11. *Galvina picta*.

Fig. 12. *Cratena viridis*.

- Fig. 1. Transverse section of *Doto coronata*, near the

middle, to show the relations of the hepatic cæca to the body and to the large turretted cerata (*cer.*). S. 1.

- Fig. 2. Section through one of the papillæ on the cerata showing the small terminal knob (*k.*) and the masses of gland cells (*gl.*). S.  $\frac{1}{2}$ .
- Fig. 3. Section through the edge of one of the cerata showing the large masses of gland cells lying between the hepatic cæcum (*h.c.*) and the epithelium (*ec.*). S.  $\frac{1}{2}$ .
- Fig. 4. Section through one of the papillæ on the cerata showing a cavity and duct (*d.*) amongst the gland cells and leading to the apex of the knob (*k.*) S.  $\frac{1}{2}$ .
- Fig. 5. Section through the base of one of the cerata of *Facelina coronata*, showing the opening of the hepatic cæcum into one of the lateral ducts of the liver (*l.l.*). S. 1.
- Fig. 6. Transverse section through the tip of one of the cerata of *F. coronata*, showing the hepatic cæcum (*h.c.*), cnidophorous sac (*c.s.*) and connecting tube (*c.d.*) all cut transversely. S.  $\frac{1}{2}$ .
- Fig. 7. Some of the long curved cnida of *F. coronata*, S.  $\frac{1}{2}$ . enlarged.
- Fig. 8. Upper half of one of the cerata of *F. drummondi*, mounted entire, showing the long connecting tube (*c.d.*) between the cnidophorous sac and the hepatic cæcum. S. 1, reduced.
- Fig. 9. Part of edge of one of cerata of *F. drummondi*, from living specimen, showing the cilia on the surface and the colours of the hepatic cæcum. S.  $\frac{1}{2}$ . *r*, red; *y*, yellow.



- Fig. 10. A few of the yellow (*a*) and red (*b*) cells squeezed out of the last when alive. Z.  $\frac{1}{12}$
- Fig. 11. Transverse section through tip of one of cerata of *Galvina picta*, showing the cnidophorous sac (*c.s.*) S.  $\frac{1}{8}$ .
- Fig. 12. Apex of one of the cerata of *Cratena viridis*, mounted entire and seen in optical section, showing the opening (*ap.*) of the cnidophorous sac (*c.s.*) to the exterior, and the clumps of gland cells (*gl.*). S.  $\frac{1}{8}$ .





Fig. 1.

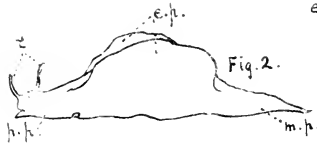


Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.

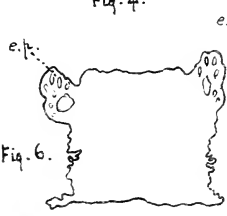


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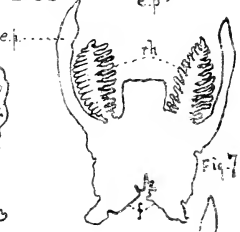


Fig. 7.



Fig. 8.

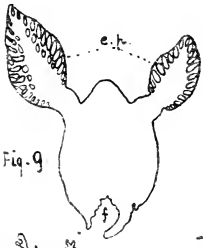


Fig. 9.

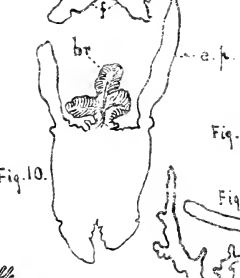


Fig. 10.



Fig. 11.



Fig. 13.

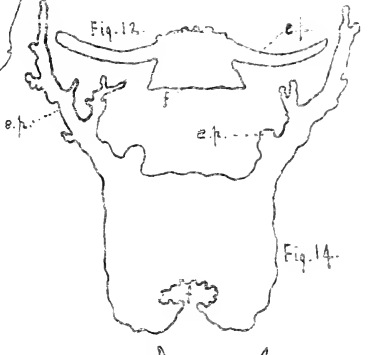


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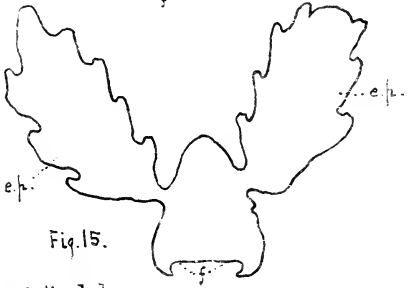


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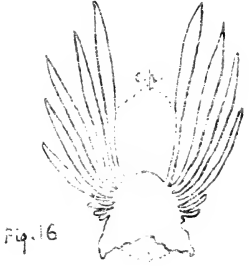


Fig. 16.

W.A.H. del.

EPIPODIAL PROCESSES.



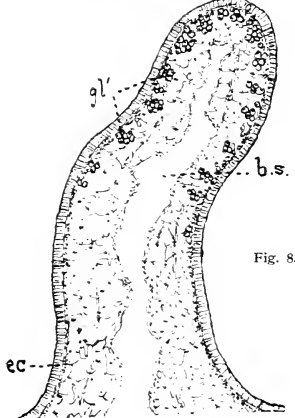
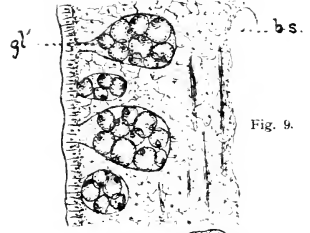
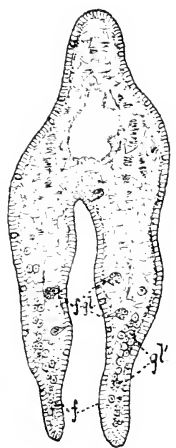
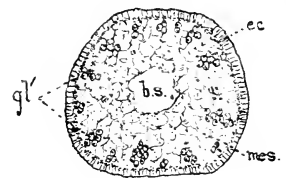
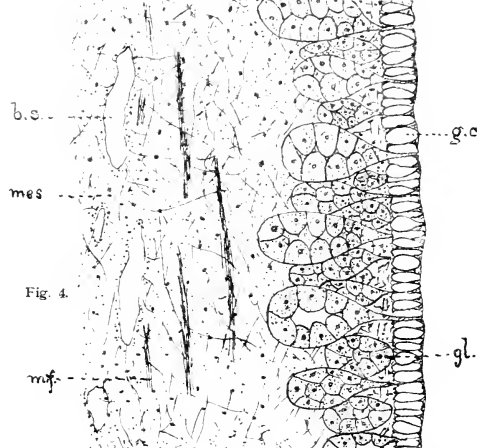
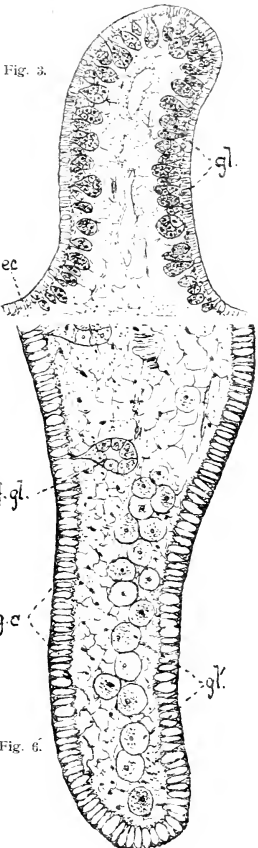
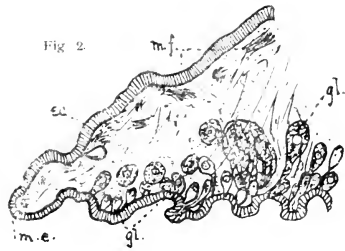
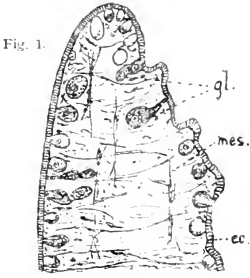


Fig. 7.

Fig. 5.

Fig. 9.

Fig. 8.

I. A. C., del.

FIGS. 1 & 2, *APLYSIA PUNCTATA*.  
 FIGS. 3 & 4, *POLYCERA QUADRILINEATA*.  
 FIGS. 5-9, *ANCUA CRISTATA*.



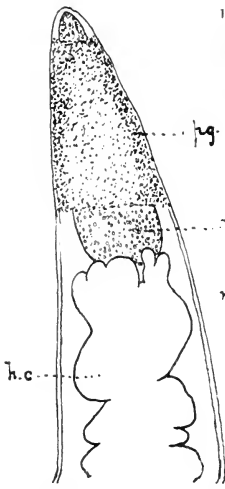


Fig. 1

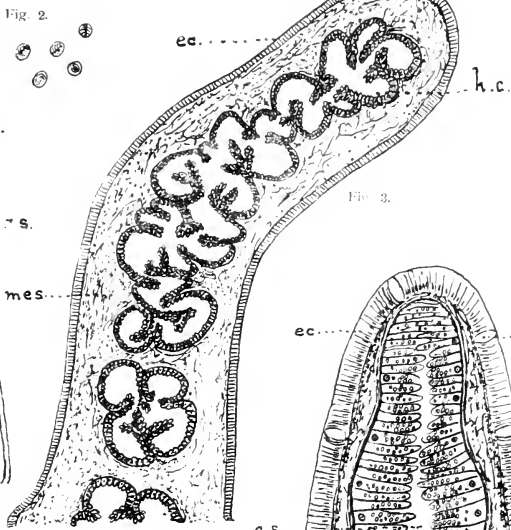


Fig. 3

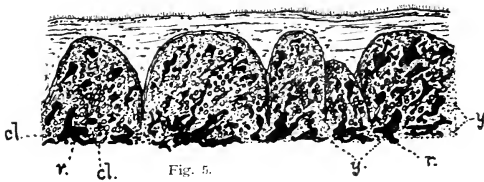


Fig. 5

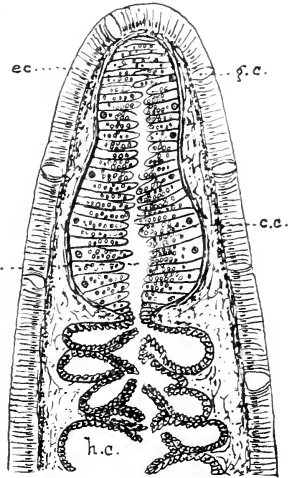


Fig. 4

Fig. 6

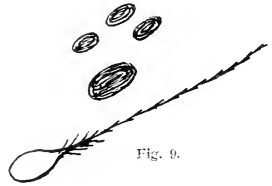


Fig. 9

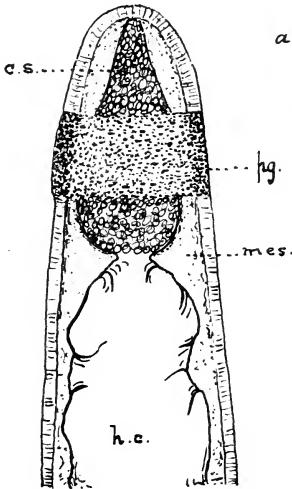


Fig. 7

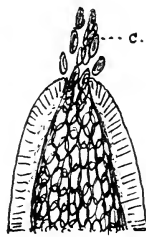


Fig. 8



Fig. 10

W. A. H., del.

FIGS. 1-6, CORYPHELLA RUFIBRANCHIALIS.  
FIGS. 7-10, CORYPHELLA LANDSBERGI.





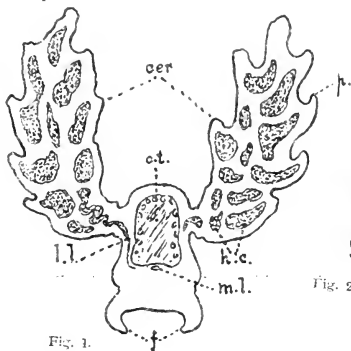


Fig. 1.

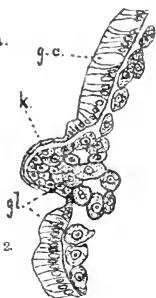


Fig. 2.

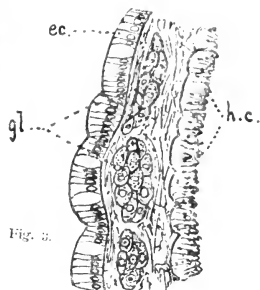


Fig. 3.

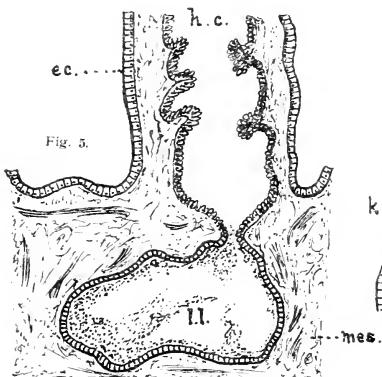


Fig. 5.

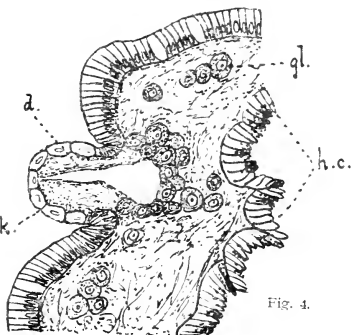


Fig. 4.

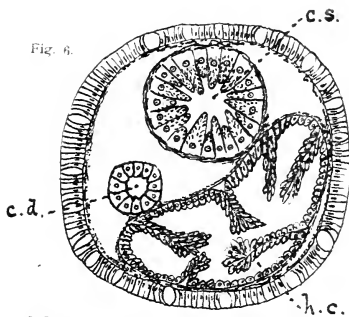


Fig. 6.

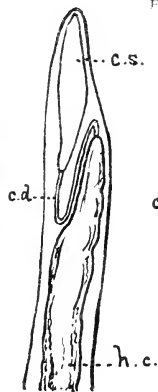


Fig. 7.

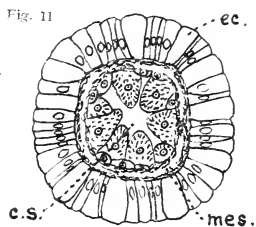


Fig. 11

Fig. 8

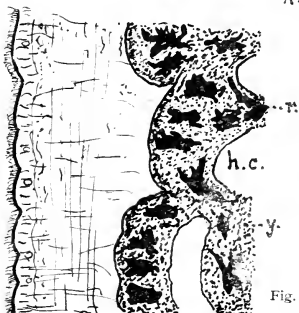


Fig. 9.



Fig. 10.

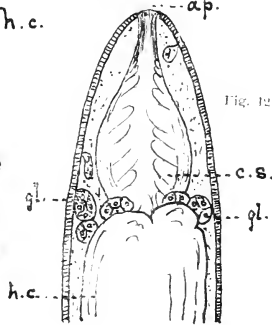


Fig. 12

W. A. H., del.

FIGS 1-4, DOTO CORONATA.

FIGS 5-7, FACELINA CORONATA.

FIGS 8-10, FACELINA DRUMMONDI.

FIG. 11, GALVINA PICTA.

FIG. 12, CRATENA VIRIDIS.





THIRD REPORT on the PORIFERA of the  
L. M. B. C. DISTRICT.

BY RICHARD HANITSCH, PH.D.,  
DEMONSTRATOR OF ZOOLOGY IN UNIVERSITY COLLEGE, LIVERPOOL.

With Plates X.—XV.

[Read 9th May, 1890.]

In the two previous reports\* on the Porifera of the district forty-four species were recorded, one of which was new to British seas and three new to science. Several cruises in Liverpool Bay during the summer of 1889 and the present spring, and also shore-working at the Biological Station, Puffin Island, in April, 1889, and at Port Erin, Isle of Man, last April, enable me to add twelve species to the record, three of which are new to science, making in all fifty-six species.

In my former report I fell into a serious error in regard to the structure and systematic position of *Seiriola compacta*, n. sp., and I desire to acknowledge my indebtedness to Professor Sollas, D. Sc., for the great kindness with which he has pointed out the mistake to me and has answered many questions having a bearing on that species. I give now a re-description of *Seiriola compacta* (see below).

The following table gives all sponges found up to the present date in the district, and shows the distribution of the species in the four parts in which they have been most

\* "Report on the Porifera of the L.M.B.C. District." by Thomas Higgin, F.L.S., in "Fauna of Liverpool Bay," Vol. I., 1886. And "Second Report on the Porifera of the L.M.B.C. District," by R. Hanitsch, in Proc. Biol. Soc., Liverpool, Vol. III., 1889, and "Fauna," Vol. II.

carefully collected. There is nothing very striking in the distribution. The estuaries of the Mersey and the Dee are by far the poorest in Porifera, as might have been expected. But it is rather surprising that up to now only one tetractinellid sponge (*Pachymatisma johnstonia*, B.) has been recorded from the Isle of Man. Most probably there are numbers of Tetractinellida living on the rocky shores of that island, and simply requiring to be sought for. The north-east corner of our district has, as far as I know, not yet been specially searched for sponges, so that only two species are recorded from Morecambe Bay. These are: *Chalina oculata*, J. and *Suberites domuncula*, N. I have not thought it necessary to give in the table a special column to that locality. Puffin Island is only separated from the North Wales column in order that there may be a record of the species found in the immediate neighbourhood of our Biological Station. In all twenty-six species have now been found on the shores of the island.

The lists in the former reports included the species *Halichondria coccinea*, B., which had been collected in Belfast Lough. I shall leave it out in the present report, as that species has not yet been found inside the boundaries of our district. Also *Pupillina suberea*, S., has now been left out as it is merely a synonym for *Cliona celata*, Gr. I shall adhere to the classification employed in the previous report, but the nomenclature of the species differs in a few instances. I now use:—

<i>Spongelia fragilis</i> , M.,	instead of	<i>Dysidea fragilis</i> .
<i>Chalina pallida</i> , B.,	..	<i>Chalinula pallida</i> .
<i>Chalina densa</i> , B.,	.....	<i>Chalinula densa</i> .
<i>Amphilectus incrustans</i> , J.,	..	<i>Desmacidon incrustans</i> .
<i>Esperella ægagropila</i> , C.,	..	<i>Esperia ægagropila</i> .
<i>Suberites domuncula</i> , N.,	..	<i>Suberites suberea</i> , M.
<i>Dercitus bucklandi</i> , B.,	..	<i>Dercitus niger</i> , C.

## LIST of PORIFERA recorded from the L.M.B.C. DISTRICT.

	Estuaries of Mersey & Dec.	Isle of Man.	North Wales.	Puffin Island.
Order I. <b>MYXOSPONGIÆ.</b>				
Family.				
HALISARCIDÆ— <i>Halisarca dujardini</i> , J. ....	×	×	×	×
<i>Halisarca rubra</i> , n. sp. ....	...	...	×	...
Order II. <b>CERATOSA.</b>				
SPONGELIDÆ— <i>Spongelia fragilis</i> , M. ....	...	...	×	×
Order III. <b>MONAXONIDA.</b>				
Subord. HALICHONDRINA.				
HOMORRHAPHIDÆ— <i>Halichondria panicea</i> , J.				
<i>Halichondria albescens</i> , J. ....	×	×	×	×
<i>Halichondria caruncula</i> , B. ....	...	×	×	...
<i>Reniera varians</i> , B. ....	×	...	×	×
<i>Reniera elegans</i> , B. ....	...	×	...	...
<i>Reniera simulans</i> , J. ....	...	×	...	...
<i>Reniera fistulosa</i> , B. ....	...	×	×	...
<i>Reniera clava</i> , B. ....	...	×	...	...
<i>Reniera semitubulosa</i> , S. ....	...	...	×	×
<i>Reniera ingalli</i> , B. ....	...	×	...	...
<i>Chalina oculata</i> , J. ....	...	...	×	...
<i>Chalina limbata</i> , M. ....	...	×	×	×
<i>Chalina montagui</i> , T. ....	...	×	...	...
<i>Chalina pallida</i> , B. ....	...	×	...	...
<i>Chalina densa</i> , B. ....	...	×	×	...
<i>Chalina gracilentia</i> , B. ....	...	...	×	×
HETERORRHAPHIDÆ—None.				
DESMACIDONIDÆ— <i>Desmacidon fucorum</i> , J. ...				
<i>Esperella agagropila</i> , J. ....	...	×	×	×
<i>Esperella floreum</i> , B. ....	...	×	...	...
<i>Amphilectus incrustans</i> , J. ....	...	×	×	×
<i>Clathria seriata</i> , J. ....	...	×	×	×
<i>Plumohalichondria plumosa</i> , C. ....	...	...	×	...
<i>Plumohalichondria atras anguinea</i> , B.	×	...	×	×
AXINELLIDÆ— <i>Hymeniacidon sanguinea</i> , J. ...				
<i>Axinella mammillata</i> , n. sp. ....	...	×	×	...
<i>Raspailia ventilabrum</i> , B. ....	...	...	×	...
<i>Raspailia rigida</i> , M. ....	...	×	×	×

	Estuaries of Mersey & Dec.	Isle of Man.	North Wales.	Puffin Island.
Subord. CLAVULINA.				
SUBERITIDÆ— <i>Suberites carnosus</i> , J.....	×	...	...	...
<i>Suberites domuncula</i> , N.....	×	×	×	×
<i>Suberites ficus</i> , E. ....	...	×	×	...
<i>Cliona celata</i> , Gr.....	...	×	×	×
<i>Polymastia mammillaris</i> , J. ....	...	...	×	×
<i>Polymastia robusta</i> , B. ....	...	...	×	...
SPIRASTRELLIDÆ—None.				
Order IV. <b>TETRACTINELLIDA.</b>				
Subord. CHORISTIDA.				
TETILLIDÆ— <i>Tethya lyncurium</i> , J.....	...	...	×	...
PACHASTRELLIDÆ— <i>Dercitus bucklandi</i> , B....	...	...	×	×
STELLETTIDÆ— <i>Seiriola compacta</i> , Hn. ....	...	...	×	×
<i>Stelletta grubei</i> , S.....	...	...	×	...
<i>Stelletta collingsi</i> , B. ....	...	...	×	×
<i>Ecionemia ponderosa</i> , B. ....	...	...	×	...
GEODIIDÆ— <i>Pachymatisma johnstonia</i> , B. ...	...	×	×	×
Subord. LITHISTIDA.				
None.				
Order V. <b>HEXACTINELLIDA.</b>				
None.				
Order VI. <b>CALCAREA.</b>				
ASCONIDÆ— <i>Ascetta coriacea</i> , F.....	...	×	×	×
<i>Ascaltis botryoides</i> , F. ....	...	×	×	...
<i>Ascaltis contorta</i> , B. ....	×	...	×	...
<i>Ascortis lacunosa</i> , J.....	...	...	×	×
LEUCONIDÆ— <i>Leucandra fistulosa</i> , J.....	...	×	...	...
<i>Leucandra gossei</i> , B. ....	...	×	×	...
<i>Leucandra nireia</i> , F. ....	×	×	×	×
<i>Leucandra johnstoni</i> , C.....	...	×	×	...
<i>Leucaltis impressa</i> , n. sp. ....	...	...	×	×
SYCONIDÆ— <i>Sycoctis aspera</i> , G. ....	...	×	...	...
<i>Sycaandra ciliata</i> , F. ....	×	×	×	×
<i>Sycaandra compressa</i> , F.....	...	×	×	×
<i>Aphroceras ramosa</i> , C. ....	...	...	×	...

Order I. **MYXOSPONGIÆ.**

*Halisarca rubra*, n. sp. (Pl. X., figs. 1 and 2.)

New species of *Halisarca* have been described so frequently, which have afterwards been shown not to belong to that genus or even not to exist at all, that it is with some reluctance that I establish the new species *Halisarca rubra*. The specimen was dredged on the "Spindrift" Expedition in July, 1889, off Holyhead, from a depth of about fifty fathoms. It encrusted both valves of a living *Mytilus edulis* with thin brick-red patches, the entire thickness of the sponge being 0·45 mm. Its surface showed a somewhat wavy outline, which condition was apparently solely caused by the hairs of the *Mytilus* projecting through it, and the sponge growing for a short distance upwards along those hairs. Oscula and pores were not visible to the unaided eye.

Vertical sections showed that the outer portion of the sponge had suffered, so that its structure could not be made out satisfactorily. The figure (see Pl. X., fig. 1) of it therefore is somewhat diagrammatic. The inner and greater portion of the sponge was well preserved (Pl. X., fig. 2). There is a "dermal membrane" between the outer world and subdermal cavities, about 0·014 mm. in thickness. The subdermal cavities are flat, and seem to be distinct from the wide irregular cavities of the canal system. Oscula and pores could not be detected. The flagellated chambers are round or oval, with a diameter of 0·08 to 0·14 mm. The size of the collar-cells, of which however the collars and flagellæ were never seen distinctly, is about 0·006 mm. The mesoderm consists of fibrous tissue. Imbedded in it are large red pigment-cells, 0·02 to 0·026 mm. in size, more or less oval and pretty numerous. Their nuclei are small, and sometimes only indistinctly seen.



In sections prepared without staining the pigment-cells have preserved almost their natural colours.

The only acknowledged species of *Halisarca* is the well-known cosmopolitan *Halisarca dujardini*. It has been re-described and figured (after Schulze) by Lendenfeld,\* but there seems to be a good deal of difference between it and *H. rubra*. In *H. dujardini* the cavities of the canal system are not distinct from the subdermal cavities, and the flagellated chambers are irregularly tubular and branched. It may be that my new species belongs to the genus *Bajulus*, Lendenfeld (loc. cit. p. 724), in which there are distinct subdermal cavities and regularly oval flagellated chambers.

Although none of Carter's species of *Halisarca* have been acknowledged by Lendenfeld, still it ought to be remembered that Carter described two red species of *Halisarca*. The one is *Halisarca rubitingens*, C, † from the Gulf of Manaar. Carter describes it as "amorphous, indefinitely spreading and agglomerating together everything in its course, at the same time that the whole is tinged externally by its red colour, appearing in the form of a thin membrane when stretched across cavities, composed of polygonal divisions (cells) in juxtaposition, filled with granular contents in which the pigment is situated." The other red species is *Halisarca cruenta*, C., ‡ from the Gulf of Suez. Carter says about its colour: "crimson colour of the surface, which is seated in an extremely thin cuticula, fading off into grey internally." Evidently in both of Carter's species the pigment is placed in the ectoderm, and

\* R. v. Lendenfeld, "A Monograph of the Horny Sponges," p. 728, Pl. 50, fig. 2.

† Carter, "Annals and Magazine of Natural History," 5th ser., vol. vii., p. 366.

‡ Carter, loc. cit., vol. viii., p. 247.

therefore they cannot be identical with *Halisarca rubra*.

It is well known that the colour in Sponges is sometimes caused by ova.\* Still that could scarcely be the explanation of the red cells in *Halisarca rubra*, as the nuclei of the cells in question are much too small to be the germinal vesicles, and in general appearance the cells did not resemble ova.

## Order II. CERATOSA.

*Spongelia fragilis*, Montagu.

To the two localities where this species had been found previously, Church Bay, near Holyhead, and Puffin Island, I am able to add now Penrhos Bay, Anglesey, where we dredged it on the "Hyæna" Expedition of May 25th, 1890.

This form is probably identical with Lendenfeld's † *Spongelia fragilis* var. *irregularis*. Still there is some difference in the colour. Lendenfeld says in regard to his variety, "the colour of the living sponge is dull violet-red on the surface and yellowish in the interior." My specimens are of a yellowish sand-grey throughout.

## Order III. MONAXONIDA.

*Reniera varians*, Bowerbank.

This species, which has been recorded from the Mersey and Hilbre Island, has now been discovered also at Puffin Island. I found one specimen hanging from a ledge of rock at the north end, below the Biological Station, in April, 1889. The under surface of this particular rock was literally covered with other species of sponges: *Clathria seriata*, *Plumohalichondria atrasanguinea*, *Amphilectus incur-*

\* Carter, "Notes Introductory to the Study and Classification of the Spongida, A.M.N.H.," 4th ser., vol. xvi., p. 37.

† R. v. Lendenfeld, "A Monograph of the Horny Sponges," p. 662.

*tans*, *Raspailia rigida*, *Leucandra nireca*, *Sycandra ciliata*, and *Sycandra compressa*.

A great number of very fine specimens were collected again at Hilbre Island on March 21st, 1890, although this species had not been seen there for several years.

*Reniera ingalli*, Bowerbank.

*Isodictya ingalli*, Bowerb., Brit. Spong., vol. iii., p. 241, pl. lxxviii.

Bowerbank gave his description from three dried specimens which had been sent to him from Southport. The one specimen, which I found in a tidal pool at Port Erin, April, 1890, has quite the appearance of that figured by Bowerbank, although it is only about one-half the length. Its colour, when alive, and also after having been kept in spirit, is a brownish-yellow. It is hard and stony to the touch. The spicules are slightly curved, and rather bluntly pointed oxea, measuring 0.15 by 0.009 mm. They are held together by a rather large amount of ceratose, and form somewhat irregular meshes, which may be unispicular or bispicular. The width of the oscula varies from 1 to 2 mm.

*Chalina gracilentia*, Bowerbank.

This species is new to our district and was first described by Bowerbank,\* who collected it at Torbay, Scarborough, coast of Northumberland, and Hastings. Oscar Schmidt† seemed to have some doubts about its systematic position or even its existence, but I am able to confirm Bowerbank's statements in regard to both points.

I found one specimen of *Chalina gracilentia* at the north-east end of Puffin Island, April, 1889, in one of the tidal pools, where it was attached to *Corallina officinalis*. It formed an encrusting mass of oval shape, 11 mm. by 5 mm., of yellowish-grey colour.

\* Bowerbank, "British Spongiadæ," vol. ii., p. 372, and vol. iii. p. 171.

† Oscar Schmidt, "Spongienfauna des Atlantischen Gebietes," p. 77.

This species is a very interesting one, as from a superficial examination with a low power one might think it a ceratose sponge. Even with a high power the spicules are difficult to recognize in the thick ceratose fibres, whilst in other species of *Chalina* they are seen well with a low power. The thickness of the ceratose fibres is 0.02 to 0.075 mm. The spicules are extremely thin oxea, 0.07 by 0.002 mm. The width of the ceratose meshes varies from 0.15 to 0.30 mm.

If Lendenfeld\* is right in his theory, as he most probably is, that "the skeleton of the Spongiidæ was developed from that of the Homorrhaphidæ by the entire replacement of the spicules by spongin," then we must certainly think of forms like *Chalina gracilentia*, which lost the small traces of spicules they still possessed, whilst simultaneously essential changes in the canal system took place, and thus became changed into Ceratosa. In regard to the changes of the canal system, especially the change of the small flagellated chambers of the Monaxonida into the large sac-shaped ones of the Ceratosa, we may perhaps accept the mechanical explanation which Keller† gives in a recent paper. As a ceratose skeleton has certainly less rigidity than a siliceous one, the flagellated chambers of the Ceratosa are more liable to become compressed, and to be seriously affected in their function, than those of the siliceous sponges. An increase in size of the flagellated chambers would therefore be of advantage, as even under pressure some parts of them would remain expanded and functional. Keller's theory accounts well enough for the large flagellated chambers of the Ceratosa and Myxospongiæ, but scarcely for those of the Hexactinellida, which seem to

\* R. v. Lendenfeld, "A Monograph of the Horny Sponges," p. 770.

† Conrad Keller, "Die Spongienfauna d. rothen Meeres." 1. Hälfte. Zeitschr. f. wissensch. Zoologie, 48, Band, 3. und 4. Heft.

have acquired both large flagellated chambers and a rigid siliceous skeleton.

*Chalina montagui*, Johnston. (Pl. XI., fig. 1.)

*Halichondria montagui*, Johnst., Brit. Sponges, p. 99, pl. vi.

*Chalina montagui*, Bowerb., B. S., vol. ii., p. 366; vol. iii., pl. lxxviii.

This species is an addition to the Fauna of our district. I found it in a large and rocky tidal pool at Port Erin, April, 1890. Johnston records it as "not uncommon in the estuary of Kingsbridge at very low water, adhering to stones, and is occasionally taken by the trawl in the open sea on the coast of Devon, Conamara, and Dublin Bay." Bowerbank adds to those localities Brighton and Hastings.

The figure of the sponge, which I give in natural size on Pl. XI., was drawn by me from a photograph which Dr. Kohn (Chemical Laboratories, University College, Liverpool) had kindly taken from the specimen after it had been in spirit for some time. The specimen is larger than the one figured by Johnston, and differs from it in having shorter and less whip-like tubular portions. Bowerbank's figure had been taken from a rather poor specimen.

The colour of the living specimen was straw-yellow. The oscula are always placed on the extremity of conical elevations, and measure 3 mm. in diameter.

The spicules are mostly oxea, but a number of styli are also present. Both kinds of spicules are slightly curved, and measure on an average 0·096 by 0·008 mm. They are imbedded either in ceratose or in the so-called ascending fibres. Inside the ceratose the spicules are arranged in unispicular rows. The thickness of the ceratose fibre is 0·007 to 0·036 mm. The diameter of the ceratose meshes varies from 0·05 to 0·1 mm. The ascending fibres extend throughout the whole mass of the sponge, and give off branches in all directions. Their diameter is 0·05 to 0·08 mm. Inside those ascending fibres the spicules are

arranged in about five longitudinal parallel rows. These fibres seem to consist only of connective tissue and spicules. Ceratose does not appear to be present in them.

*Esperella floream*, Bowerbank.

*Hymeniacidon floream*, Bowerbank (vol. ii., p. 190).

*Rhaphiodesma floream*, Bowerbank (vol. iii., p. 94).

This species is an addition to our fauna, and was dredged off the Calf of Man, on the "Hyæna" cruise of Easter, 1889. Another species of the same genus, *Esperella ægagropila*, J., had previously been collected at Holyhead.\* Our species was first described by Bowerbank, under the name *Hymeniacidon floream*, which was afterwards changed by the same author into *Rhaphiodesma floream*. Oscar Schmidt† was the first who pointed out that this species, together with *Hymeniacidon lingua* and *Hymeniacidon subclavata* belonged to Nardo's older genus *Esperia*. In the course of time the genus *Esperia* had to be changed into *Esperella*,‡ so that we now arrive at the name *Esperella floream*, B.

Our specimen was found encrusting a living *Pecten opercularis*, with a thin and rugged layer of greyish colour. The thickness of this layer is about 1 mm. The skeleton consists of megascleres and microscleres. The former are styli (0·24 mm. by 0·008 mm.), which lie in irregularly arranged and loose bundles. The microscleres consist firstly of anisochelæ, which are arranged in beautiful rosettes. Similar structures are found in *Esperella lingua*, B.,§ in *Jophon abnormalis*, Ridley and Dendy,|| and in

\* Thos. Higgin, "Report on the Porifera of the L.M.B.C. District." In "Fauna of Liverpool Bay," vol. i., p. 85.

† Oscar Schmidt, "Spongienfauna des Atlantischen Gebietes," 1870, p. 76.

‡ Vosmaer, "Bonn's Klassen u. Ordn. d. Thierreichs, Porifera," p. 353.

§ Bowerbank, "British Spongiadæ," vol. i., pl. xviii., fig. 297.

|| Ridley and Dendy, "Report on the Monaxonida, collected by H. M. S Challenger," pl. xvii., fig. 7.

*Desmacidon titubans*, Schmidt.\* The length of the isolated anisochelæ in *Esperella floreum* is 0·036 mm. Besides those microscleres we find also simple sigmata, 0·06 mm. in length. Lastly there appeared to be present also a most minute kind of microscleres, but, on account of their smallness, I could not make out whether they were sigmata or chelæ. They measure 0·008—0·016 mm. in length. Possibly they are simply younger stages of the large anisochelæ and sigmata.

In no other species of sponge did I ever see such great masses of ova and developing embryos (morulæ) as in *Esperella floreum*. The ova are placed quite close to each other so that one might almost speak of ovaries, and they lie near to the limiting membrane, "in the position of greatest security." The morulæ are nearer to the surface. It was interesting to me to find that the greatest part of Ridley's and Dendy's "Embryological Notes" † is taken from the examination of some species of *Esperella*. These authors found that in large and massive sponges, like *Esperella lapidiformis*, where the position of the ova and embryos is a matter of no very great importance, so long as they do not lie near to the surface, those elements are scattered through the whole of the choanosome; whilst in a small and delicate species, like *Esperella biserialis*, the embryos take refuge in the centre of the spicular axis. Further they state, that in *Esperella mummiformis* the embryos are found grouped close to the stone to which the sponge is attached, near the centre of the base.

Our species has been recorded by Bowerbank from East Loch, Tarbet, Harris, and Strangford Lough.

\* Carter, "Ann. and Mag. Nat. Hist., ser. 5, vol. ix., pl. xii., fig. 24.

† Ridley and Dendy, loc. cit., p. 4.

*Amphilectus incrustans*, Johnston.*Halichondria incrustans*, Johnston.*Halichondria saburrata*, Johnston.*Halichondria panicea*, Grant.*Desmacidon incrustans*, Schmidt.

This species seems to be of world-wide distribution. Higgin\* states that it has been found in the West Indies and Falklands Islands; Bowerbank† records it from Frith of Forth, Hebrides, Orkneys and Shetland Islands, Welsh and Irish Coasts, Channel Islands, and Hastings. Further, it has been previously collected in two parts of our district, at Port Erin and Holyhead, and now I am able to add also Puffin Island to the list.

This sponge has been described or mentioned by Grant, Johnston, Bowerbank, Carter, and Higgin under the genus *Halichondria*. But Oscar Schmidt recognized that it, together with eighteen other of Bowerbank's species of *Halichondria*, belongs to the Desmacidonidæ, and accordingly, in my "Second Report," &c., I called this sponge *Desmacidon incrustans*. However, as I intend to follow Ridley and Dendy's principles of classification as far as possible and to accept their definitions of genera, I find it now necessary to remove our species to the genus *Amphilectus*, Vosmaer, ‡ also one of the Desmacidonidæ. In doing so I think it advisable to repeat what Ridley and Dendy say in regard to this genus:—"We make use of this genus in the manner indicated by its founder, namely, as a provisional receptacle for a number of doubtful Desmacidonidæ."§

\* Higgin, "Report on the Porifera," in "Fauna of Liverpool Bay," p. 84.

† Bowerbank, "British Spongiadæ," vol. ii., p. 249.

‡ For definition of the genus *Amphilectus* see Vosmaer, "Notes from the Leyden Museum" vol. ii., p. 109.

§ Ridley and Dendy, "Report on the Monaxonida collected by H.M.S. Challenger," p. 123.



*Amphilectus incrustans* is fairly plentiful at Puffin Island, where it is found encrusting the rocks at about low-water mark (April, 1889). The colour is straw-yellow, and a kind of meandering marking on its surface is very characteristic. These markings seem to be caused by the alternate presence and absence of spicules. There are two kinds of megasclera: firstly tornotæ, measuring 0.19 mm. by 0.005 mm., which are found chiefly in the ectosome, and project with about half of their length beyond the ectoderm. And further: spined styli, measuring 0.195 mm. by 0.008 mm., which are found scattered irregularly through certain districts of the choanosome. The microcleres consist of palmate isochelæ (0.034 mm.) and simple sigmata (0.02 mm.). I found also a few anisochelæ, but I am not quite sure whether they belong to the sponge. Ceratose is present in a small amount and is best seen in very thin sections. The arrangement of the spicules is rather remarkable, as they are found only in certain tracts which stand at right angles to the surface. Alternating with those spiculated portions we find tracts of tissue which are quite devoid of spicules, and these latter tracts seem to be wider than the spiculated ones. The alternate arrangement of these tracts causes, I think, the meandering marking on the surface of the sponge. The diameter of the oscula is about 1 to 2 mm.

A red coloured and elastic sponge which I collected at Port Erin, April, 1890, apparently belongs to the same species.

*Clathria seriata*, Johnston.

*Halichondria seriata*, Johnston.

*Spongia seriata*, Grant.

*Chalina seriata*, Bowerbank (vol. ii., p. 376).

*Ophlitospongia seriata*, Bowerbank (vol. iii., p. 167).

In my previous report, in giving the list of the Porifera recorded from the L.M.B.C. district, I placed the sponge

referred to by Mr. Higgin under the name *Ophlitaspongia seriata*, under the genus *Clathria*, Schmidt. Having found this form in profusion at Puffin Island, April, 1889, and at Port Erin, Easter, 1889 and 1890 (at both places for the first time), I am able to give now a further account of its systematic position.

I may use the same words in regard to this species which were used by Ridley and Dendy\* about *Clathria inanchorata*: "Although it possesses no chelæ, yet this species agrees so closely with the genus *Clathria* in other respects that we have deemed it advisable to include it in that species, it is perhaps a form that once possessed isochelate microsclera and has now lost them." And this *Clathria inanchorata* is the only Desmacidonid sponge which forms an exception to Ridley and Dendy's definition of the family Desmacidonidæ. Their definition runs as follows (page 62):—"Desmacidonidæ: Megascclera of various forms, usually monactinal. Microsclera always present and always including chelæ." Then they add in a footnote: "We have included one or two species without chelæ on the supposition that they have had them and subsequently lost them." I would prefer the exception to be included in the definition proper of the family, especially as we do not know whether their "supposition" corresponds to phylogenetic facts. For that reason I am inclined to accept rather Lendenfeld's† definition of the Desmacidonidæ: "Cornacuspungiæ with a supporting skeleton composed of spiculiferous, often echinated fibres. Generally with chelæ in the ground substance. If chelæ are absent, the fibres are echinated by projecting spicules."

\* Ridley and Dendy, "Report on the Monaxonida collected by H.M.S. 'Challenger,'" p. 150.

† R. v. Lendenfeld, "Descriptive Catalogue of the Sponges in the Australian Museum, Sydney," p. 210.

Our *Clathria seriata* fits in very well in Lendenfeld's definition of the Desmacidonidæ, and agrees also with the generic characters of *Clathria* as given by the same author, page 22: "Genus *Clathria*—Desmacidonidæ with a skeleton composed of bundles of spicules invested by spongin, from which spined styli protrude." One of Lendenfeld's species of *Clathria* has chelæ (*C. pyramida*) and two have no chelæ, (*C. macropora* and *C. australis*). Therefore up to now there are four species of *Clathria* without chelæ, viz., *C. australis*, *C. inanchorata*, *C. macropora*, and *C. seriata*.

The living sponge is of a dark blood-red colour, and encrusts the rocks with a layer of about 3 mm. in thickness. The skeleton consists of a network of horny fibres 0·016—0·028 mm. thick. The meshes are square, and 0·09—0·225 mm. wide. In the axis of the horny fibres, as well as echinating from the fibres, smooth styli are found, 0·1 mm. by 0·008 mm. The echinating styli generally stand together in bundles, and spring from the points where the fibres meet. According to Bowerbank toxa are very abundant in this species, but I found comparatively few of them. They measure 0·05 mm. by 0·001 mm.

The oscula are numerous, and 1 to 1·5 mm. in diameter.

As I mention on page 208, this species is frequently found along with *Plumohalichondria atrasanguinea*, B. As these two species agree completely in colour, and as *Pl. atrasanguinea* is decidedly the form which is best defended by the spicules, it might be regarded as a case of mimicry. The bright colouring of *Pl. atrasanguinea* would then be warning, and that of *Clathria seriata* protective. The similarity in colour may, however, be quite accidental.

*Plumohalichondria atrasanguinea*, Bowerbank.

*Microciona atrasanguinea*, Bowerbank.

This form is new to our district, another species of the

same genus, *Plumohalichondria plumosa*, Carter, having previously been obtained at Holyhead.\* I found it at Puffin Island, April, 1889, and at Hilbre Island, May 1889, a short way above low-water mark.

Bowerbank † records it from St. Katherine's Cave, Tenby; rocks off Hastings; Guliot Caves, Sark; Lennen Cove, Land's End, Cornwall, and he describes the external appearance of this sponge in the following words:—"Its appearance is that of a small patch from one to two inches in diameter, of dark clot of blood adhering closely to the surface of the rock, and it can be obtained only by cutting away the piece of stone to which it adheres. It rarely exceeds about half a line in thickness. Its extreme thinness readily distinguishes it from the deep red coloured sponge, *Chalina seriata*, § which occurs abundantly along with it in that cave (at St. Katherine's Island, Tenby), and which is so thick as to be easily removed from the rock with a knife." Bowerbank's description applies very well to the condition in which I found this form, together with *Clathria seriata*, at Puffin Island. In order to get sections of *Plumohalichondria atrasanguinea* one has to remove a portion of the rock (carbonate of lime) together with the sponge, and dissolve the former with acids. Specimens from Hilbre Island are of less use for histological purposes because the rocks there consist of sandstone.

The ceratose skeleton of our species consists of a limiting membrane which is closely applied to the rock, and of ascending fibres, arising about at right angles from the limiting membrane. Those fibres are furnished abundantly with echinating megascleres of two kinds; there are styli

\* Thomas Higgin, "Report on the Porifera," in "Fauna of Liverpool Bay," p. 78.

† Bowerbank, "British Spongiadæ," vol. ii., p. 139.

§ *Chalina seriata* is identical with *Clathria seriata*, see p. 205.

(0·3—0·53 mm. by 0·012 mm.) and spined styli (0·148 mm. by 0·008 mm). The former generally spring from the inner portions of the fibres, and at less acute angles (about 25°), whilst the spined styli have their bases more in the outer portions of the fibres and spring at greater angles (about 50°) from the fibres. There are also two kinds of microscleres—toxa (0·124 mm. by 0·002 mm.) and extremely minute chelæ (0·012 to 0·016 mm). The microscleres are irregularly scattered through the tissue between the ascending fibres.

A very brief description of this species has also been given by Carter.\*

*Axinella mammillata*, n. sp. (Pl. X., figs 3—5).

I was doubtful for some time in which genus of the family Axinellidæ, the new sponge described below, should be included. At first I was rather inclined to make of it a new species of *Raspailia*, Nardo, but as Ridley and Dendy † propose to reserve the genus *Raspailia* exclusively for the whip-like forms, I decided to place the new sponge under the genus *Axinella*, Schmidt. ‡ Still in doing so I do not feel great satisfaction, as the genus *Axinella* seems at present to be a receptacle for all Axinellidæ which do not belong to the more clearly defined genera: *Hymeniacidon*, *Phakellia*, *Ciocalyptra*, *Acanthella*, *Raspailia*, *Dendropsis*, and *Thrinacophora*. Ridley and Dendy say, in regard to the genus *Axinella*, "Sponge typically ramose, but may be massive. Skeleton fibre plumose. Megasclera stylote and sometimes oxecote. No microsclera. This is a very critical genus, and it is impossible to give a satisfactory

\* Carter, "Annals and Mag. Nat. Hist.," fourth ser., vol. xvi., p. 195, and fifth ser., vol. vi., p. 40.

† Ridley and Dendy, "Report on the Monaxonida, collected by H.M.S. 'Challenger,'" p. 178 and p. 188.

‡ Oscar Schmidt, "Spongien des Adriatischen Meeres." 1862, p. 60.

diagnosis of it. It comes very near to *Raspailia*, but the latter is conveniently kept distinct on account of its very characteristic whip-like external form." Consequently the genus *Acinella* seems to fulfill a similar function amongst the *Acinellidæ* to that of *Amphilectus*, Vosmaer amongst the *Desmacidonidæ*.

Externally and in colour, *Acinella mammillata*, n. sp., has very much the appearance of *Polymastia mammillaris*, J. It consists of a basal mass with papillæ arising from it. The basal mass measures 22 mm. by 16 mm. horizontally and 8 mm. vertically. There are about thirty papillæ on the specimen, with a length of 1 to 8 mm. and 1 to 1.5 mm. in thickness. Generally we find two or three papillæ springing from a common origin. The colour is orange, with exactly the same tint as *Raspailia rigida*, M.

The skeleton consists only of megasclera, and these are styli of two different sizes, the one kind measuring 0.5 mm. by 0.008 mm., and the other kind 0.15 mm. by 0.004 mm. Inside the papillæ the longer styli are packed together in bundles which run parallel to the longitudinal axis of the papillæ. The shorter styli do not form bundles, they stand at right angles to the longitudinal axis of the papillæ, and project for about half their length through the ectoderm. Some of the styli show a slight swelling on their broader end and approach tylostylote character.

Ceratose is present in this species, but only in very small amount. It is found near the base of the bundles of the large styli.

Interesting are certain spindle-shaped granular cells (see Pl. X, figs. 4 and 5) of the mesoderm, measuring about 0.018 mm. by 0.003 mm. Their nucleus is small, and often only indistinctly seen. These cells are aggregated together in strands, and are found in the immediate neighbourhood of the longitudinal bundles of styli, and running parallel

to them. Their chief character is: they are filled up by strongly light-refracting clear granules, the diameter of which I estimate to be 0·0006 mm. From their position and appearance I scarcely doubt that those cells are the skeleton-forming elements (scleroblasts), and the appearance suggests that these granules represent anabolic stages in the formation of the siliceous material for building up the spicules. However, developing spicules were never seen inside those cells.

Apparently the same structures have been figured by Oscar Schmidt\* in *Halysarca guttula*, S., *Spongia adriatica*, S., and *Spongelia elegans*, S. He describes them as irregular, mostly spindle-shaped bands of sarcode, with delicate processes, full of molecular granules, but without cell membrane, nucleus or nucleolus. He gives the following resumé about the nature of these structures: "Die sehr allgemein bei den Spongien vorkommenden Körnerballen, welche oft regelmässig und dicht geschichtet erscheinen und nicht selten mit einem helleren Centrafleck versehen sind, sind weder nach ihrer Entstehung noch nach ihren Bestandtheilen als gemeine Zellen aufzufassen. Sie sind ein Product oder Derivat der Sarcode, und da ich die Körnchen bei keinem Schwamme vermisste, ein mehr oder weniger wesentlicher Bestandtheil dieser Substanz." Notwithstanding Schmidt's views I cannot help regarding those structures as true cells. To call them "Product oder Derivat der Sarcode" is no satisfactory explanation from the standpoint of modern histology.

Similar cells have been figured by Ridley and Dendy† in *Axinella* (?) *paradoxa*, which in the explanation of the

\* Oscar Schmidt, "Supplement der Spongien des Adriatischen Meere enthaltend Histologie," &c., p 3, pl. i., figs. 6—11.

† Ridley and Dendy, "Report on the Monaxonida, collected by H.M.S 'Challenger,'" pl. xlix., fig. 2a.

plate are called "portion of a band of elongated mesodermal cells found accompanying a skeleton fibre."

I have mentioned already the great similarity which exists in the external appearance of *Axinella mammillata* and *Polymastia mammillaris*. As it might be misleading to distinguish the species by the spicules alone, as those of *Axinella mammillata* sometimes approach the tylostylote character, and those of *Polymastia mammillaris* the tylole character, it appeared quite necessary to sectionize one of the papillæ for the sake of identification. The difference then is quite striking. In *Polymastia mammillaris* the papilla has the form of a tube with a large central cavity, with large subdermal spaces and well developed pore-membranes.\* None of these characters are present in *Axinella mammillata*. Inside of the papillæ we have here and there larger or smaller quite irregular cavities, no distinct subdermal spaces, and of oscula, pores and pore-membranes nothing definite could be seen.

I found one specimen of this new species in one of the tidal pools on the north end of Puffin Island, at lowest tide, April, 1889.

*Raspailia ventilabrum*, Bowerbank.

*Dictyocylindrus ventilabrum*, Bowerbank.

In my previous report I regarded this species as identical with *Raspailia viminalis*, Schmidt, and described it under that name. But, as pointed out recently by Topsent,† there exists a difference between *R. viminalis*, S., and *R. ventilabrum*, B. The styli are slightly tylostylote in *R. viminalis*, whilst in *R. ventilabrum* they are of the normal character.

\* See my former Report in Proc. Liverpool Biol. Society, vol. iii., pl. vi., figs. 2 and 3.

† Emile Topsent, "Etudes de Spongiaires." Revue Biologique du Nord de la France, tome ii., no. 8, Mai, 1890.



A single specimen had previously been recorded from Church Bay, near Holyhead. On the "Hyæna" expedition of May 25th, 1890, we dredged three specimens in Penrhos Bay (10 fathoms) and off Rhoscolyn Beacon (12 fathoms), on the west coast of Anglesea. The best of the specimens showed a narrow base with four branches, three of which were again divided dichotomously. The colour was a dull purple. The height of the specimens ranges between 4 and 6 cm. Their branches are perfectly cylindrical, whilst Bowerbank's\* figure shows rugged ridges along the branches. Probably Bowerbank's figure is not quite reliable, as it had been taken from a dried specimen.

*Raspailia rigida*, Montagu.

*Spongia rigida*, Montagu, Mem. Wern. Soc., vol. ii., pt. i.

Non *Raspailia* (?) *rigida*, Ridley and Dendy, Chall. Rep., p. 191.

The species, which in my former report I regarded as *Raspailia stelligera*, Schmidt, seems in reality to be *Raspailia rigida*, Montagu. Topsent's† recent paper has drawn my attention to this fact. There are two species of the genus *Raspailia*, Nardo, which possess stellate spicules, both first described by Montagu under the names *Spongia stuposa* and *Spongia rigida*, the latter differing from the former by having much shorter branches and larger stellate spicules. Bowerbank considered the *Sp. rigida* merely as a dwarfed variety of *Sp. stuposa*, and included both in the name *Dictyocylindrus stuposus*. But Topsent shows that they are really distinct species. Consequently as my specimens have very short branches indeed and comparatively large stellate spicules, I consider them to be *Raspailia rigida*, M. As stated by Topsent, the *Ras-*

\* Bowerbank, loc. cit., vol. iii., pl. xvi.

† Emile Topsent, loc. cit.

*pailia stelligera*, Schmidt, is only a superfluous synonym for *Raspailia stuposa*, Montagu.

There are, as mentioned above, two species of *Raspailia* with stellate microscleres, *R. stuposa*, M., and *R. rigida*, M. In my former report I drew attention to Ridley and Dendy's statement that the only stellate forms of microscleres "which are certainly known to occur in the Monaxonida" are spirulæ, discastra and amphiastra," and I proposed that spherasters should be mentioned as a fourth form of stellate microscleres in the Monaxonida, and that the limits of the genus *Raspailia*, as given by Ridley and Dendy, should be enlarged by leaving out the negative character "no microsclera," so as to reconstitute the older and wider genus defined by Nardo and Schmidt. I see now that Lendenfeld's definitions of the group in question also want alterations. In his "Descriptive Catalogue"\* the definition of the order "Cornacuspongiæ," which comprises also the Axinellidæ, is too narrow, as it gives the negative character "Microsclera, never stellate." This character should be left out. Similarly in the "Monograph†" Lendenfeld defines his sub-family "Axinellinæ," which includes *Raspailia*, as "Axinellidæ without microsclera." This definition also wants correction.

This species which has now been found on the shores of Puffin Island several times, has also been dredged on the "Hyæna" expedition of May 25th, 1890, in Penrhos Bay, west coast of Anglesey, from a depth of about 10 fathoms.

*Suberites domuncula*, Nardo.

*Halichondria suberea*, Montagu.

Johnston ‡ describes this sponge under the name *Hali-*

\* R. v. Lendenfeld, "Descriptive Catalogue of the Sponges in the Australian Museum, Sydney," p. 74.

† R. v. Lendenfeld, "A Monograph of the Horny Sponges," p. 903.

‡ Johnston, "British Sponges," p. 140.

*chondria suburea*, and says, in regard to its habitat, "It has the singular property of being attached only (so far as I have been able to ascertain) to old univalve shells, which it entirely invests." He mentions then that most of those shells were inhabited by hermit-crabs. Schmidt's\* definition is similar, "Suberites globosus, incrustans et involvens conchas, quas Paguri domos sibi elegerunt." Mr. Higgin has already recorded specimens of this peculiar habit from Holyhead and Morecambe Bay, and I am able to add Calf of Man, where it was dredged on the "Hyæna" expedition of April, 1889. But still this species does not seem to restrict itself exclusively to univalve shells inhabited by hermit-crabs, although those cases are the conspicuous and interesting ones. A sponge, apparently of the same species, was dredged on the above mentioned "Hyæna" expedition of April, 1889, and also off Calf of Man. It encrusted a living *Pecten opercularis*, forming a thin layer (about 2 mm. in thickness) of greyish colour. I have found it also encrusting tetractinellid sponges, on *Seiriola compacta*, mihi, and on *Stelletta collingsi*, B. As I shall state more fully on page 221, I erroneously described in my former report such an encrusting layer of *Suberites domuncula* as the ectosome of *Seiriola*. The upper portion of fig. 1, Pl. VII., Vol. III., Proc. Liverpool Biol. Soc. may therefore be taken as a fairly correct representation of a vertical section through a *Suberites domuncula*. The thickness of that specimen was unusually small, only about 0.24 mm. The spicules of it are tylostyli 0.1 to 0.38 mm. by 0.003 to 0.006 mm. They are arranged in bundles, and project for about one-half of their length through the ectoderm. The heads of the longer tylostyli are supported by the basal membrane. The figure also

\* Oscar Schmidt, "Spongien des Adriatischen Meeres," Theil i., p. 67.

shows pore-membranes, pores and sub-dermal cavities.

*Suberites ficus*, Esper.

*Alcyonium ficus*, Esper.

*Halichondria ficus*, Johnston.

*Hymeniacidon ficus*, Bowerb., B. S., vol. ii., p. 206; vol. iii., pl. xxxvi.

*Halichondria ficus*, Carter, A.M.N.H., 5, ix., p. 353.

*Suberites ficus*, Schmidt, Spongienfauna des Atlant. Gebietes, p. 76.

Two specimens of this species were found by Mr. Herbert C. Chadwick opposite the ferry-slip, at Bangor, in August, 1887, attached to the rock. I was unable to record it in my former Report, as I heard only quite recently about this find. The one specimen is about 3 cm. in height, the other one 1·3 cm. This species has been recorded by Bowerbank from the coast of Scotland; coast of Northumberland; Island of Harris; Hebrides; and from Gilter Sound, near Tenby. I may mention that about fifteen fine specimens of *Suberites ficus* were dredged by Professor Herdman in the Sound of Mull, in 1881, and are now in the Zoological Museum of University College, Liverpool.

*Cliona celata*, Grant. (Pl. XI., fig. 2, and Pl. XII).

*Vioa celata*, Nardo.

*Spongia terebrans*, Duvernoy.

*Halichondria celata*, Johnston.

*Hymeniacidon celata*, Bowerbank.

*Raphyrus Griffithsii*, Bowerbank.

*Vioa celata*, O. Schmidt.

*Papillina suburea*, O. Schmidt.

*Spongia sulphurea*, Desor.

*Cliona sulphurea*, Verill.

Mr. Higgin, in his "Report on the Porifera of the L.M.B.C. District," page 85, has already mentioned that in our district both forms of *Cliona celata* are found, the "massive" and the "sinuous" one, but I am not aware that massive specimens of such a size were ever found before in our neighbourhood as those which were dredged on the "Hyæna" expedition of May 25th, 1890, on the west coast

of Anglesey. The first specimen was got in Penrhos Bay, from a depth of about ten fathoms. More material was taken off Towyn (twelve fathoms), and lastly off Rhoscolyn Beacon (twelve fathoms) the dredge brought up a specimen larger than any sponge ever found in our district, and probably not exceeded in size by any sponge ever collected on the British coast. It measures horizontally 31 cm. by 20 cm., and vertically 12 cm. The figure on Pl. XII. represents the specimen in not quite one-half natural size. I drew it from a photograph which Mr. Benjamin Davies (Physical Laboratories, University College, Liverpool) had kindly taken from the specimen after it had been in spirit for some time. Those members of our expedition who attempted to photograph it on board of the "Hyæna" were less successful.

The colour of the largest and of most of the smaller specimens, when alive, was ochreous-yellow. But the first specimen which we got from Penrhos Bay, was distinctly sulphur-yellow. The oscula are large and well marked. They have the shape of slits, and measure from 2 by 1 mm. to 8 by 3 mm. Two of them are seen in the figure upon one of the smaller lobes. A row of oscula on the upper edge of the largest lobe could not be represented in the figure. The pore-areas form extremely numerous and well-marked circular patches (2 mm. in diameter) on the extremity of very short papillæ, just projecting beyond the level of the sponge. In the "sinuous" form of *Cliona celata* those little papillæ with their pore-areas are generally the only things which are visible inside of or projecting from the small circular holes of the inhabited and perforated shell.

The spicules are tylostyli. They measure 0.315 mm. by 0.008 mm. A few of them were smaller, down to 0.225 by 0.003 mm. A vertical section through the sponge shows

at the first glance two very different tissues. The one is strong, fibrous and full of spicules, the other one is highly porous and reticulated, with a smaller number of spicules. The latter chiefly forms the choanosome, the former the ectosome, but broad strands of the ectosome are given off, which project down and branch throughout the choanosome, thus giving a strong support to the soft tissue of the choanosome (Pl. XI., fig. 2). The incurrent and ex-current canals are large and numerous. The size of the flagellated chambers is about 0.04 by 0.028 mm.

If one sees only the two extremes in the mode of growth of *Cliona celata*, the small boring form, which scarcely projects out of the holes of a perforated oyster shell, and the large massive form described above, then it is really difficult to convince oneself of the identity of the two forms. Intermediate stages, however, soon show the identity. The Zoological Museum of University College, Liverpool, possesses a specimen, dredged by Professor Herdman in Cailliach Bay, Mull, September, 1882, which represents an exceedingly good example of such an intermediate stage. The pore-areas of the future massive form are all fully developed, but they are easily recognized as being the upper surfaces of small papillæ which project from the holes of the perforated foreign body. Further, there is a layer of sponge-mass (varying from 1 to 3 mm. in thickness) outside and above the non-perforated surface of the foreign body (an igneous rock), which layer extends laterally to and fuses with the papillæ.

After the boring form of *Cliona celata* had been described by Grant and Nardo, Johnston discovered the massive stage and recognized it as a variety of the boring one. Other authors again considered both forms as different species, so also Bowerbank, who established a new genus for the massive form and called it *Raphyrus Griffith-*

sii.\* For an exhausting account of this comedy of errors I refer to Leidy's recent paper "The Boring-Sponge, *Cliona* †"

Leidy, in his paper, also discusses the question whether the *Cliona sulphurea*, Desor, of the American coast, which is found both boring and massive, might be identical with *Cliona celata*, Grant, of Europe. He finds that the two forms agree in all respects except two. Hancock ‡ had stated that in *Cliona celata*, Grant, hexagonal siliceous granules are found on the surface of the sponge, by which the latter is able to work out the cavities it inhabits. Leidy says he has not been able to detect those granules in the American sponge. The second difficulty is: "Grant, Hancock, Bowerbank, and Lieberkühn give as the size of the spicules of *Cliona celata* about  $\frac{1}{50}$  of an inch, while in all our ('i.e. American') forms of *Cliona*, in the oyster and clam, and in the largest massive varieties, the size of the spicules is only about  $\frac{1}{80}$  of an inch."

The first difficulty about the hexagonal granules has been solved by Topsent.§ He considers them as broken pieces of the prismatic layer of the perforated shell, perhaps intermixed with grains of quartz. In regard to the second difficulty, Topsent remarks that the difference in size of spicules cannot be of much value, as he himself has observed spicules from 0.18 mm. to 0.35 mm. in length. On page 217 I gave as the length of the spicules 0.315 mm. As  $\frac{1}{50}$  inch is equal to 0.508 mm., and  $\frac{1}{80}$  inch is equal to 0.317 mm., we see that Topsent's and my own observations agree with Leidy's measurements as exactly as one could expect,

\* Bowerbank, "British Spongiadæ," vol. ii., p. 354; vol. iii., pl. lxiv.

† In. "Pro. Acad. Nat. Sciences, Philadelphia," part i., January—April, 1889, p. 70.

‡ Albany Hancock, "On the excavating power of certain Sponges belonging to the genus *Cliona*," 1849.

§ Emile Topsent, "*Cliona celata* ou *Cliona sulphurea* ? Bulletin de la Société Zoologique de France," 1889, p. 351.

whilst we all three differ from the older and perhaps incorrect observations. There can be no doubt whatever that *Cliona sulphurea*, Desor, is identical with *Cliona celata*, Grant. I will add that I have measured also the spicules of a boring form of *Cliona celata* from Puffin Island, and get the following results: most spicules about 0·36 by 0·008 mm., a few smaller down to 0·27 by 0·003 mm.

*Polymastia mammillaris*, Johnston.

Several specimens of this were dredged on the "Hyæna" expedition of May 25th, 1890, in Penrhos Bay (10 fathoms), off Rhoscolyn Beacon (12 fathoms), and off Porth Dafarth, Anglesey. The largest of the specimens forms a globular mass with a diameter of 4 cm. More than one hundred papillæ rise from its upper surface. The other specimens were slightly smaller and flatter. They all were of a bright orange-yellow. One small specimen was also collected at the east end of Puffin Island, June 18th, 1890. This species had previously been dredged in Church Bay, near Holyhead. For description and figures see my former report.

*Polymastia robusta*, Bowerbank.

In my former report I recorded this species from Church Bay, Holyhead. We have dredged since two specimens of it on the "Hyæna" expedition of May 25th, 1890, in Penrhos Bay (10 fathoms), and off Rhoscolyn Beacon (12 fathoms), on the west coast of Anglesey. The specimens are hemispherical masses, of a diameter of about 4·5 cm. in horizontal direction and 2 cm. in height. The colour of the one specimen was a dirty greyish-yellow; of the other one a pure orange tint.

#### Order IV. **TETRACTINELLIDA.**

*Tethya lynceurium*, Johnston.

Five specimens of almost perfect globular form were



dredged on the "Hyæna" expedition of May 25th, 1890, in Penrhos Bay (10 fathoms), and off Rhoscolyn Beacon (12 fathoms), on the west coast of Anglesey. The cortex of the living sponge was cadmium-yellow, its inner portion brown. The diameter of the specimens is 1·5 to 2 cm. One of them was covered with about thirty buds.\*

One specimen of this species had previously been dredged in Church Bay, Holyhead.

*Dercitus bucklandi*, Bowerbank.

This sponge, which had already been recorded by Mr. Higgin under the name *Dercitus niger*, C., from Holyhead, has now also been discovered at Puffin Island. I found a few specimens of it at the entrance of the large cave on the north end of the island, at low spring tide, April, 1889. The largest of the specimens measures 3 cm. by 2 cm. in horizontal direction and 0·6 cm. in height. Colour, dark black.

For an extensive list of the literature, and a revised description of this species, see Sollas.†

*Seiriola compacta*, Hanitsch (Pl. XIII., figs. 1—4).

In my former report on the Porifera of the L.M.B.C. District ‡ I described and figured a new species of a tetractinellid sponge under the above name, which I took to be the representative of a new family. But in doing so I fell into a serious error, and I have to thank Professor Sollas, D.Sc., for pointing out the mistake to me. The two layers which I described as ectosome and choanosome of *one* sponge are really two quite separate sponges, an encrusting Suberite and an encrusted Stellettid. "Each is," as Prof. Sollas writes me, after having seen my preparations, "a separate individual, the Suberite is defined from the

\* Compare Bowerbank, "British Spongiadæ," vol. ii. p. 94.

† Sollas, "Report on the Tetractinellida collected by H.M.S. 'Challenger,'" p. 108.

‡ Proc. Liverpool Biological Society, vol. iii., p. 169—172, pl. vii.

Stellettid by its own basal membrane, and the Stellettid from the Suberite by its outer epithelium, distinguished in favourable parts of the sections by the somewhat dense layer of sanidasters which usually are more crowded there than elsewhere. The basal membrane of the Suberite supports the heads of the longer tylostyles as so commonly happens in these sponges." Curiously enough Döderlein\* fell into a quite similar error in regard to *Discodermia calyx*, D., and Bowerbank † in regard to *Stelletta collingsi*, B., and *Stelletta schmidei*, B. As, notwithstanding the above stated error, the encrusted tetractinellid sponge is new to science, and is the only representative of a new genus, *Seiriola*, ‡ I propose to give now a corrected description of it. No new figure of the spicules will be necessary, as I can refer to Vol. III., Pl. VII., where, however, no notice should be taken of the upper thinner layer which does not belong to *Seiriola compacta*. This foreign layer is characterized by tylostylote spicules and is separated from the lower portion, the *Seiriola compacta*, by a definite line of demarcation. It belongs to a monaxonid sponge, *Suberites domuncula*, Nardo.

The first specimen of *Seiriola compacta* was found at Puffin Island, in June, 1888, in one of the caves on the north-east side of the island, which are exposed only at low spring tides, and then accessible only by boat. It formed a knob-like mass, like that of so many tetractinellid sponges, and measured horizontally 4 cm. by 1·5 cm., and vertically 1·3 cm. It came into my hands after it had been in rather weak spirit for several weeks, and was then

\* Sollas, "Report on the Tetractinellida," collected by H.M.S. "Challenger," p. 295.

† Sollas, loc. cit., p. 186.

‡ From Seiriol, an early Welsh saint, who is said to have had his cell on Puffin Island.

of dark grey colour. In April, 1889, I collected in the same cave several specimens of *Seiriola* which were white with a slight greyish tint, and have kept their colour perfectly well in strong spirit. The specimens have about the same dimensions as the original one, but they are flatter. Although the shape and colour of this sponge agree completely with those of *Stelletta collingsi*, B., which I collected at the same time and in the same locality, still one may distinguish the two forms in the following way: *Stelletta* has a hispid surface; *Seiriola* is smooth to the touch; *Stelletta* shows a cortex even in a rough vertical section made with the pocket-knife; *Seiriola* does not. Curiously also a specimen of the new material was encrusted by *Suberites domuncula*, and in the same way also one or two specimens of *Stelletta collingsi*. The rest were not encrusted. Oscula and pores were not visible in the living specimens.

The skeleton of *Seiriola compacta* consists of megascleres and microscleres. The former show the following forms: dichotriæna, orthotriæna, oxea, styli, strongyla, tylota. The dichotriæna are very numerous, and are arranged immediately beneath the surface, with their cladomes directed towards the surface. The rhabdome measures from 0.36 to 0.42 mm., the protocladus from 0.06 to 0.09 mm., and the deuterocladus from 0.037 to 0.45 mm. The orthotriæna are far less numerous and slightly smaller than the dichotriæna. They are also placed close to the surface. The oxea are the most numerous spicules, and are arranged in bundles, which take their origin in or immediately beneath the region of the triæna, and stretch vertically down through the whole depth of the sponge. The oxea measure 0.34 to 1.5 mm. by 0.009 to 0.026 mm. Amongst them we find a few stylote, strongylote, and tylote spicules.

The microscleres are oxyasters, 0.025 mm. in diameter,

and sanidasters (not spirasters, as I called them in my previous report) 0·012 to 0·016 mm. in length, and are both very typical forms. The oxyasters are found only in the choanosome, the sanidasters chiefly in the ectosome, and a few also in the choanosome.

Besides those megascleres and microscleres, I found fragments of a third kind of spicule (see fig. 2 c., Pl. VII., Vol. III.), the appearance of which, in my former report, I compared with broken blades of fret saws. The largest of these pieces measured 0·08 by 0·0014 mm. They were found just beneath the surface of the sponge. But now I think it quite possible that they do not belong to *Seiriola* at all, but rather to *Stelletta collingsi*, in which latter sponge I now describe them for the first time (see Pl. XIV., figs. 1 and 2). As my specimens of *Seiriola* and *Stelletta* had been taken from the same rock, and had been kept together for some time in the same jar of spirits, it is possible that fragments of those spicules found their way accidentally into the *Seiriola*.

Oscula and pores could not be distinctly seen, neither in the living specimens nor in sections. The incurrent and excurrent canals seem to branch in a very irregular manner through the sponge. The chamber-system appears to belong to the eurypylous type,\* in so far as the flagellated chambers lie closely round the excurrent canals, and as the apopyles are not continued into special tubes and are extremely short. At the same time the term "eurypylous" does not apply correctly to *Seiriola*, as the apopyles are extremely narrow. The flagellated chambers and collar cells are very small. The former are oval, and measure 0·012 by 0·008 mm. The collar cells measure 0·0013 mm.

The mesoderm of *Seiriola* consists of sarcenchym, the

\* Sollas, loc. cit., p. xv.

greatest part of which however has been replaced by cystenchymatous tissue, also called vesicular connective tissue or bladder-cells ("blasiges Bindegewebe" of German authors). These bladder-cells are generally spherical, with an average diameter of 0.04 mm. In the original, less well preserved material of *Seiriola*, these cells contained very little protoplasm which, together with the small nucleus, adhered to one side of the cell-wall only, leaving the greatest part of the cell quite empty (compare Pl. VII., fig. 1, Proc. L'pool Biol. Soc., Vol. III). Also in the second and well preserved material the bladder cells showed eccentrically situated nuclei; the protoplasm, however, was found not only round the nuclei and along the neighbouring parts of the cell-wall, but threads of it radiated throughout the remainder of the cell (Pl. XIII., figs. 1 and 2). Bladder-cells have been already observed by various authors in other sponges, as by Vosmaer\* in *Poly-mastia hemispherica*, by Sollas† in *Pachymatisma*, *Stryphnus*, &c., and also in some of the Lithistida. A similar tissue is known to occur in many Molluscs and in Tunicata. ‡

Of great interest too were strands of spindle-shaped cells which occur in great frequency (Pl. XIII., figs. 1—3). The cells are arranged longitudinally and in parallel rows, and are apparently imbedded in a clear gelatinous matrix. Their size varies greatly, the largest cells measure about 0.048 by 0.014 mm. Both ends of the cells are prolonged into delicate fibres. They are all highly granular, and intensely stained after treatment with picro-carmin. The

\* Vosmaer, "Sponges of the 'Willem Barents Expedition, 1880 and 1881,' in "Bijdragen tot de Dierkunde."

† Sollas, "Report on the Tetractinellida," collected by H.M.S. "Challenger," p. xxxix.

‡ W. A. Herdman, "Report on the Tunicata," collected by H.M.S. "Challenger," Vol. I., pp. 28—29.

nuclei are small and not very conspicuous, apparently on account of the opaque protoplasm of the cells. The nature of these cells seems to be distinctly different from that of the much smaller spindle-shaped cells described in *Axinella mammillata*, n. sp. (page 211). In the latter species the granules of the cells are distinctly spherical, clear, and highly light-refracting. In *Seiriola* the granules are opaque, and apparently of no definite outline. Further, in *Axinella* the spindle-cells run in strands along the chief masses of spicules, and suggest at once that they might be "scleroblasts." But in *Seiriola* such a relation between the spindle-cells and the spicules does not seem to exist. On the contrary, quite independently of the presence or absence of spicules, the strands of those cells permeate the choanosome in an irregular fashion, giving off numerous branches (Pl. XIII., fig. 3). Further, I have not been able to find any connection between those strands and the incurrent and excurrent canals, or with any other structure. Transverse sections through the strands are frequently met with in preparations, and they show a round outline. Sollas's "myocytes" seem to be similar structures, but they differ from those cells in *Seiriola* by chiefly occurring "concentrically arranged about the openings of the water-canals." Still I shall not be surprised if future investigations prove those cells to be neuromuscular elements.

In regard to the systematic position of *Seiriola compacta* Professor Sollas wrote me as follows:—"The choanosomal spicule is a characteristic oxyaster, the ectosomal microsclere is a typical sanidaster; this latter places the sponge in the Sanidasterina. Of the genera of this group it approaches most nearly *Stryphnus*, but differs from all the species of this genus which I have seen. The sanidaster is a better sanidaster, i.e., more typical and regular

than in most species of *Stryphnus*, and the oxeas are not colossals, while they do seem to be arranged in bundles." Prof. Sollas further suggested placing *Seiriola compacta* as a new species of the genus *Stryphnus*, Sollas.\*

In consequence of Prof. Sollas's advice I have now decided to drop the new family "Seiriolidæ" which I established in my former report, and I place the new sponge amongst the Sanidasterina, a sub-family of the family Stellettidæ. But I still intend to retain the new genus "*Seiriola*." The differences between it and the genus *Stryphnus* justify, I think, my doing so. These differences are :—

- (1.) *Stryphnus*—The choanosomal megascleres are colossal oxeas, closely strewn through the sponge, not aggregated to form fibres and not radiately arranged. *Seiriola*—The choanosomal megascleres are oxeas of ordinary size, and besides those also styli, strongyla and tylota. The spicules seem to be aggregated in bundles, and somewhat radiately arranged.
- (2.) *Stryphnus*—The microscleres are some form of euaster, and an irregular amphiaser or sanidaster. *Seiriola*—The microscleres are typical forms of oxyaster and sanidaster.
- (3.) *Stryphnus*—The flagellated chambers are either apodal or slightly diplodal. *Seiriola*—The flagellated chambers are eurypylous.

*Stelletta collingsii*, Bowerbank (Pl. XIV., figs. 1—3).

*Tethea collingsii*, Bowerbank.

*Tethea schmidtei*, Bowerbank.

*Collingsia sarniensis*, Gray.

*Collingsia schmidtei*, Gray.

*Stelletta collingsii*, Sollas.

The sponge, which in my former report was mentioned

\* Sollas, loc. cit., p. 171.

under the name *Ecionemia ponderosa*, B., has, by further examination, turned out to be a *Stelletta collingsi*, B., or at least a variety of it.

I have found in it all the different kinds of spicules which have been mentioned by Bowerbank, and more recently by Sollas,\* and some other spicules in addition to those. The megascleres are—oxea 1·8 by 0·032 mm.; orthotriæna, the rhabdome of which measures 1·42 by 0·032 mm., and the cladi 0·105 by 0·028 mm.; a few dichotriæna, the protocladi of which measure in length 0·056 to 0·084 mm., and the deuterocladi 0·028 to 0·046 mm.; and a very few prototriæna, rhabdome 0·40 mm., cladi 0·036 mm. Both dichotriæna and prototriæna had not been mentioned by previous authors. The microscleres are—chiaster, 0·012 mm. in diameter, found only in the ectosome, just beneath the surface; and oxyasters with a varying number of actines, found chiefly in the choanosome. It seems to be the rule that the larger the oxyasters are, the smaller is the number of their actines. I found that—

4 radiated oxyasters measured	0·056 mm. in diameter
6                    "                    "	0·040   "            "
8                    "                    "	0·032   "            "

Besides those above-mentioned kinds of megascleres and microscleres I found an additional kind of spicule which I will call "prionorrhabs" † (Pl. XIV., figs. 1 and 2). They are long and slender spicules, 0·40 by 0·002 mm., one end of which is profusely spined, the other and larger portion is smooth. The two extreme ends of the spicules are sharply pointed. I have found these prionorrhabs only in the ectosome, with their spined ends imbedded in it and the smooth ends projecting through the ectoderm and penetrating into a calcareous sponge *Sycan-*

\* Sollas, loc. cit., p. 185.

† From *πρίων* a saw.



*dra ciliata*, which was attached to the surface of the *Stelletta*. The prionorhabds are arranged radiately, the ideal centre of the circle lying inside the *Sycandra*. But only this one small portion of the *Stelletta*, opposite to which the *Sycandra* is situated, shows those spicules.

As this special kind of spicule has never before been described in *Stelletta collingsi*, nor in any other sponge, the question arises whether my specimen is identical at all with *St. collingsi* or whether the spicules are present in all specimens of *St. collingsi* and have been overlooked by former investigators, or lastly, whether they are a special acquirement which may become developed in the sponge under certain conditions. I am inclined to accept the last of the three views. I have mentioned already that the prionorhabds were found only in a certain portion of *Stelletta*, and I believe that they have been acquired by the sponge under the special abnormal conditions to protect itself against the encroaching foreign body, a calcareous sponge. As in my specimen they are very localized, it is quite possible that they have been overlooked by other workers.

I collected several specimens of *Stelletta collingsi* at Puffin Island, in one of the caves on the north end of the island, in April, 1889. One specimen had been found there already, in June, 1888. The colour of the living specimen is greyish-white.

*Pachymatisma johnstonia*, Bowerbank.

The colour of this species is known to be subject to great variation. Bowerbank\* states—"Littoral specimens, light to dark slate-grey. Deep sea specimens, pink or red." And Sollas† says—"Slate-grey on the portion exposed to the light, almost white beneath; specimens from

\* Bowerbank, "British Spongiadæ," vol. ii., p. 51.

† Sollas, "Report on the Tetractinellida," collected by H.M.S. "Challenger," p. 243.

considerable depths, pink or red (Bowerbank).” I had excellent opportunity of convincing myself of this variation in colour in one of the large caves at Puffin Island, in April, 1889. The cave, situated on the north end of the island, is accessible only at lowest spring tides, and even then only with boat. Right at the entrance to the cave I noticed that the specimens of *Pachymatisma* were of a dark slate-grey colour. Rowing further into the interior I found specimens of a light grey, and in the farthest recess of the cave I discovered some splendid specimens of a perfect cream-white tint. I found quite similar conditions in April, 1890, near Brada Head, Port Erin, in a cave which also is accessible only with boat and at lowest tide. The specimens of *Pachymatisma*, larger even than those at Puffin Island, were lighter in colour the further back in the cave they were found.

The explanation of these facts is, in my opinion, found only in the direct action of the light of the sun. The more exposed the specimens were to the light, the darker they were; the more protected, the lighter. I know very well that such an explanation is not at all in accordance with the generally accepted views, and Wallace’s\* statement, “that light and heat of the sun are not the direct causes of the colour of animals,” is not only his own view, but is shared by the majority of modern biologists. Still my own view finds support in what Lendenfeld† has recently said in regard to the Ceratosa — “No differences are observed in the colour of different parts of the surface except that the lower side is generally lighter-coloured than the upper side. This is less of a protective acquisition than a direct effect of the light. The parts of the surface exposed to it are darker coloured by its photo-

\* Wallace, “Darwinism,” p. 195.

† R. v. Lendenfeld, “A Monograph of the Horny Sponges,” p. 742.

graphic action than the lower side which is always in shade." I therefore merely apply what Lendenfeld said in regard to different parts of the same specimen to different specimens of the same species.

I will not omit to state that in neither of the two cases could one think of accounting for the colouring by protective resemblance to the environment. The lighter specimens especially were as different in colour from the rocks (carbonate of lime at Puffin Island and slate of Ordovician age at Brada Head, Port Erin) as they possibly could be. Altogether it has not been proved yet that sponges ever imitate their surroundings in colour. Out of the numerous species of our district which I have had occasion to examine in the living condition, not a single instance seemed to give a sure proof of such an imitation. If here or there a species of sponges, organisms which in their shades and tints show almost as innumerable transitions as the spectrum itself, happens to resemble its surroundings, whilst the vast majority of the other species do not, then it is surely out of place to take that one example as a proof of imitation of the environment. I may quote what Lendenfeld \* says in regard to the *Ceratosa*—"The horny sponges never *imitate* their surroundings in colour, although some of them, particularly those which have an arenaceous cortex, are very similar in colour to the sea bottom on which they grow. Most of the horny sponges are, like many of the other shallow water *Silicea*, very intensely coloured, and it would appear that these vivid colours have been adopted by the sponges for the purpose of frightening their enemies." This seems really to be the only explanation for most of the colours in sponges. Animals which, like the great majority of sponges, are so extraordinarily well defended by their skeleton, are scarcely in need of a pro-

\* R. v. Lendenfeld, "A Monograph of the Horny Sponges," p. 742.

tective colouring to enable them to escape from their enemies; what they really want are warning colours.

The dimensions of the largest specimen of *Pachymatisma* from Puffin Island is 10 cm. by 7 cm. in horizontal direction; 1.5 cm. in height. The largest specimen from Port Erin measures 12 cm. by 6 cm. horizontally and 6 cm. vertically. I give also the measurements of the spicules, as my results differ somewhat from Bowerbank's and Sollas's\* :—

I.—Megasclera: strongyla, 0.57 to 0.75 mm. by 0.012 to 0.024 mm. Orthotriæna: rhabdome, 0.405 by 0.016 mm; cladus, 0.255 by 0.016 mm. Also a few styli are present, which are not mentioned by Bowerbank and Sollas. They measure 0.635 by 0.009 mm.

II.—Microsclera: sterraster, either spherical, 0.045 to 0.075 mm. in diameter; or elliptical, from 0.06 by 0.045 mm. to 0.09 by 0.068 mm. Oxyaster, 0.048 to 0.056 mm. in diameter; microstrongyla, 0.018 by 0.003 mm.

This species seems to be the only tetractinellid sponge which up to now has been found at the Isle of Man, and it is now for the first time recorded in our L.M.B.C. reports from that locality. I hear that Mr. Geo. Swainson, of Bolton, collected some specimens of it at Parwick Bay, Isle of Man, during last autumn.

## Order VI. **CALCAREA.**

### *Ascetta coriacea*, Fleming.

I found a single small specimen of this species at Puffin Island, April, 1889, at lowest spring tide, in the large cave on the north side of the island. It encrusted a living oyster, which latter was firmly attached to the wall of the cave.

\* Sollas, loc. cit., p. 242.

*Ascetta coriacea* had previously been recorded from Port Erin and Holyhead, and I collected again great quantities of it at Fleshwick Bay, near Port Erin, Easter, 1890.

*Ascaltis botryoides*, Fleming.

A number of specimens of this form were obtained in Fleshwick Bay, near Port Erin, on the "Hyæna" expedition of Easter, 1889. I found them in a shallow pool just beyond the entrance of a long and narrow cave, where I collected some again at Easter, 1890. The level of the pool was near high-water mark (!).

Mr. Higgin records this species from Holyhead.

*Ascaltis contorta*, Bowerbank.

*Leucosolenia contorta*, B., Brit. Spong., vol. ii., p. 29; vol. iii., pl. iii.

*Leucosolenia contorta*, Carter, Midland Naturalist, vol. iii., p. 195.

A few small specimens have been found for the first time in our district by Mr. Herbert C. Chadwick, near Beaumaris, August, 1889, and subsequently I found it myself at Hilbre Island, March, 1890. Bowerbank records it from Guernsey, Scarborough (?), and from the Guliot Caves, Sark.

*Ascortis lacunosa*, Johnston.

*Grantia lacunosa*, Johnston.

*Leucosolenia lacunosa*, Bowerbank.

I refer to this species a few specimens which were dredged on the "Hyæna" expedition of May 25th, 1890, in Penrhos Bay, off Rhoscolyn Beacon, and off Porth Dafarth, where they were found sticking to Zoophytes.

The presence of oxeote spicules in the stalk-like portion of these specimens shows that they belong to this species and not to *Ascetta primordialis*, Hkl., some varieties (especially *Nardorus primordialis*)\* of which they resemble very closely. For figures and descriptions see Bowerbank †

\* Hæckel, "Die Kalkschwämme," vol. iii., pl. ii., fig. 5.

† Bowerbank, loc. cit. vol. ii., p. 22; vol. iii., pl. iv.

and Hæckel.\* Two specimens, which in my former report I recorded as *Ascetta primordialis*, are also referable to this species.

*Leucaltis impressa*, n. sp. (Pl. XV., figs. 1—3).

I found three specimens of this new species at Puffin Island, April, 1889, in one of the large tidal pools on the north-east end of the island. The sponge consists of a solitary persona, which has an elongate and somewhat flattened shape. In two of the specimens the surface is longitudinally corrugated, but is even in the third specimen; it is, however, smooth in all three cases, and hard to the touch. The average height is 12 mm., the diameters in the two horizontal directions 6 mm. and 4 mm. The osculum is terminal, it bears no frill, and measures 0·5 mm. in diameter. The colour is white.

A transverse section shows a thick body-wall and a gastral cavity of about the same width as the body-wall. The diameter of the gastral cavity is therefore only about one-third of the diameter of the whole specimen. The flagellated chambers are spherical or ovoid and exceedingly numerous. They measure from 0·09 mm. to 0·18 mm. in diameter. The inhalent canals branch and anastomose between the flagellated chambers, and open finally into the gastral cavity. These openings are 0·05 to 0·1 mm. in diameter.

The skeleton of the body-wall and of the outer surface consists of triacts and tetracts. The former are by far the more numerous, and each of their rays measures about 0·1 mm. by 0·008 mm. There are also a few triacts with rays of 0·16 mm. in length. In all these triacts one of the rays is straight, the two others slightly curved. The tetracts which are found in the outer surface and in the body-wall generally have about the same dimensions as the triacts,

\* Hæckel, loc. cit., vol. ii., p. 70; vol. iii., pl. xi, fig. 2.

but their fourth ray, which stands vertically upon the three others, is short and hook-like. It measures 0·03 mm. In addition to these spicules we find large gastral tetract spicules. They consist of three short rays (0·14 mm.) which lie in one plane, and of a fourth long ray (0·43 mm.), which stands at right angles to the former. The short rays are slightly curved, they lie in the inner surface of the body-wall and parallel to its circumference. The fourth ray projects freely into the gastral cavity. These tetract spicules are very numerous, so that their short rays form a kind of dense basket-work on the inner surface of the body-wall.

The spherical flagellated chambers of this species and its ramifying canals place it amongst the *Leuconidæ*, and its triact and tetract spicules bring it under the genus *Leucaltis*, Hæckel. Following now Hæckel's "Übersicht der 6 Species des Genus *Leucaltis*,"\* and taking no notice of the tetracts with the one hook-like ray, we arrive at *Leucaltis pumila*, Bowerbank. The respective steps in that "Übersicht" are: 1. "Skelet nicht scharf getrennt in ein völlig verschiedenes Rinden-und Mark-Skelet." 2. "Hauptmasse des Skelets aus Dreistrahlern gebildet." 3. "Vierstrahler entweder bloss in der dermalen oder bloss in der gastralen Fläche. Alle oder ein Theil der Dreistrahler und Vierstrahler nicht regulär." 4. "Vierstrahler bloss in der stacheligen gastralen und canalen Fläche." 5. "Basal Strahl der Vierstrahler länger als die lateralen.—*Leucaltis pumila*." Yet when we compare the specific characters of *Leucaltis pumila*, as given in the detailed descriptions of Hæckel and Bowerbank,† with our species, we find so many and such great differences between these two forms that I feel obliged to establish a new

\* Hæckel, "Die Kalkschwämme," Bd. ii. p. 143.

† Bowerbank, "British Spongiadae," vol. ii., p. 41.

species. These differences are: 1. In *Leucaltis pumila* there are no tetracts with hook-like rays, such as are found in *Leucaltis impressa*. 2. The proportion in size of the gastral tetracts is different in the two species, the stalk being much longer in the new form. 3. The inner surface of the body-wall in *Leucaltis impressa* appears not to be provided with triacts in addition to tetracts as in *Leucaltis pumila*. 4. Bowerbank mentions the "very large size of the surface spicula" in *Leucaltis pumila*, of which there is no trace in our species.

I may mention that *Leucaltis pumila* has, according to Hæckel, a very wide geographical distribution. It has been found at Guernsey by Norman; at Magador (coast of Morocco) by Hæckel; at the Cape by Wilhelm Bleek; and in the Indian Ocean (Bass Strait) by Wendt.

*Leucandra gosseii*, Bowerbank.

This form had previously been recorded from Port Erin and Holyhead. A few specimens of it have been collected again at Port Erin (April, 1889, and April, 1890), and also at Fleshwick Bay (April, 1890). It is one of the rarest calcareous sponges in our district.

*Leucandra johnstoni*, Carter.

A number of fine specimens of it were collected by me at Fleshwick Bay, Isle of Man, and a few also at Port Erin, in April, 1890. It had previously been found at Port Erin and Holyhead.

*Leucandra nivea*, Fleming.

In Mr. Higgin's report this species was recorded from the Isle of Man only. I have found it since, and in profusion, at Puffin Island, April, 1889; and a few specimens also at Hilbre Island, June, 1889. An unusually large and highly corrugated specimen of it, recalling *Leucandra johnstonia*, C., was collected by Mr. Charles Walker at Fleshwick Bay, April, 1890.



It generally forms small white patches on the rocks, and is easily recognizable.

*Sycandra ciliata*, Fleming.

Owing to an oversight *Sycandra ciliata* was not recorded in the two previous reports as having been found at Hilbre Island. It had been collected there in the summer of 1885 by the members of the Liverpool Marine Biological Committee,\* and I have found a few small specimens of it in the same locality in March, 1890. Common in other parts of the district.

#### EXPLANATION OF THE PLATES.

<i>ch.</i> choanosome.	<i>m.</i> gastric cavity.
<i>cy.</i> cystenchymatous tissue.	<i>p.a.</i> pore area.
<i>d.m.</i> dermal membrane.	<i>p.c.</i> "problematic cells."
<i>e.</i> ectosome.	<i>pg.</i> pigment cells.
<i>e.c.</i> exhalent canals.	<i>pr.</i> prionorrhabs.
<i>f.c.</i> flagellated chambers.	<i>s.c.</i> subdermal cavities.
<i>i.c.</i> inhalent canals.	<i>s.l.</i> layer of scleroblasts (?).

#### PLATE X.

Fig. 1. Vertical section through outer portion of *Halisarca rubra*, n. sp., semi-diagrammatic ( $\times 250$ ).

Fig. 2. Vertical section through inner portion of *Halisarca rubra*, n. sp. ( $\times 250$ ). It is doubtful whether the parts in figs. 1 and 2, named "i. c.," are inhalent or exhalent canals.

Fig. 3. *Axinella mammillata*, n. sp., natural size.

Fig. 4. Scleroblasts (?) of *Axinella mammillata* ( $\times 800$ ).

Fig. 5. Portion of a longitudinal section through one of the papillæ of *Axinella mammillata* ( $\times 150$ ).

#### PLATE XI.

Fig. 1. *Chalina montagui*, Johnston, natural size.

\*W. A. Herdman, in "Introduction" to "Fauna of Liverpool Bay," Vol. I. p. 8.

- Fig. 2. Vertical section through the massive form of *Cliona celata*, Grant ( $\times 3$ ).

## PLATE XII.

- Fig. 1. *Cliona celata*, Grant, not quite one-half natural size.

## PLATE XIII.

- Fig. 1. A portion of the choanosome of *Seiriola compacta*, Hanitsch, showing chamber-system, strand of "problematic cells" (in longitudinal section), and cystenchymatous tissue ( $\times 250$ ).
- Fig. 2. Transverse section through a strand of "problematic cells" of *Seiriola compacta*, with cystenchymatous tissue around it ( $\times 250$ ).
- Fig. 3. Section through the choanosome of *Seiriola compacta*, showing the branching of the strands of "problematic cells" ( $\times 50$ ).
- Fig. 4. Portion of fibrous layer of *Seiriola compacta*, situated between ectosome and choanosome ( $\times 250$ ).

## PLATE XIV.

- Fig. 1. Vertical section through the upper portion of the ectosome of *Stelletta collingsi*, Bowerbank. The encroaching *Sycandra ciliata* (in the upper left corner of the plate), shown diagrammatically, ( $\times 200$ ).
- Fig. 2. Spined portion of a prionorrhabd ( $\times 800$ ).
- Fig. 3. *a*, chiaster ( $\times 800$ ); *b*, *c*, and *d*, forms of oxyaster ( $\times 400$ ).
- Fig. 4. *a*, protriaena; *b*, dichotriaena ( $\times 60$ ).

## PLATE XV.

- Fig. 1. Portion of transverse section through *Leucaltis impressa*, n. sp. ( $\times 80$ ).
- Fig. 2. Two specimens of *Leucaltis impressa*, natural size.
- Fig. 3. *a*, *b*, *c*, and *d*, triacts and tetracts of the body-wall ( $\times 150$ ); *f*, gastral tetract ( $\times 150$ ).

Fig. 1.



Fig. 2.

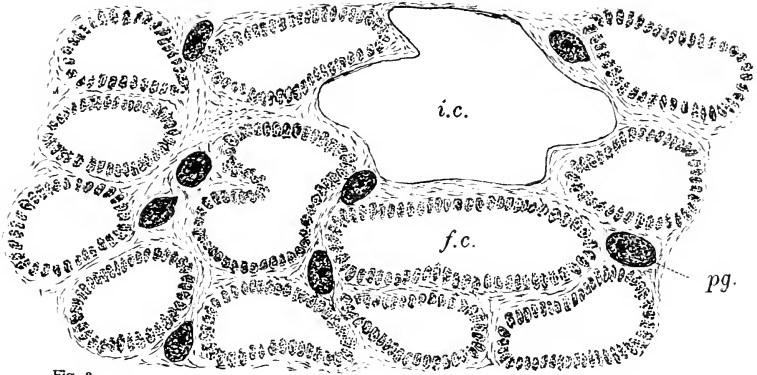


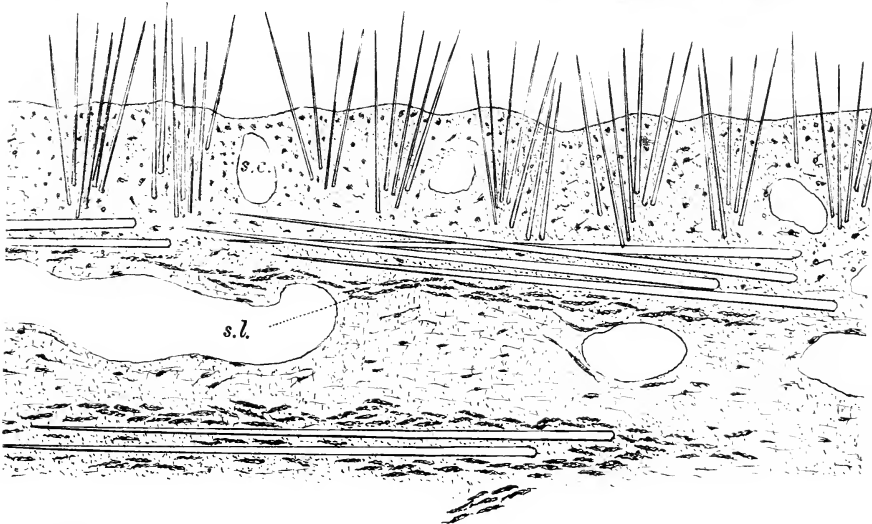
Fig. 3.



Fig. 4.



Fig. 5.



R. Hanitsch, del.

HALISARCA RUBRA, N. SP.  
AXINELLA MAMMILLATA, N. SP.



Fig. 1.

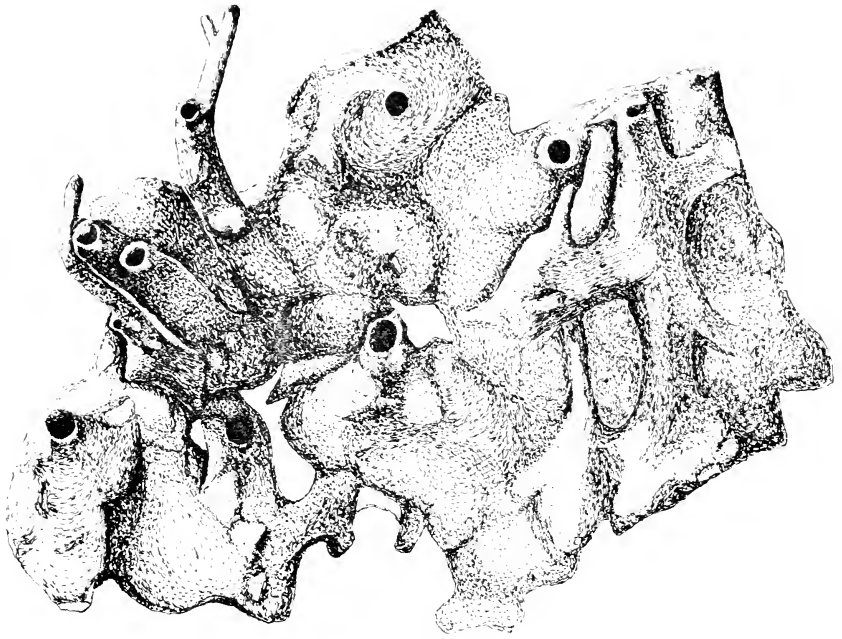
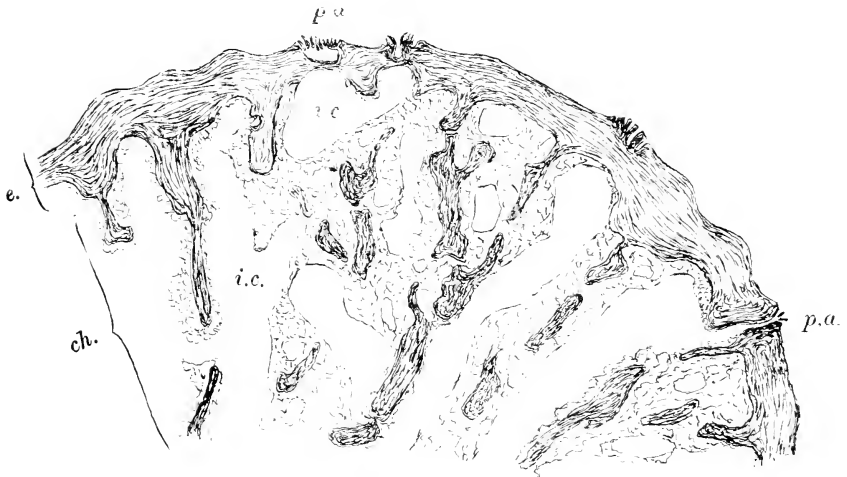


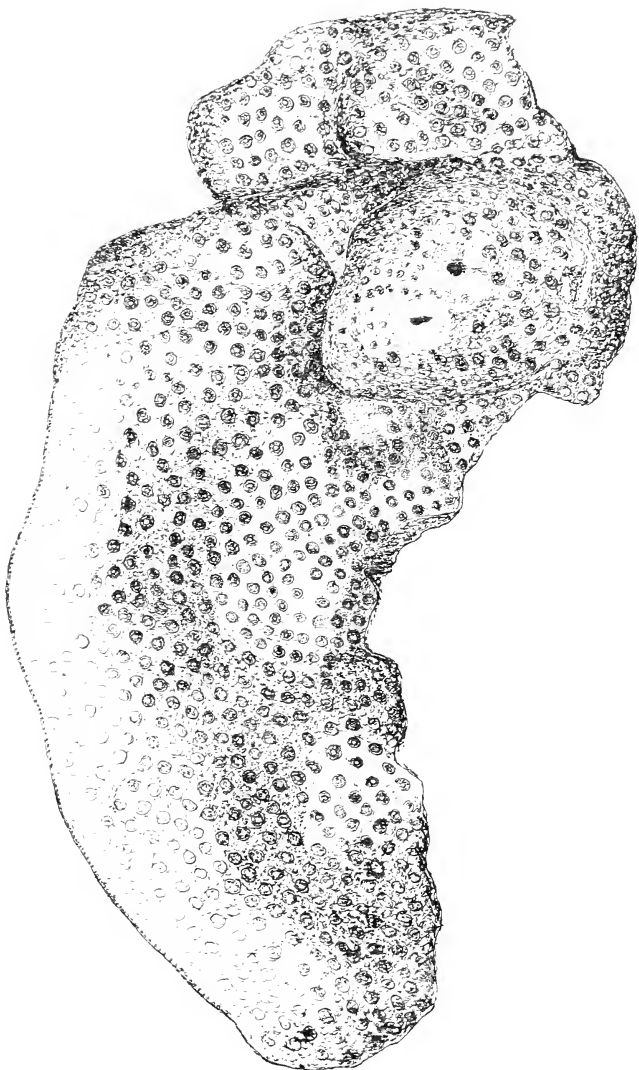
Fig. 2.



R. Hanitsch, del.

CHALINA MONTAGUI, JOHNSTON.  
CLIONA CELATA, GRANT.





R. Hanitsch, del.

CLIONA CELATA, GRANT.





Fig. 1.

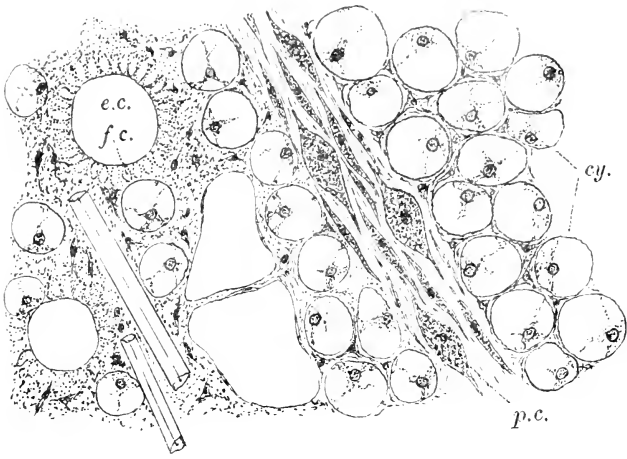


Fig. 2.

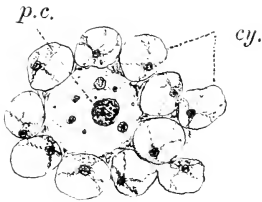


Fig. 4.



Fig. 3.

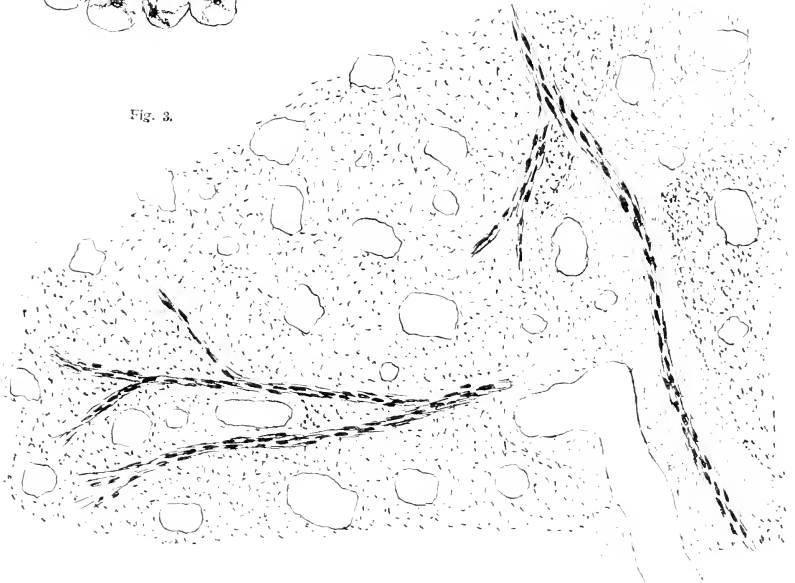




Fig. 1.

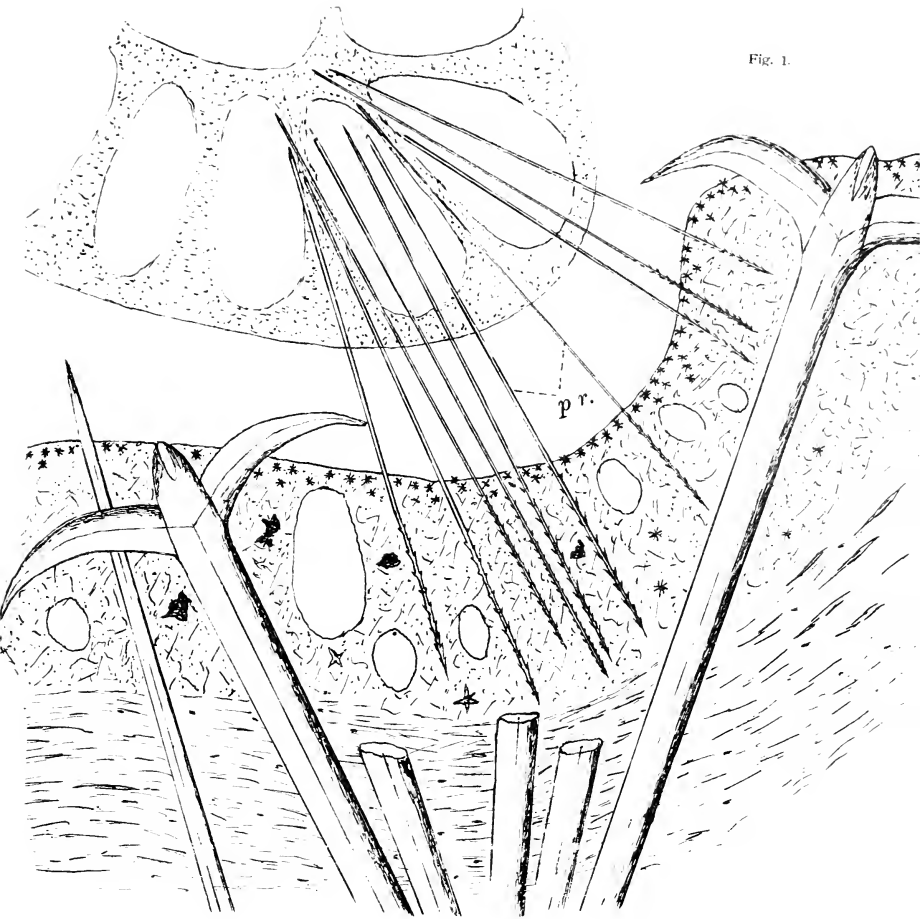


Fig. 2.

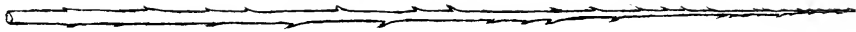


Fig. 3.

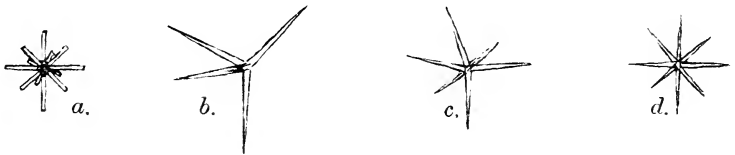
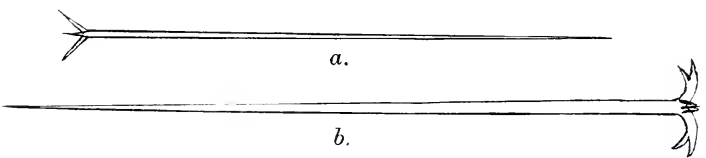


Fig. 4.



R. Hanitsch, del.

STELLETTA COLLINGSI, BOWERBANK.



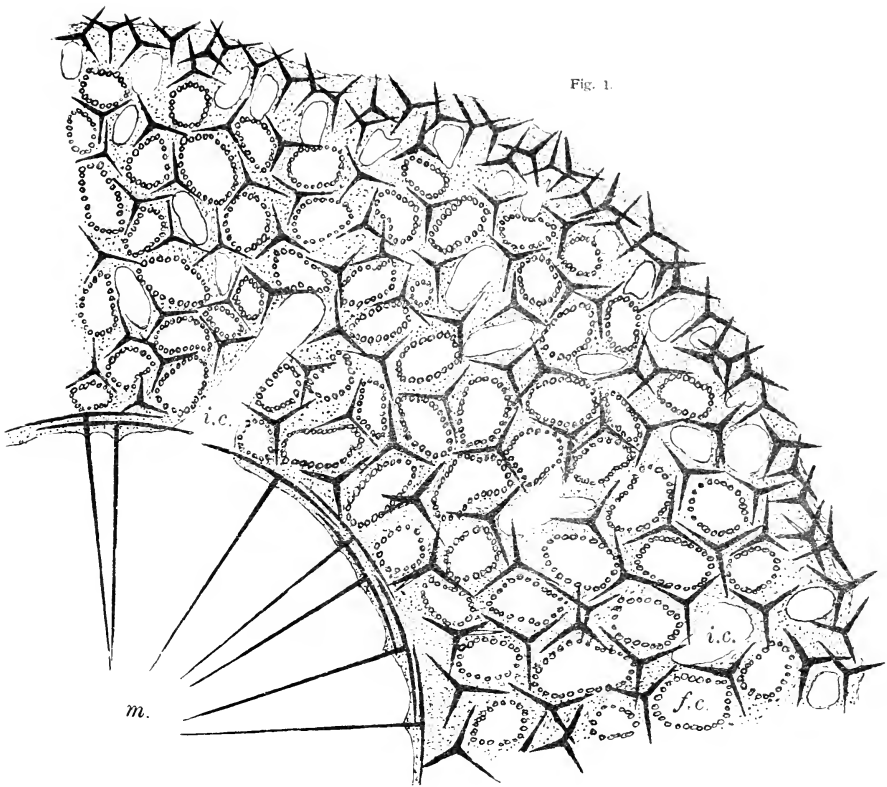


Fig. 1.

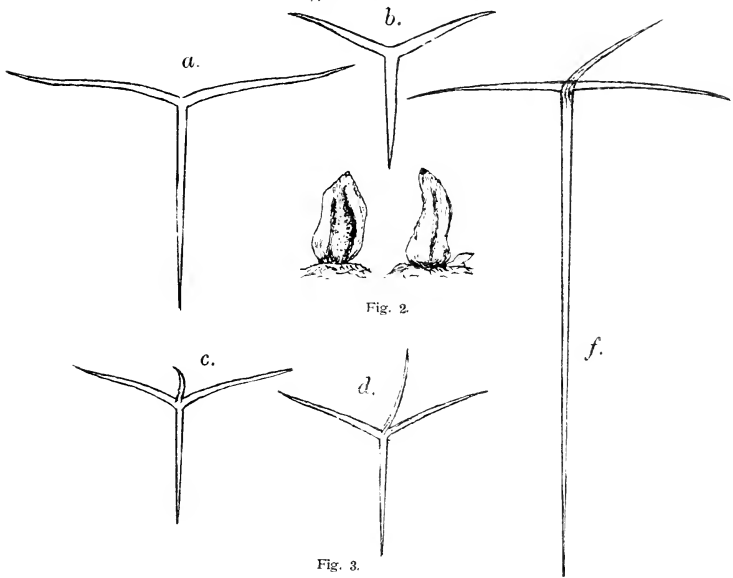
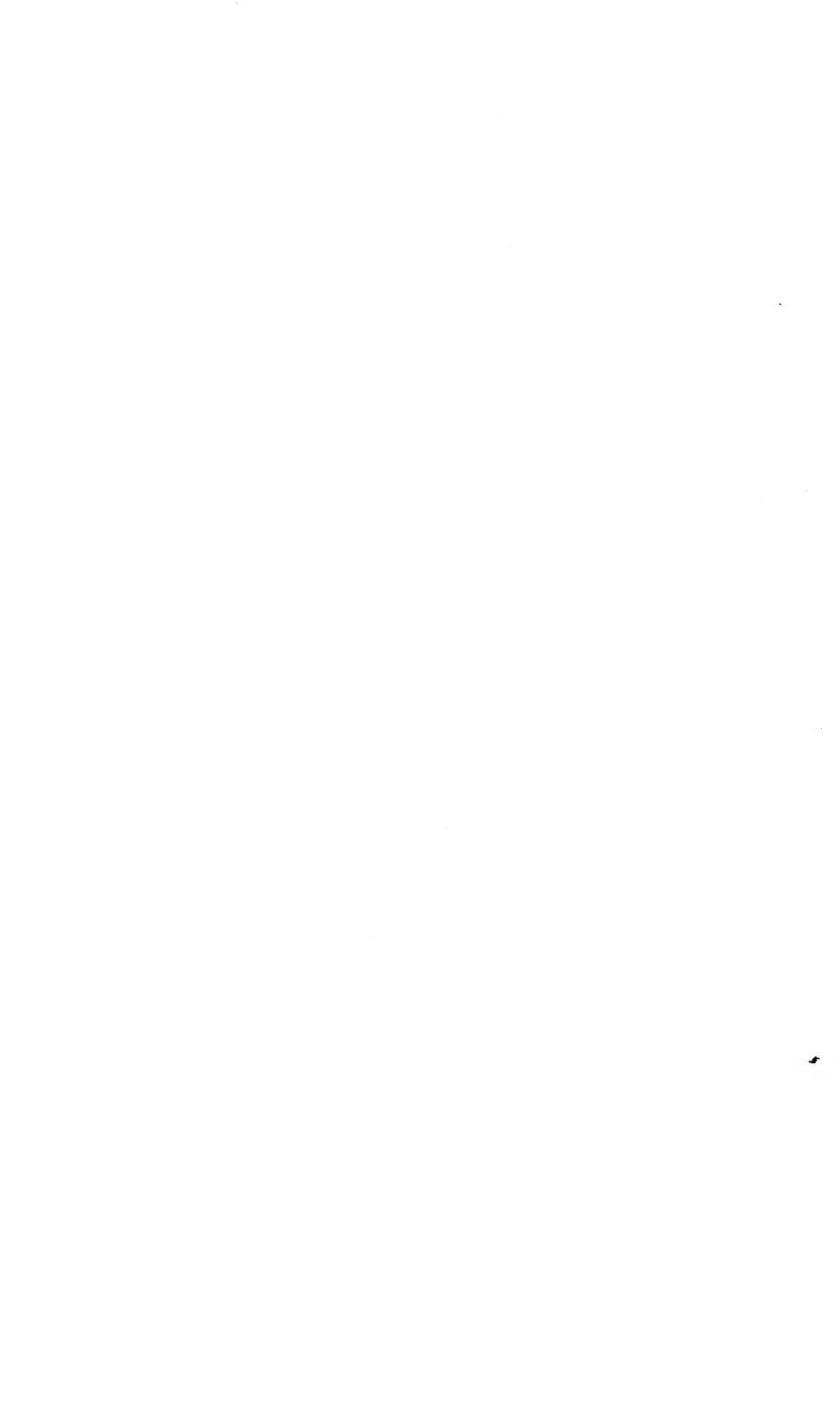


Fig. 2.

Fig. 3.

R. Hanitsch. del.

LEUCALTIS IMPRESSA. N. SP.



REPORT on the HIGHER CRUSTACEA of  
LIVERPOOL BAY taken in 1889.\*

BY ALFRED O. WALKER, F.L.S.,

With Plate XVI.

[Read May 9th, 1890.]

THE operations of the L.M.B.C. during 1889 have on the whole been very successful as regards the higher Crustacea, and especially the Amphipoda. Many new species have been added to the fauna of Liverpool Bay and a few to that of the British Isles.

Adopting the same plan as in the previous two Reports, the localities where work has been carried on may be enumerated as follows:—

- I. Puffin Island—chiefly shore hunting.
- II. Isle of Man, visited at Easter, when the electric light was used at various depths. These are indicated in the Report by E.L.b. and E.L.s. for the bottom and surface respectively.
- III. Colwyn Bay from the Little Orme (8 fath.) to Penmaenrhos. The greater part of the species collected here were obtained by using a small dredge with a frame of sheet brass 12in. long by 2½in. wide with a bag of “cheese-cloth” open at the tail end but closed by a wrapping of string. A small lead weight was attached to the dredge cord about 3ft. in front of the dredge. After dragging the dredge for a short time on sandy ground it would be brought up containing a considerable quantity of

\* See former Reports in “Fauna of Liverpool Bay,” Vol. I., 1886, pp. 221—226, and in Vol. II., pp. 171—181 and pp. 68—85.

sand. The bag was untied over a small bucket of sea water, into which the sand was dropped and, after being well stirred round with the sand, allowed to settle for a few seconds, when the water was poured through a muslin bag with a moveable  $\frac{1}{2}$ in. brass sieve over its mouth to stop the larger pieces of weed, &c. Most of the Crustacea pass into the bag with the water, and after repeating the stirring and straining process the sand is thrown away. The dredge is put out again as soon as it has been emptied and is working while the washing and straining is going on. The muslin bag containing the living animals collected is then everted into a wide-mouthed glass jar (a French plum jar is the best) filled with sea water. This may be taken home and the contents emptied into dishes when most of the Crustacea will swim out of the weed and sand that still remains and be captured by a small muslin ring net; or the bag may be at once turned out into a bottle of spirit, or spirit, glycerine and water, to be examined at leisure. The number of creatures that are taken by this method in places that are absolutely barren to the dredge with a net bag, is astonishing. I have to thank Dr. Norman for showing me this excellent device. In shore-hunting it was found a good plan to wash Algae in a bucket, pouring the water after several such washings through a muslin net which is then treated as above. This appears to be the best method of obtaining *Podocerus isopus* in March and April.

IV. The coast of Anglesey, from Puffin Island to Porthwen Bay (13 to 22 fathoms), "Spindrift" trip on June 8th. See Dr. Herdman's "Third Report on the Puffin Island Biological Station," p. 33.

V. The deep water (40 to 60 fathoms) between Holyhead and the Isle of Man, "Spindrift" trip on July 20. "Third Report on the Puffin Island Biological Station," p. 36.



VI. The shore at low tide in Moelfre Bay, Anglesey, where Mr. F. Archer made some collections in August.

The following species, not previously recorded in the several localities, were taken during 1889 :—

I. Puffin Island.

\* *Mysis ornata* (2)§, Sars. Off the Lighthouse ; one male.

*Janira maculosa*, Leach. W. Spit ; low-water.

*Jæra nordmanni*, Rathke. S. side of island ; low-water.

\* *Pleustes glaber* (12), Boeck. Shore ; Feb., I. C. T.

† *Tritæta dolichonyx* (13), Nebeski. On Compound Ascidians ; W. spit ; low-water, with *Tritæta gibbosa*.

\* *Microprotopus maculatus*, Norman. Turbot Hole, 15 fath.

\* *Corophium bonellii*, M. Edwards. Ditto ditto.

II. Port Erin, Isle of Man, Easter, 1889, "Hyæna", E.L.

= Electric Light ; s. = surface ; b. = bottom.

† *Siriella norvegica* (1), Sars. E.L. s. Several, chiefly males.

\* *Gastrosaccus spinifer*, Goes. do. A few males and females.

\* *Conilera cylindræa*, Montagu. One at sea (? on floating weed).

*Spheroma rugicauda* (?) (8), Leach. { Found together in a  
dead *Balanus* shell,

\* *Cymadocet emarginata* (8), Leach. { 1888, (W. A. H.)

*Tryphosa ciliata*, Sars. E.L., 5 fathoms. One young.

\* *Pontocrates haplocheles*, Grube. E.L. b. Three ; also one in 1888, at E.L. in Ramsey Harbour.

*Tritæta dolichonyx*, Nebeski. E.L. b. Six males.

*Halirages hispidus*, Bate. E.L. s. and b. Common.

*Calliopius leviusculus*, Krøyer. E.L. s. Several.

*Calliopius norvegicus*, Boeck. E.L., 5 fath. One female.

\* *Leucothoe spinicarpa*, Abildgaard. Four ; from branchial sac of *Ascidia venosa*, "Hyæna," May 20, 1888.

\* Not previously recorded in Fauna of Liverpool Bay.

† " " " " of Great Britain.

§ The numbers following the names refer to the succeeding notes, p. 244.

- Amathilla sabini*, Leach. E.L. s. Common.  
*Gammarus locusta*, Linn. ditto ditto.
- Fleshwick Bay, Isle of Man, same trip, shore.  
*Stenothoe monoculoides*, Mont. One.  
*Calliopius norvegicus*, Boeck. Several.
- III. Colwyn Bay, 2½ fath. to 8 fath. (Little Orme).  
*Gastrosaccus spinifer*, Goes.
- \* *Mysis neglecta* (3), Sars. Rhos Bay, low tide, June 15.  
 \* *Mysis inermis*, Rathke. Shore; Penmaen Rhos, Aug. 11. One adult.
- Mysis ornata*, Sars. Shore to 8 fathoms. Several.  
*Cuma scorpioides* (4), Montague. Little Orme, Sept. 18.  
*Iphinoe trispinosa*, Goodsir. Colwyn Bay; 2½ fathoms, sand. Several females.
- \* *Lamprops fasciata* (5), Sars. Colwyn Bay and Little Orme. Several, males and females.  
 \* *Diastylis spinosa* (6), Norman. Colwyn Bay.  
 \* *D. rathkei*, Kr. Two immature males; Little Orme; Sept. 18.  
*Pseudocuma cercaria* (7), van Beneden. Colwyn Bay. Abundant.
- Dynamene rubra*, Montague. Penmaenrhos shore.  
*Astacilla longicornis* (9), Sowerby. Little Orme, and shore Colwyn Bay, Sept. 2.
- † *Metopa rubro-vittata* (10), Sars. Little Orme. Several.  
*Stenothoe marina*, Bate. ditto One.  
*Amphilocheus manudens* (11), Bate. ditto Several.  
*Iphimedia obesa*, Rathke. Colwyn Bay. Scarce.  
 \* *Danaia dubia*, Bate. Little Orme. A few.  
*Monoculodes longimanus*, Bate and Westwood. Common in sand.  
*Megaluropus agilis*, Norman. Rather common.  
*Pleustes glaber*, Boeck. Little Orme. One.  
 † *Atylus falcatus* (14), Metzger. ditto, Colwyn Bay; a few.

*Microprotopus maculatus*, Norman. do., Rather common.

*Aora gracilis*, Bate. Little Orme and Colwyn Bay.

Rather common.

*Corophium bonellii*, M. Edwards. Little Orme. One.

*Dulichia porrecta*, Bate. Little Orme and C. Bay. Several.

*Podalirius typicus*, Kröyer, ditto ditto ditto.

IV. "Spindrifft" trip from Puffin Island to Porthwen Bay, Anglesey, June 8, 13 to 21 fathoms.

*Portunus pusillus*, Leach. Dulas Bay; three specimens.

*Ebalia tuberosa*, Pennant. ditto two ditto.

*Ebalia tumefacta*, Montague. ditto four ditto.

*Anapagurus hyndmanni*, Thompson. Two miles off Porthwen Bay. One small specimen.

\* *Galathea nexa*, Embleton. Two specimens.

\* *Crangon nanus*, Kröyer. Turbot Hole. Two females with ova.

*Crangon allmanni*, Kinahan. Three miles off Dulas Bay. One young.

*Mysis ornata*, Sars. Turbot Hole. One young.

*Mysis inermis*, Rathke (?). Dulas Bay. Young.

*Cuma scorpioides*, Montague. ditto. One female with ova.

*Lamprops fasciata*, Sars. Three miles off Dulas Bay. One female.

*Atylus falcatus*, Metzger. Off Red Wharf Bay. One female with ova.

\* *Lilljeborgia pallida* (15), Bate. Porthwen Bay. One.

*Photis longicaudatus*, Bate. Dulas Bay; one young female.

\* *Autonoe longipes*, Lilljeborg. One male.

*Podocerospis rimapalma*, Bate. A few males and females.

\* *Podocerus ocius*, Bate. Turbot Hole. Two females.

\* *Unciola irrorata*, Say. Several specimens.

\* *Unciola planipes*, Norman. Red Wharf and Dulas Bays. Several.

V. Second "Spindrifft" trip, 16 miles N. of Holyhead

July 20, 40 to 60 fathoms.

*Xantho rivulosa*, Risso.

*Galathea neva*, Embleton. Several.

*Galathea dispersa*, Bate. One.

\* *Hippolyte spinus*, Sowerby. One specimen.

*Pandalus brevis*, Rathke. One female.

*Pandalus annulicornis*, Leach.

*Janira maculosa*, Leach. Two.

*Euonyx chelatus*, Norman. Abundant on *Echinus sphaera*.

*Pleustes bicuspis*, Kröyer. Two.

*Tritacta gibbosa*, Bate. One.

*Ampelisca tenuicornis*, Lilljeborg. Two.

*Gammaropsis erythrophthalmus*, Lilljeb. One.

*Podocerus falcatus*, Montague, var. *pulchellus*. One.

*Erichthonius (Cerapus) abditus*, Templeton. A few, males and females.

“Hyæna” trip, May 21, 1888, 20 miles S.E. of Isle of Man, on sponge, 30 fathoms.

\* *Colomastix pusilla*, Grube. Two (= *Cratippus tenuipes*, Bate and Westwood = *Exunguia stilipes*, Norman, in Ann. and Mag. N.H., 4th ser., vol. iii., p. 59.).

VI. Moelfre Bay, Anglesey; low tide, Aug., F. Archer.

*Dynamene rubra*, Montague.

*Dynamene montagui*, Leach.

*Calliopius norvegicus*, Boeck. A few females.

*Deramie spinosa*, Mont.

*Amphithoe podoceroïdes*, Rathke. Abundant.

\* *Sunamphithoe gammaroides* (16), Bate. Several, males and females.

*Caprella acanthifera* Leach. Many, with well-developed spines.

#### NOTES ON THE ABOVE SPECIES.

1. *Siriella norvegica*, Sars.

To this species I refer several males and one or two

females taken with the electric light. The general characters and the peculiar tridentate spinule at the extremity of the telson agree with Sars' description. The spines, however, on the inner edge of the inner uropods agree rather with those of *S. crassipes*, Sars, (from which species this differs in its longer limbs) in having no small spines between the larger, all being nearly equal in size and set closely together, except towards the extremity. A female examined had three setæ on the inner margin of the last joint of the peduncle of the upper antennæ, and two setæ on the distal extremity of that joint, which agrees with Sars' figure. Length about 15 mm. from tip of antennal scale to tip of telson.

2. *Mysis ornata*, Sars.

In Report I., p. 221, I have erroneously recorded *M. spiritus* (Norman) for this species, which is not uncommon in Liverpool Bay. It may be known from *M. spiritus* by its short, thick eye-stalks, and by having only five joints in the tarsi of the anterior legs instead of seven to nine.

3. *Mysis neglecta*, Sars.

This species is sometimes abundant in tidal pools in June and July. The colour varies from the faintest tint of green (almost colourless) to dark olive-green. The greater number were grass-green. All had the peduncle and inner branch of the upper antennæ, the eyes, and tips of both branches of the uropods, golden-yellow. The fringes (setæ) of the antennal scales and uropods were red-purple. A large living specimen, which was of the usual pale grass-green when taken out of the white dish in which it was swimming, placed in a watch-glass on a black glass plate, became in about an hour dark olive-green, while a smaller and almost colourless specimen lost what little colour it had. Some specimens were much infested on the head and thorax by an *Epistylis*. This species differs

from *M. flexuosa* (Müller) in having only five joints in the anterior tarsi instead of six, and in the antennal scale being barely twice as long, instead of more than twice as long, as the peduncle of the upper antennæ.

#### 4. *Cuma scorpioides*, Mont.

I have referred the specimens taken to this species as the oldest. Nevertheless if Sars is correct in saying that this species is distinguished from *C. edwardsi*, Goodsir, (among other characters) by the inner branch of the uropods consisting of one single joint instead of two joints as in *C. edwardsi*,\* then our specimens should be referred to the last-named species. Sars also states that *C. edwardsi* may be distinguished from *C. scorpioides* “by its shorter length and by its dark brown-violet colour.”† But all my specimens, except one, are of a sandy colour, and that one, which is almost black, was taken at the same time and place as two or three sandy-coloured individuals, from which it does not differ in structure. Hoek appears to be doubtful whether these two forms are specifically distinct.‡ Goodsir’s description§ of *C. edwardsi* and *C. audouinii* is so full of errors that it is impossible to make much of it. The figure of *C. audouinii* shows indications of pleopoda, which are not mentioned in the description, and I am inclined to think that one of the above species is the female and the other the immature male of *C. scorpioides*. The “thumb-like process” of the “first pair of legs” (the third maxillipedes) is merely the external extremity of the first joint, and is, of course, not jointed at all. No such jointed process at the extremity of this, as described and figured by Goodsir, exists in the Cumacea,

\* Middlehavet’s Cumaceer, p. 21.

† Oversigt af Norge’s Crustaceer, p. 55.

‡ Nederlandsche Dierkundige Vereen., 1889, Deel 2, p. 2.

§ Edinburgh New Phil. Journal, 1843; vol. 34, pp. 123—6. pl. ii. & iv,

yet he makes the difference between the above two species largely to depend on the number of joints in it. Until it is proved more clearly than it seems to be at present, that there is more than one species having the characteristic raised lateral line on the carapace and free thoracic segments parallel with the dorsal outline, I must incline to the opinion that both the above species should be referred to *C. scorpioides* (Montague). It is to be noted that the two species of Goodsir are evidently both straw-coloured, which does not agree with Sars' definition.

5. *Lamprops fasciata*, Sars.\* (Pl. XVI., figs. 1-3.)

Several specimens were taken, mostly females. The largest female measured  $7\frac{1}{2}$  mm. from point of rostrum to tip of telson. Sars, who describes the female only, gives  $4\frac{1}{2}$  mm. as the length. In the male the carapace equals in length the first three thoracic segments. The lower antennæ reach to the end of the second free thoracic segment; the peduncle is thick and densely furred on the upper side. This species resembles *Pseudocuma cercaria* in having three oblique striæ or folds on the sides of the carapace, but it may be at once distinguished by its well developed telson and larger size. The peduncle of the uropoda has eight spines on the inner margin, of which the six distal are compound, i.e., are themselves spinous. It has been taken by Mr. D. Robertson in the Firth of Clyde, and at Tarbert, Loch Fyne.

6. *Diastylis spinosa*, Norman (Brit. Ass. Report, 1868, p. 271.).

*Diastylis bimarginatus*, Bate (A. & M.N.H., ser. 5, vol. i., p. 409, and cut).

„ „ Sim ( „ „ ser. 5, vol. ii., p. 453, pl. xviii).

*D. bradyi*, Norman (Ann. and Mag., N.H., ser. 5, vol. iii., p. 59).

There can, I think, be no doubt that *D. bradyi* is the female of *D. spinosa*. Although adult males are rare, yet,

\* Om den aberrante Krebsdyrgruppe Cumacea, &c., p. 191; and Norman, Ann. and Mag. N. H., 1887, p. 100.

as a few of these and *no other adult males* and a large number of *D. bradyi*—all females or immature males, and *no other species of female*—have been taken together in Colwyn Bay on more than one occasion, it is impossible to suppose that they can be other than the same species. Prof. G. O. Sars, to whom I sent specimens, has been good enough to inform me that he was misled by a damaged specimen of *D. spinosa* in referring to it as its female *D. echinata*, Bate.\* He adds, “I now regard your identification of *D. spinosa* as the adult male of *D. bradyi* to be most likely correct.” The immature male attains its full growth before acquiring the spinous pleon of the adult, this being, until the last moult, even less spinous than in the female.

7. *Pseudocuma cercaria*, van Beneden.

Very abundant in sand; Colwyn Bay.

8. *Cymadocea emarginata*, Leach.

*Spheroma rugicauda*, Leach.

These were found together in a dead *Balanus* shell, a circumstance which lends support to Hesse's opinion that *Spheroma* is the female of *Cymadocea*.†

9. *Astacilla longicornis*, Sow.

*Arcturus longicornis*, Bate and Westwood.

Two specimens were taken, one at low-water with the young (which, being cream-coloured, contrasted strongly with the dark brown parent) attached to the long outer antennæ, as described by Bate and Westwood, by their hind legs. They sometimes left their perch and returned to it after swimming about. This species has been recorded from the mouth of the Dee by Mr. Byerley.

10. *Metopa rubro-vittata*, G. O. Sars.

This appears to be rather a common species in Colwyn Bay. Two or three specimens were beautifully and

\* “Challenger” expedition, Zoology, Report on Cumacea, p. 50.

† Ann. des Sciences Nat., 5th ser., vol. xvii., p. 1, &c.



regularly spotted or speckled with bright crimson.

11. *Amphilocheus manudens*, Bate.

As illustrating how little dependence can be placed on colour in the determination of species, I may mention that among several specimens taken at the same time all, except one, *which was bright scarlet*, were mottled with brown, and in one or two instances, almost entirely black.

12. *Pleustes glaber*, Boeck.

*Pleustes (Paramphithoe) assimilis*, G. O. Sars.

It appears to be somewhat doubtful whether these are specifically distinct. The principal distinction is in the hinder angle of the third pleon segment, and this is variable in the few specimens I have, which seem rather referable to the var. *assimilis*. Mr. D. Robertson also suggests the identity of the two species.\* I prefer to retain the older genus *Pleustes*, as expanded by Boeck, in place of *Paramphithoe*, for which there seems to be no necessity.†

13. *Tritata dolichonyx*, Nebeski. (Pl. XVI., figs. 4 and 6.)

I have little doubt that this is the adult male of *T. gibbosa* (Bate). Only the males appear to have the characteristic excavation in the anterior edge of the hand of the second gnathopods, and both Mr. D. Robertson † and myself (Puffin Island, on Compound Ascidians) have taken them associated with *T. gibbosa*. It has been taken in the Adriatic and the Canary Islands. §

14. *Atylus falcatus*, Metzger. ||

*A. uncinatus*, G. O. Sars (Oversigt af Norges Crust., p. 101, pl. v., 1882).

*A. falcatus*, Hoek (Tijdschrift der Nederland. Dierk. Vereen, 1889, Deel ii., p. 26, pl. viii).

\* A Contribution towards a Catalogue of the Amphipoda and Isopoda of the Firth of Clyde. Trans. of the Glasgow Nat. Hist. Society, 1888, p. 94.

† "Challenger" Report on Amphipoda. Stebbing, pp. 424—870.

‡ Stebbing l.c., p. 520.

§ Walker, "Proc. Liverpool Biol. Society," Vol. II., p. 130 (1888).

|| Die wirbellosen Meeresthiere der ostfriesischen Küste. Hannover, 1871.

This species has occurred in two localities in the district. The single specimen from Red Wharf Bay (an ovigerous female) agreed with Sars' figure in having no dorsal teeth on the first three pleon segments as shown by Hoek. Those from Colwyn Bay, on the other hand, agreed with Hoek's figure in this respect. Both differed from Hoek's figure and agreed with Metzger's description and Sars' figure in having the hinder angle of the first three pleon segments produced backwards as a small tooth. The Red Wharf Bay specimen measured 6 mm.; an ovigerous female from Colwyn Bay 5 mm. None of my specimens have the remarkable first peræopod hairy, as shown in Hoek's figure. Mr. Stebbing, on the faith of Sars' description, has suggested that this species ought probably to be referred to the genus *Tritæta*,\* but the presence of a mandibular palp seems to preclude this. Its general aspect also is much more that of an *Atylus* than a *Tritæta*.

15. *Lilljeborgia pallida*, Bate.

According to Bate and Westwood the third uropods "have the branches much shorter than the peduncle," while Boeck says they are "paulo longiores." My specimen agrees with Boeck.

16. *Sunamphithoe gammaroides*, Bate.

*Amphithoe gammaroides*, Bate and Westwood (Brit. Sess. Crust., p. 427).

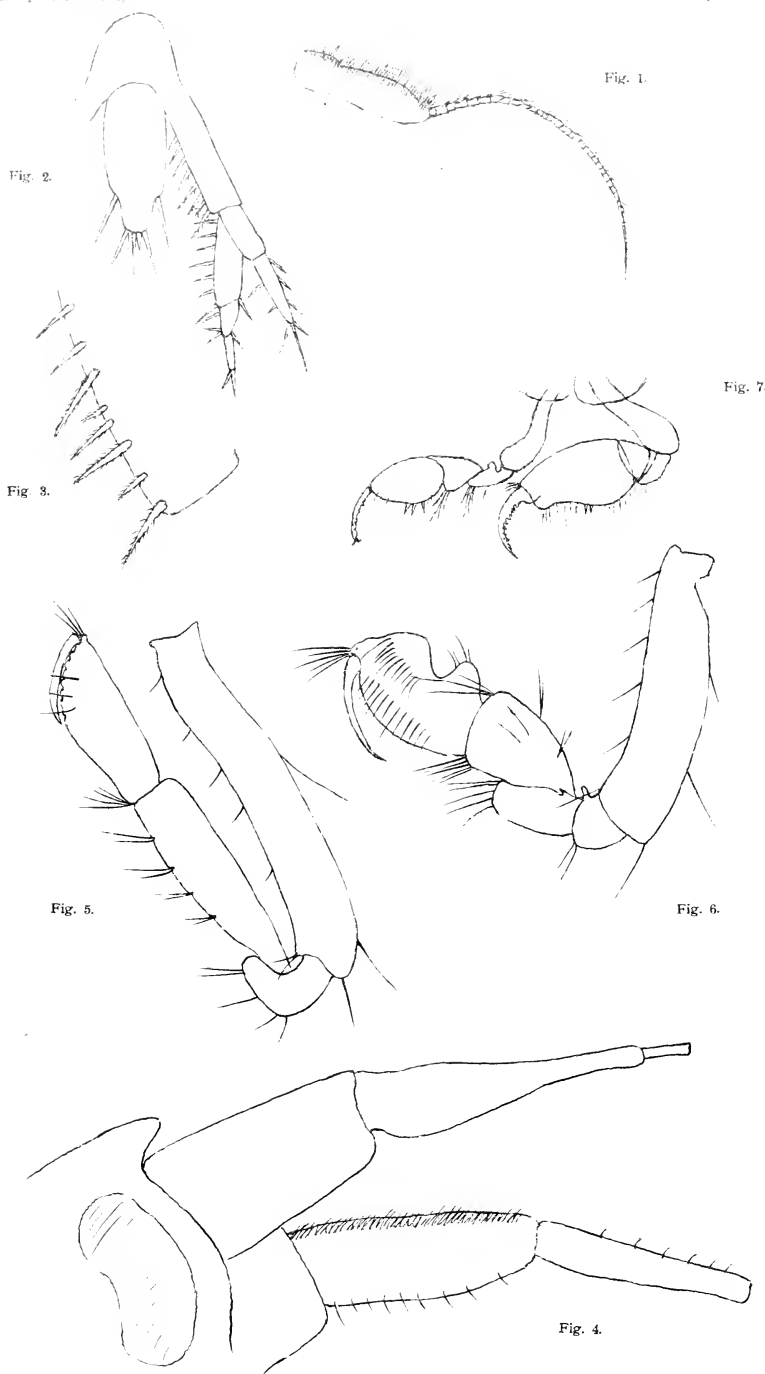
*Sunamphithoe gammaroides*, Stebbing (Ann. and Mag. N.H., 4th ser., vol. xiv., p. 114, pl. 11 and 12).

This would appear to be a rare species. It is not in Dr. Norman's catalogue.

17. *Podocerus isopus*, Walker. (Pl. XVI. fig. 7.)

I have this year for the first time met with the adult male of this species. The second gnathopod is much larger in proportion to the first than in the immature male and female. The palm, however, is distinctly convex, and

\* "Challenger" Report on Amphipoda, p. 941.



FIGS. 1-3. *LAMPROPS FASCIATA*, SARS.  
FIGS. 4-6. *TRITÆTA GIBBOSA*, BATE.  
FIG. 7. *PODOCERUS ISOPUS*, WALKER.



the hand cannot be described either as "*curvata*" (Boeck) or "*arcuata*" (Kröyer), the terms used by these two authors in their descriptions of *Podocerus anguipes* (Kröyer), which, in other respects (except size), this species much resembles. It occurred abundantly in tidal pools at dead low water in April.

EXPLANATION OF PLATE XVI.

Figs. 1-3. *Lamprops fasciata*, Sars, adult male.

Fig. 1. Lower antenna.

2. Telson and right uropod.

3. Inner edge of peduncle of uropod.

Figs. 4-6. *Tritata gibbosa*, Bate (= *Tritata dolichonyx*, Nebeski), adult male.

Fig. 4. Peduncles of upper and lower antennæ.

5. First gnathopod.

6. Second do.

Fig. 7. *Podocerus isopus*, Walker, adult male; first and second gnathopods.









FOURTH ANNUAL REPORT of the LIVERPOOL  
MARINE BIOLOGICAL STATION on  
PUFFIN ISLAND.

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[Read 14th November, 1890.]

THE YEAR.

THE past year, although rather an uneventful one, can show its fair share of work done both at Puffin Island and also by means of dredging expeditions in Liverpool Bay. In accordance with the decision of the Committee expressed at the end of last year's report, the Puffin Island Biological Station was closed from the beginning of November till the middle of March, but although it seemed best to do this under the special circumstances of the time, the Committee hope that they may never require to close the station again. The interruption to work and the disorganization of arrangements was considerable, extra trouble and fresh expense were caused at the re-opening in spring; and although the former keeper, who had obtained a temporary situation in Liverpool during the winter, came back to the Station and was in charge most of the summer, he had evidently become unsettled and no longer displayed that single-minded devotion to Biology which is essential in such a situation. Later in the summer he became engrossed in other matters which occupied his time and energies to an extent quite incompatible with any further tenure of the Puffin Island post,

and consequently he had to leave the employ of the Committee. He has been succeeded as keeper by Thomas Jarrett, who was at one time an assistant at the Biological Station and left, of his own accord, for the purpose of getting married—after which he went to sea.

Jarrett and his wife have now been in charge of the Station for some weeks, and are carrying on the work of taking observations and making collections very satisfactorily. Only a few days ago, by taking a tow-netting off Puffin Island in the very early morning before it was light, he obtained a number of specimens of the interesting phosphorescent Schizopod *Nyctiphanes norvegica*, which had never been found before in our district.

#### STATION RECORD.

The following Naturalists have been working at the Biological Station for longer or shorter periods during the present summer :—

DATE.	NAME.	WORK.
1890.		
April.	I. C. Thompson, F.L.S., Liverpool	Copepoda.
—	R. J. Harvey Gibson, F.L.S., University College, Liverpool	Alge.
—	G. A. Burrow, Botanical Assistant, Liverpool	Alge.
May.	I. C. Thompson, F.L.S.	Copepoda.
—	George Brook, F.L.S., University of Edinburgh	Embryos of Molluscs.
—	W. A. Herdman, University College, Liverpool.	Nudibranchs and Tunicata.
—	R. J. H. Gibson, F.L.S.	Alge.
—	Nath. Caine, Liverpool	General.
—	A. J. Ewart, University College, Liverpool	Alge.
—	J. Hornell, Liverpool	Polychaeta
—	J. Lomas, Liverpool	Polyzoa.
—	Percy F. Kendall, Manchester	Mollusca.

[A number of others forming the dredging party on the "Hyæna" expedition of May 23rd paid a passing visit to the Station.]

<i>June.</i>	J. Hornell, Liverpool	...	...	...	...	Polychaeta.
—	R. J. Harvey Gibson, F.L.S.	...	...	...	...	Alge.
—	George Murray, F.L.S., British Museum	...	...	...	...	Alge.
—	L. N. Boodle, R. Coll. of Sci., London	...	...	...	...	Alge.
—	E. A. L. Batters, F.L.S., London	...	...	...	...	Alge.
—	H. C. Chadwick, Manchester	...	...	...	...	Echinoderms.
<i>August.</i>	J. Vicars, Bootle	...	...	...	...	Land Plants.
—	J. A. Clubb, University College, Liverpool	...	...	...	...	Nudibranchs.
—	E. Briscoe, Liverpool	...	...	...	...	General.
—	A. Butchart, Liverpool	...	...	...	...	General.
—	A. T. Watson, Sheffield	...	...	...	...	General.
<i>Sept.</i>	Miss L. R. Thornely, Liverpool	...	...	...	...	Hydroida.
—	Miss J. H. Willmer, Birkenhead	...	...	...	...	Polyzoa.
—	Miss M. Beaumont, Liverpool	...	...	...	...	General.
—	W. Thornely, Liverpool	...	...	...	...	General.
<i>October.</i>	I. C. Thompson, F.L.S.	..	...	...	...	Copepoda.
—	R. J. Harvey Gibson, F.L.S.	...	...	...	...	Alge.
—	W. A. Herdman.	...	...	...	...	Tunicata and Nudi- branchs.
—	Alfred Leicester, Southport	...	...	...	...	Land Mollusca.

This list happens to contain exactly the same number of entries as the corresponding one for 1889, but in the present year the Station was not open for work until April. The absence of any workers during July may be partly accounted for by the general bad weather during that month, and by the specially bad weather on July 12th when several of the Committee who intended to work for some time at the Station started with a dredging expedition in the steamer "Spindrift" but could not be landed at Puffin Island and were brought back in the evening to Liverpool.

The sailing boat "Bonnie Doon", the black rowing boat "Ascidian" and the small blue punt are still in serviceable condition and have been in constant use during the season. The fixed work-table and shelving in front of the window in the room opening off the kitchen, and the sleeping bunks in the inner room, were put up early in the

year and have proved useful additions to the somewhat meagre accommodation at the Station.

#### PUBLICATIONS.

Since the last Report no new volume of the "Fauna"\* has been issued, but several L.M.B.C. papers have been communicated in the usual way to the Biological Society and published in the Transactions. Extra copies of these in sheets have been printed off for the purpose of being included in the third volume of the "Fauna" which will probably be ready some time in 1892. These papers are:—(1.) a third report by Dr. R. Hanitsch, on the Sponges of the district, a lengthy paper illustrated by six plates, adding twelve species to our record and three species new to science, containing a re-description of the remarkable *Seiriola compacta* from the caves on Puffin Island, and giving an account of the enormous masses of *Cliona celata* obtained off Rhoscolyn, on the west coast of Anglesey, during the "Hyæna" cruise of May, 1890; (2.) a list of the land Mollusca of Puffin Island, by Mr. Alfred Leicester; (3) a report (one plate) by Mr. Alfred O. Walker on the Higher Crustacea collected during 1889, containing some notes on Cumacea, and a description for the first time of the adult male of the Amphipod *Podocerus isopus*; (4) a paper by Mr. I. C. Thompson, on the remarkable Copepod genus *Monstrilla* and the family Cymbasomatidæ; and (5) the third report on the Nudi-branchiata, by Professor Herdman and Mr. J. A. Clubb, with four plates, and containing some further investiga-

\* Volume I. of the Fauna of Liverpool Bay, price 8/6, was published in 1886. It contains 372 pp. and 12 plates. Vol. II., price 7/6, and containing 240 pp. and 12 plates, was issued in July, 1889. Copies of these may be obtained on application to the Liverpool Marine Biology Committee, University College, Liverpool.

tions into the structure and functions of the cerata or dorsal papillæ, a discussion of the condition of the epipodia in various genera, and an account of some experiments made at the Liverpool Aquarium in feeding fishes with certain Nudibranchs.

A number of additional L.M.B.C. reports are well advanced and will be laid before the Biological Society in the course of the present session. Amongst these may be mentioned,—an extensive report by Mr. Harvey Gibson on the Algæ, in the preparation of which Mr. Gibson has been fortunate enough to secure the assistance of Mr. E. A. L. Batters, Mr. George Murray and other celebrated algologists; and a report upon the Polychæta, on which Mr. J. Hornell has been engaged for a couple of years, and in which upwards of 70 species will be discussed, at least half of which are additions to the Fauna. The long expected report upon the Fishes of the district, by Mr. Moore, will, it is hoped, be soon completed; and we welcome as new recruits Dr. C. Herbert Hurst, of Owens College, who has taken charge of the Pycnogonida, and Mr. F. Archer, who has been a valued friend and critic and a member of our Committee from the beginning, and who is now responsible for the Testaceous Mollusca and has already added considerably to the records published by Mr. Darbishire in our first volume of “The Fauna.”

#### SURFACE ORGANISMS.

The weekly records filled up by the keeper show that the gelatinous surface Algæ referred to in last year's report have again been present in abundance. This condition of the sea was first noticed on June 6th, and continued with intermissions until September 6th, when it finally disappeared. According to Mr. A.W. Bennett, to whom it has been

submitted, the brown gelatinous matter is a Diatom allied to *Rhizosolenia*, but in a peculiar condition being without its siliceous covering. Mr. Thompson noticed the abundance of small drum-shaped greenish-brown Algæ in the tow-nettings which he examined from June 7th onwards. Ctenophora have been present in profusion on the surface throughout the summer. Mr. T. Comber, F.L.S., has examined some of this year's surface gatherings for Diatoms, and finds by far the most prevalent form in the samples he received is *Biddulphia baylii* (96 per cent. in gatherings taken in May). However, his further observations are reserved until more material has passed through his hands. The surface Dinoflagellata (*Ceratium tripos* and allied forms) which are sometimes present in great abundance are now being investigated by Mr. I. C. Thompson.

The Puffins (*Fratercula arctica*) are still abundant. They came to the island this year in the last week of April, and left about the middle of August.

#### THE SEA-WEEDS OF THE DISTRICT.

Investigations on the Algæ of Puffin Island and the neighbourhood are now being carried on very actively by Mr. Harvey Gibson, who tells me that he has on record 275 species in all, of which 70 are additional to his former report. Early in April Mr. Thompson, Mr. Gibson and the Botanical Laboratory Assistant, Geo. Burrow, went to the Island for the Easter holidays. Mr. Thompson worked the surface successfully, taking gatherings by moonlight round the Island (when *Zaus spinatus* and other forms were taken), and also leaving a tow-net out all night attached by a rope 20 feet long to the "D. B." or Dinnor buoy, about one mile out to sea from Dinnor Point, Anglesey. This net was found when examined 24 hours after to have caught an enormous

quantity of surface organisms, the greater number being Copepoda, and these chiefly *Temora longicornis*, *Centropages hamatus*, *Pseudocalanus elongatus* and *Calanus finmarchicus*; with these were a quantity of *Peltidium depressum*, a littoral species usually found attached to *Laminaria*, but apparently swimming on the surface during the early morning hours. A large number of Cumacea (3 species) were also in the tow-net and several Schizopoda, Amphipoda (5 species) and some *Sagitta*. The net, although kept extended near the surface by the strong tide, probably sank at the slack tide near to the bottom so as to have taken Cumacea and such a feebly-swimming Amphipod as *Dulichia porrecta*.

Mr. Gibson occupied himself with the Algæ, examining especially the Beacon rocks, the Sponge caves and shelving rocks on the north side of the Island, the caves at Dinmor Point and the D. B. buoy, where he was fortunate enough to find, along with many common forms, over 20 of the rarer species, including *Lynghya gracilis*, *Dermocarpa prasina*, *Entocladia wittrocki*, *Epicladia flustræ*, *Pringsheimia scutata*, *Calliblepharis jubata*, and *Ahnfeltia plicata*, new to our district, and one, *Rhodochorton seiriolanum*, new to science. Mr. Gibson again visited the Island towards the end of May along with Mr. Ewart, and made further collections of Algæ from the rocks, chiefly of the North side and N.E. Spit, including *Callithamnion corymbosum*, *Ceramium acanthoutum*, *Griiffithsia setacea*, *Ralfsia verrucosa*, *Hildenbrandtia rosea*, and *Polyides rotundus*.

Later on (June 21st), an important party of Botanists, consisting of Mr. George Murray, F.L.S., of the British Museum; Mr. L. N. Boodle, Demonstrator of Botany at the Royal College of Science, London; Mr. E. A. Batters, F.L.S.; and Mr. Harvey Gibson, visited the station with the object of prosecuting further researches on the Algal flora of the Island. As this was the first occasion on which the

marine plants had received the attention of an algologist so skilled as Mr. Batters, it was to be expected that many rarities would be collected and many additions made to the preliminary list already published. The party utilised every low tide occurring during their stay, and although the tides were by no means very favourable, yet at least 150 species were collected, including:—*Ascocyclus reptans*, *Isthmoplea sphaerophora*, *Symploca harveyi*, *Ectocarpus terminalis*, *Laminaria hyperborea*, *Lithophyllum lenormandi*, *Punctaria tenuissima* *Chantransia secundata*, *Phyllophora trillii*, *Callithamnion gracillimum* and *Dictyota dichotoma*, var. *intricata*. A form hitherto undescribed and forming the type of a new genus was discovered by Mr. Batters encrusting the stems of *Cladophora pellucida*, and will be described by Bornet and Batters under the name of *Schmitziella endoplaea*, n.sp. and n. gen. One of the richest localities on the island is undoubtedly the deep gully on the north-east side, and there, and in the deep rock pools on the east Spit, the best finds were made. Altogether the two days' work was productive of no less than 27 species new to the district, of which one is new to science. Mr. Gibson and Mr. Batters visited Hilbre Island in July and examined the rocky parts of the Island. Their chief finds were:—*Sphaecelaria radicans*, *Litosiphon pusillus*, *Prasiola stipitata*, and several species of Cyanophyceæ.

Mr. J. Vicars visited Puffin Island again this year for the purpose of collecting land plants (see Appendix A. to last year's report, p. 43). He chose his time so as to be a couple of months later in the year than on his previous visit, but was not able to make any additions to the list.

In a final visit to Puffin Island at the end of October, Mr. Gibson found on the S.W. Spit, *Rhodochorton membranaceum*, *Rhodymenia palmata*, *Prasiola stipitata*, and many species already noted from Hilbre Island, and elsewhere,



but new to this locality. On this occasion also the cystocarps of *Catenella opuntia*, which have been seldom seen before, were found in abundance.

#### ZOOPHYTES, ANNELIDS, &C.

Before the "Hyæna" dredging expedition in May, a party of eight members of the Committee and others, including Mr. George Brook, F.L.S., Lecturer on Embryology in the University of Edinburgh, worked at the station; and a week later Mr. J. Hornell, who had been on the "Hyæna" trip, left the rest of the party at Bangor and then devoted some time to the investigation of the Annelids first of the mud flats about Garth, where he found several species new to the district, and secondly at Puffin Island. Amongst the most notable forms collected on this occasion by Mr. Hornell were *Dasychone lucullana*, *Serpula reversa*, *Sigalion boa*, *Trophonia plumosa*, *Phyllodoce laminosa*, *Flabelligera affinis*, *Scoloplos armiger* and a specimen of the curious and aberrant *Spherodorum flavum*. The most abundant Polychæta on the shore at Puffin are *Eulalia viridis*, *Nereis pelagica*, *Polydora lagisca*, and a *Cirratulus*. The Gephyrean worm *Phascolosoma vulgare* also occurs in mud under stones on the south Spit (October 26th, 1890).

Mr. Chadwick collected at Beaumaris and at Puffin Island towards the end of June, and had a couple of days dredging from the Turbot Hole upwards to the straits; and Mr. J. A. Clubb and others did some work at the station in August. Mr. Chadwick dredged a fine *Chalina oculata*, eight inches in height, four examples of *Pilumnus hirtellus* each ensconced within a separate whelk shell, many *Clavelina lepadiformis*, which is very abundant near Beaumaris, and some *Cucumaria planci* which have since reproduced by transverse fission in captivity, three of them

having now become seven in number (see Trans. L'pool Biol. Soc., vol. V., 1890-91).

Early in September, three lady students of University College, Liverpool, Miss L. R. Thornely, Miss J. H. Willmer, and Miss M. Beaumont, accompanied by Mr. W. Thornely, spent a week at the Station chiefly in collecting and preserving material and in examining the Hydroids and the Polyzoa, at which Miss Thornely and Miss Willmer had been working for some time previously.

Miss Thornely has examined and identified nearly all the collections of Hydroid Zoophytes and Polyzoa made in the various expeditions during the year, and reports to me that we have now found 71 species of Hydroids in the L.M.B.C. district, and of these 34 have been found on the shores of Puffin Island. Among the rarer forms found recently may be mentioned: *Hydranthea margarica*, *Sertularella tenella*, *Campanularia hincksii*, *Gonothyræa gracilis*, *Aglaophenia tubulifera*, and *Plumularia echinulata*. During her work at Puffin Island Miss Thornely found the following four species of Polyzoa which had not been previously recorded, viz., *Lepralia pallasiana*, *Cellepora avicularis*, *Pedicellina cernua*, and *P. gracilis*. Miss Thornely has also identified 25 species of Polyzoa found by Mr. F. Archer at Bull Bay.

In April, Dr. Hanitsch, Mr. Hornell, and Mr. C. H. H. Walker spent some time in collecting at Port Erin, Isle of Man, where they succeeded in getting some remarkably fine specimens of *Pachymatisma johnstoni* and other species of sponges, including two new to the district, viz., *Reniera ingalli*, B., and *Chalina montagui*, J., the latter an extremely fine specimen, equal to if not surpassing in size any specimen of the species ever recorded. In fact Dr. Hanitsch considers that in sponges this year has been remarkable rather for the number of fine specimens obtained than for

additions to the list of species. Those collected during the "Hyæna" expedition will be referred to further on.

#### PROTECTIVE COLOURING.

The important and now popular subject of the relations existing between the forms and colours of animals and their environment has received a good deal of attention at Puffin Island, and various instances of protective and warning colours have been noted in the reports. There are two additional cases of "procrptic" colouring (according to Poulton's excellent system of nomenclature) which seem worthy of record, viz., the small flat-clawed crab *Porcellana platycheles* and the Annelid *Eulalia viridis*.

*P. platycheles* is very common on the shores of Puffin Island and is generally found on the under surfaces of irregular fragments of carboniferous limestone. A dozen or more specimens may be exposed on turning over a large stone, but until one is aware of the concealment, the crabs are so inconspicuous that they usually escape notice. They place their flat bodies in slight depressions on the stone, and the dirty greyish-brown colour of the carapace corresponds exactly with the muddy surface of the decaying limestone, while to still further aid this protective resemblance, the strong hairs with which the limbs are fringed entangle mud particles and other foreign bodies and so help in grading off the body of the crab into the surrounding stone. And then the habits of the animal come in: *P. platycheles* is a peculiarly sluggish crab, and certainly in many cases its salvation must depend upon lying quiet. When the stone is turned over the crabs usually "sham dead" or rather, in this case, "sham rock," and so long as they remain motionless are very inconspicuous indeed. It is obvious that in such a case the more sluggish the animal is in time of danger the greater

is its chance of escape, and very probably the habit of lying quiet has been acquired for this purpose by the action of natural selection. The ventral surface of the crab is white, in marked contrast to the dark coloured back, and this I believe is also protective. When stones are turned over or shaken a certain number of crabs lose their hold and fall on their backs. They then lie still with the white ventral surface exposed and are readily mistaken for the white worn fragments of shells and chips of rock found imbedded in the mud under such stones.

*Eulalia viridis* is a Phyllodocean worm of a brilliant green colour which is very common on the shore at Puffin Island in the crevices of rocks and in the holes made by *Saricava rugosa*, and is often seen hanging in a loose coil or festoon from an overhanging ledge or from the under surface of a stone. It is of course, when seen by itself or when attention has been drawn to it, a conspicuous object on account of its colour, but when lying upon green seaweeds it is very effectually concealed. Very frequently, however, the worm occurs amongst red and reddish-brown seaweeds where it naturally forms a contrast with its surroundings. In such cases it bears considerable resemblance to the tufts of the green filamentous Alga *Cladophora rupestris* which are seen scattered about amongst the red seaweeds. You may look at a tangled green bunch which seems to be an Alga and wonder what it is that is slightly unusual in its appearance, when perhaps one of the coils will slowly move and the apparent seaweed resolves itself before your eyes into a specimen of *Eulalia*. It is wonderful how easily even the practised eye of a naturalist may be deceived by these resemblances, and I have no doubt it is the same with the eye of the careless fish or other passing enemy.

## NUDIBRANCHIATA.

Mr. Clubb and I have been carrying on our observations on Nudibranchs during the last year whenever opportunity offered. We went to Hilbre Island on February 20th, to attend the 20-foot tide. Although low water was not till 6 p.m. when it was rather cold and dark, we succeeded in finding the following species:—*Eolis papillosa* (spawning), *Acanthopsole coronata*, *Coryphella rufibranchialis*, *Cuthona nana* (?), *Galvina picta* (two distinct colours), *Dendronotus arborescens* (many of all sizes), *Ancula cristata* (very abundant, and spawning) and *Doris bilamellata* (spawning).

In regard to the other animals noticed on this occasion it may be mentioned that the spawn masses of *Arenicola* and of *Scoloplos* were abundant in pools on the sand. The Hydroid Zoophyte *Garveia nutans* was also abundant. This form is certainly spreading in the district and has been found twice this year at Puffin Island, by Mr. Thompson on April 4th, and by myself on October 26th. The masses of *Sabellaria alveolata* at Hilbre were found to be spreading and to cover a large area. Many young colonies of *Acyronium digitatum* were observed, and many small specimens of *Sabella*. The starfishes which are usually so very abundant were almost entirely absent on this occasion. No young mussels, and no specimens of *Hydrobia* were found.

A month later, in March, we made a second trip to Hilbre at a very low ebb, accompanied by Dr. Hanitsch, and again succeeded in obtaining a number of Nudibranchs. We found several specimens of the rare *Coryphella landsburgi*. This is apparently the first time this species has been found in our district since the two original specimens recorded by Dr. Byerley in 1849 and 1853. These new specimens afforded us the opportunity of re-describing the

living animal and of observing the condition of the cnida or stinging cells. We also found *Galvina picta* again, and Mr. Walker has sent us specimens dredged at Colwyn Bay during the same month. There can be no doubt that this species is becoming more abundant in the neighbourhood.

We were much impressed on both the February and March visits to Hilbre with the effective protection afforded to *Doris bilamellata* by its rich yellow and brown tints which, although rendering it conspicuous in a white dish or a vessel of clear water, harmonize completely with the animal's natural surroundings, the dark purple-brown rocks spotted with patches of adhering mud, sand, small Algæ and Zoophytes. A reef of rock which we were exploring on the March visit had a number of specimens of this Nudibranch scattered over it which were not at first noticed because of the perfect manner in which their colours blended with those of the environment.

*Ancula cristata* was again present in extraordinary profusion at Hilbre in March. On one reef of rocks a little way above low water mark, there must have been many thousands of specimens present. For yards it was impossible to walk without treading on them, and handfuls were readily collected by scraping the specimens together from the mud-covered rocks. Many of these we brought to Liverpool alive and used for the experiments with fishes in the Museum Aquarium, which were described in our Third Report on the Nudibranchiata, and in "Nature" for 26th June, 1890. This Nudibranch anchors itself to the rock by a string of mucus attached to its tapering tail, and this habit enables it to live as it does on exposed rocks in the wash of the tide. I have several times watched specimens of *Ancula* in a few inches of water when there was a strong tide running past the rocks and waves dashing on them,

and noticed that they were swayed backwards and forwards in the water, but remained securely anchored by their tails.

*Ancula* is not protectively coloured; and as it has no cnidophorous sacs with stinging cells, like those of *Eolis*, its bright white and yellow colouring and conspicuous appearance on dark rocks seems at first inexplicable. From experiments made at the Aquarium last spring I came to the conclusion that it is distasteful to fishes, and possibly it is the secretion of certain large compound glands at the apices of the cerata or dorsal processes which is of an offensive nature.

*Doto coronata*, when it is found at Hilbre Island, generally occurs on colonies of the Zoophyte *Clava multicornis*; but Dr. Sibley Hicks tells me that he has found it in our district, on the sides of the body of the sea-anemone *Anthea cereus*, lying in cavities which it had apparently eaten out for itself. Another rare Nudibranch which we found at Hilbre in March was *Cratena viridis*, of which only two specimens had been found before in our district, one at the Isle of Man and the other at Puffin Island. A fourth was dredged later in the summer in Rhoscelyn Bay, Anglesea, during the cruise of the "Hyæna."

Altogether we have now recorded forty-three species of Nudibranchs in our district, of which thirty-one have been found at Hilbre Island and seventeen at Puffin Island. Besides affording opportunities for investigations into the condition of the stinging organs in various species of Eolids, and into the relation of the colouring to the environment in other forms of Nudibranchs, these specimens have enabled us to make a comparison of the epipodial structures throughout a series of genera, from which we have arrived at the conclusion that all the dorso-lateral projections, or cerata, of Nudibranchs, often the

most conspicuous and brightly coloured parts of the body, are to be regarded as outgrowths of an epipodial ridge.

The experiments with fishes referred to above, and which I announced my intention of undertaking in last year's L.M.B.C. report, have been fully described since in the third report on the Nudibranchiata. They showed that the order of edibility of the forms which were offered to the fishes was :—*Dendronotus*, *Doris*, *Ancula*, and *Eolis*; *Eolis* being the most distasteful form, *Ancula* next, *Doris* less so, and *Dendronotus* edible, but from its size offering difficulties to the rather small fishes which we tried.\* These results are of importance in connection with the explanation of the colours of the various Nudibranchs. It is obvious that if an animal is not thoroughly objectionable, from taste or otherwise, and has not yet become conspicuous with warning colours, it will be an advantage for it to be protectively coloured. *Eolis* is a most distasteful form, and has conspicuous colours of a warning nature. *Ancula* is also distasteful and is conspicuously coloured. *Doris* is less distasteful and is still protectively coloured; while *Dendronotus*, which I regard as edible, is very effectually concealed amongst the seaweeds it lives on, by its large branched cerata and red-brown colours.

#### THE "HYÆNA" EXPEDITION.

The Liverpool Salvage Association having once more kindly placed their s.s. "Hyæna" at the disposal of the L.M.B.C., a four days' dredging cruise was arranged and successfully carried out at Whitsuntide. The old gunboat left the Mersey on Friday, May 23rd, and steamed to the Menai Straits. Some of the party spent the afternoon and evening collecting on the shore at Puffin Island, near which the "Hyæna" was anchored for the night. On the

\* For further details see Trans. Biol. Soc., Liverpool, Vol. IV., p. 150.



following morning (after landing some beds, chairs, dredges, and other supplies for the Biological Station), the various sections of the party were gathered from Puffin Island, Beaumaris, and Bangor in time for breakfast on board the steamer. There were nearly thirty biologists in all (the largest number we have yet had on one of these cruises), including Mr. N. Rundell, Secretary of the Salvage Association, Captain Young, who had been with us on several previous "Hyæna" trips, representatives from Owens' College, Manchester; University College, Liverpool; the Manchester Museum; Edinburgh University; University College, Bangor; Firth College, Sheffield; and other naturalists from Liverpool, Manchester, Chester, Sheffield, and Southport.

It had been proposed to explore the northern coast of Anglesea, but the weather was so bad and the sea so rough in the direction of Point Lynas that, after a few hauls of the dredge off the north side of the South Spit, Puffin Island, the plans were altered and a start was made in the opposite direction. In passing up the Straits some dredging was done off Lleiniog, between Penmon Point and Beaumaris, depth six fathoms, where several specimens of the rare Nudibranch *Cratena concinna* were obtained, along with a single very small specimen (2.5 mm. long) of *Dendronotus arborescens*. The latter is interesting in connection with our attempt (see the second of these Reports, p. 7) to introduce this species at Puffin Island. We cannot of course be sure that this small specimen is the offspring of any of the *Dendronotus* which we set free in September, 1888, only about a mile away, but, at any rate, this is the first specimen of this species which we have found in that neighbourhood.

The next haul was off Port Dinorwic, where the dredge came up filled with sand, stones, and broken shells, on

which many animals were attached, including large numbers of the small red Ascidian *Styela grossularia*. The "Hyæna" then passed on into Carnarvon Bay and commenced working along the southern coast of Anglesea. The dredges and various kinds of tow-nets, surface and bottom, were used at intervals. A very large midwater net, attached to a triangular wooden frame was used for the first time and worked satisfactorily, but did not catch much, probably on account of the large size of mesh of the strong material of which it was made.

Mr. W. E. Hoyle's deep-water closing net has now been modified in the direction indicated in last year's report, so that it can be opened and closed not by the agency of sliding weights, but by an electric current. The "Hyæna," with its powerful dynamo, affords special facilities for experiment with this novel form of tow-net, which was used frequently during the cruise, not so much with the object of collecting specimens as for the purpose of detecting and remedying any possible defects in the construction, and of guarding against conditions which might interfere with the proper action of the apparatus. On the whole the net worked satisfactorily, the causes of occasional failures were discovered, and when an improved form of frame, made according to the design advocated by Professor Hensen, of Kiel, has been incorporated, the apparatus will, no doubt, be a most useful addition to the implements of the marine biologist. The mechanical details for working this tow-net may be described as follows :\*---

The mode of opening and closing the net by the successive detachment of two cords, or links, has been retained ; but these are now looped round the shorter arms of two bell-crank levers, the longer extremities of which

\* See Report of Committee on this Tow-net, laid before Section D of the British Association, at the Leeds Meeting in September, 1890.

rest upon two studs projecting laterally from the sector of an escapement wheel near its circumference. The lengths of the levers are so adjusted that when the first tooth of the escapement is liberated one of them falls, whilst the second is retained until the third tooth has been liberated. The escapement sector is actuated by a spring, and its movements are controlled by an electro-magnet, whose armature is attached to, or rather made solid with, the escapement itself. The current passes to the magnet down a wire in the rope by which the net is towed, and when the net is let down closed the circuit is open. As soon as the desired depth has been reached contact is made, the movement of the armature releases the first tooth of the escapement, and the net opens. When the circuit is broken the second tooth of the sector is caught by the escapement, and held until a second contact sets free the other lever and closes the net.

A further contemplated improvement is the combination of this electric opening and closing tow-net with the electric illuminated tow-net which we have now used during several successive cruises of the "Hyæna." A small incandescent lamp will be placed in the mouth of the net, and the same current will be used for causing the movements of the net and for supplying the light.

Several hauls of the dredge were taken during the afternoon in Carnarvon Bay on a sandy bottom, at depths of 12 to 20 fms., in which, amongst other things, *Ascidia plebeia*, a Holothurian, *Leda pernula*, *Astarte sulcata*, *Acmea testudinalis*, and *Pandora inæquivalvis* were obtained. The "Hyæna" anchored for the second night in a small rocky bay, Porth Dafarch, on the south side of Holyhead Island (close to where the s.s. "Missouri" was wrecked a few years ago), and about half the party were landed to sleep on shore. After dark, those who remained on board com-

menced tow-netting by electric light, and repeated, with some modifications, the experiments which had been made during the last two cruises of the "Hyæna" at the Isle of Man in 1888 and 1889, and which were fully described in the L.M.B.C. reports for these years.

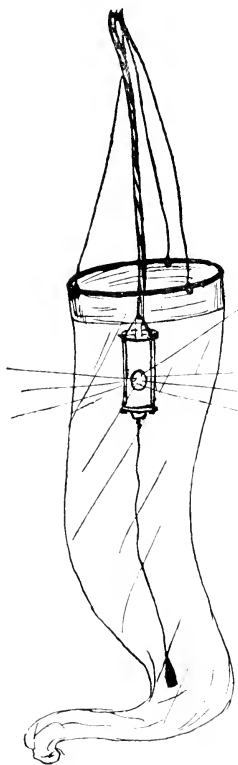


Fig. 1.—Tow-net with electric light.

On the present occasion the large arc lamp was hoisted over the side of the ship so as to throw a strong glare on the water, and Edison-Swan incandescent lamps were sent down to the bottom in tow-nets, which were hauled up at intervals. Comparatively few Cumacea, Amphipoda and Schizopoda were obtained this time, but shrimps and young

fishes were, for the first time in our experience, attracted by the light to the surface, and some of them were caught and preserved. The fishes proved to be young of *Ammodytes lancea* and *Gadus virens*.

One of the ship's boats was kept in the area illuminated by the arc lamp, and by leaning over her side the small objects in the surface-layer of water could be most distinctly seen, and particular animals picked out and captured with a hand-net as they darted about in the neighbourhood of the light. Mr. Leicester and Mr. Hornell were indefatigable in this work and rendered good service. Dr. Hurst and I arranged to be awakened by the sailor on watch at three a.m., when we got up and took a surface tow-netting about dawn, which was afterwards found by Mr. Thompson to contain a much greater number of Copepoda, and more variety than any of the other tow-nettings, either day or electric-light, surface or bottom. Amongst other interesting things it contained a large number of specimens of *Peltidium depressum* which had not been taken at all during the day, and only in very small numbers with the electric-light bottom-net. This same species was taken shortly before near Puffin Island by Mr. Thompson in the tow-net which he left out all night attached to the Dinnor buoy. This Copepod is usually found sticking on *Laminaria* in the day-time, but evidently comes to the surface in abundance late at night or early in the morning. It is evident that this plan of taking surface gatherings at 2 or 3 a.m. will have to be further developed in our future cruises. Probably the best way will be for the biologists to keep watches like the sailors and have the tow-nets going all night long.

The following day was spent in steaming slowly about off the southern coast of Anglesea, dredging and tow-netting at frequent intervals. The surface life was found to be

very poor, comparatively few Copepoda and almost no representatives of other free-swimming groups being obtained; but Mr. Thompson noticed the relative abundance in all the tow-nettings, both surface and bottom, during the day, and also with the electric light at night and at dawn, of unusually large specimens of *Dias longiremis*, and also the prevalence of the somewhat uncommon *Isias clavipes* in all the surface gatherings, though none were taken in the bottom ones.

Mr. Walker reports that as regards the higher Crustacea the results were rather poor. A few novelties, however, were the Cumacean *Eudorella truncatula*, Bate, taken close to Puffin Island with a small canvas dredge on the previous day, a new species of *Podocerus* from near Lleinio, and *Leptocheirus hirsutimanus*, Bate, taken in the Straits, and also off Towyn.

The dredging results during this day were good. The following localities were explored:—(1) Porth Dafarch, (2) Penrhos Bay, (3) two miles off Towyn Lodge, (4) between Towyn and Rhoscolyn Head, and (5) off Rhoscolyn Beacon, where we had six hauls. Some very fine Sponges were obtained, and Ascidians (six species) were plentiful. One patch of rich ground was discovered near Rhoscolyn Beacon, where *Antedon rosacea*, in the “pentacrinoid” and also in the adult state, was brought up in abundance, along with various Tunicata (*Ascidia virginea*, and *A. venosa*), Holothurians, Nudibranchs (*Cratena viridis* and *Doto fragilis*), Zoophytes, Polyzoa, and especially large Sponges. Altogether this expedition was, probably, more prolific in regard to Sponges than in any other group.

Dr. Hanitsch tells me that, in addition to a number of commoner species, we obtained in that one day (May 25th), in the dredgings in Penrhos Bay, off Towyn, and off Rhoscolyn Beacon, specimens of *Raspailia ventilabrum*, *Poly-*

*mastia mammillaris*, *P. robusta*, *Tethya lynceurium* (budding), and magnificent examples of the massive form of *Cliona celata*, the largest specimen, from near Rhoscolyn Beacon, measuring 31 cm. by 20 cm. horizontally, and 12 cm. vertically, and being probably not exceeded in size by any sponge ever collected on the British coasts.

Miss L. R. Thornely, who has carefully examined all the material we brought back from this expedition, informs me that we obtained 26 species of Hydroid Zoophytes, including *Halecium tenellum*, *Diphasia attenuata*, *Plumularia echinulata*, *Eudendrium capillare*, and *Garceia nutans*. Miss Thornely has also given me a list of the Polyzoa which she has identified from this cruise, comprising 38 species, six of which have not previously been recorded from that region (Anglesea) of our district, viz., *Scrupocellaria scrupaea*, *Membranipora pilosa* form *dentata*, *Smittia reticulata*, *Cellepora avicularis*, *Bowerbankia caudata*, and *Pedicellina cernua* form *glabra*. In a collection made by Mr. F. Archer at Bull Bay, on the north coast of Anglesea, later in the summer, Miss Thornely finds 25 species, including several of the rarer ones mentioned above, and *Cellepora ramulosa*.

Mr. Hornell tells me that this cruise gave for the first time to our local fauna the Annelids *Spinther oniscoides*, *Nicomache lumbricalis*, *Sabellaria spinulosa*, large numbers of *Polynoe scolopendrina*, and one example of *Nychiea cirrosa*, which, curiously, was first described as British by the Swedish naturalist, Malmgren, from a wrongly named specimen of *Polynoe* in the British Museum, labelled as hailing from Beaumaris.

On the third night we again anchored in Porth Dafarch, and after dark the electric lights were again used for a couple of hours. This time the large arc lamp was taken to the stern and suspended close to the surface of the

water, but as it was not working steadily one of the incandescent submarine lamps was lowered over the side and kept a few inches under water, and this proved most effective in attracting animals to a stationary tow-net or a hand net beside it.

Some samples of the mud and other deposits brought up by the dredge from several localities during this cruise, and that of the "Spindrift" on September 27th, have been carefully examined by Mr. F. G. Pearcey, of the Manchester Museum, for Foraminifera. Mr. Pearcey has kindly supplied me with a list of the 71 species found, which I append to this Report (see Appendix A, p. 40). It will be noticed that this list of Foraminifera adds 8 species to those previously recorded in our district, and of these one, *Ammodiscus spectabilis*, is new to British seas. Mr. E. Halkyard, F.R.M.S., informs me that he has found at Southport the two unrecorded species *Polymorphina sororia* and *P. myristiformis*; while further additions to our list have been made from material collected by Mr. Thompson from the Mersey at Aigburth, and examined by Mr. E. Burgess, and which will form the subject of a separate paper in the Transactions of the Liverpool Biological Society, Vol. V., p. 73.

On the fourth day the "Hyæna" returned through the Menai Straits to Liverpool. As usual the specimens collected were distributed to our specialists, and are now in process of being worked out. I have only been able to give a meagre preliminary account of the results, and I have no doubt we shall hear more in future L.M.B.C. Reports of the "Hyæna" expedition of 1890.

#### OTHER DREDGING EXPEDITIONS.

Through the kindness of Mr. J. Herbert Lewis a small tug, the "Albert," belonging to Messrs. Coppach, Carter and Co., of Connah's Quay, was lent to the Committee for



an afternoon's dredging at the mouth of the Dee, on July 5th. Mr. Carter accompanied the vessel from Mostyn, and picked up the party from Liverpool at Hoylake about one p.m. Unfortunately the sea was rough, and although a number of hauls of the dredge were taken, both in Hilbre Swash and in the Welshman Gut, they were rather unproductive. Late in the afternoon the beam trawl was tried with more success, bringing up quantities of Zoophytes, Sponges, &c., along with some fish. The dredging party landed on Hilbre Island in the evening for the low tide, and were joined there by some of the other members of the Liverpool Biological Society, it being the occasion of the annual field meeting for the presidential election.

The tow-nets had been worked as usual with great success during the afternoon, and Mr. Thompson has furnished me with a list of Copepoda, &c., from Hilbre Swash, in which the following occur, besides many of the usual commoner forms:—*Dius discandatus*, *Cyclopina gracilis*, *Laophonte lamellifera*, *Lichomolgus* (?), and *Eutерpe gracilis*, along with several Cumacea, *Appendicularia* and the Cladoceran *Podon intermedius* which, although not uncommon, appears not to have been before recorded from British seas. Some good Copepoda were taken in the tow-net at Puffin Island on August 27th, including one specimen of *Monstrilla rigida*, and a larval *Lernæa*.

A most welcome grant of £50 from the Government Grant Committee of the Royal Society, to be applied to the further exploration of Liverpool Bay, has enabled us to hire seaworthy tugs on a couple of occasions for single day trips to the "central area" of Liverpool Bay. This region, which lies N.W. and W. of the bar lightship and onwards towards the Isle of Man, we regard as being still comparatively virgin ground, and as on each occasion when we have visited any part of it, notwithstanding very

adverse weather and want of sufficient time, we have been encouraged by finds which gave promise of rich ground



Fig. 2.—Map of the L.M.B.C. District.

and abundant spoil, we feel that more of our efforts in the future must be directed towards the exploration of this region outside the bar.

On July 12th we hired the tug “Spindrift,” belonging to the Liverpool Steam Tug Company, for a day’s work, and a party of fourteen of us started from the Landing Stage for a long day at sea. We steamed to a point about 25 miles N.W. of the bar lightship, where, at depths of about twenty fathoms, we had a dozen hauls of large and small dredges, besides tow-netting work. The bottom, as a rule, was composed of sand and broken shells, covered in places with enormous quantities of Ophiuroids—mostly *Ophiothrix pentaphyllum*. *Spatangus purpureus* was also obtained in abundance and of large size. Mr. Walker tells me that a very large *Iphimedia obesa* and two *Euonyx*

*chelata* were picked off an *Echinus*. During the "Hyæna" expedition another similar case of Amphipoda living on an Echinoderm had been met with when a number of females and young males of *Melita obtusata* were found on *Asterias rubens*.

The following Annelids were obtained in this "Spindrift" expedition:—*Lumbrinereis fragilis*, *Sthenelais limicola*, *Malmgrenia castanea*, *Syllis tubifer*, *Sphaerodorum flavum*, *Eunice* sp., *Hermadion pellucidum*, and *H. assimile*. It is worthy of remark that the two species of *Hermadion* were in all cases discovered as commensals with Echinoderms. One specimen of *H. pellucidum* was picked off a *Solaster*, another off an *Astropecten*, and a third off an Ophiurid, while *H. assimile* was taken from *Echinus sphaera*.

On September 12th, Mr. Walker saw two very fine living specimens of *Palinurus vulgaris*, the spiny lobster, which had been caught at Valley in Anglesea. This is believed to be the first record of its occurrence in Wales.

Another expedition to the "central area" in the "Spindrift" took place on September 27th. We hoped on this occasion to be able to reach the ground where the very large specimens of *Fusus antiquus*, brought into market by the Fleetwood trawlers, live, and for that purpose Mr. R. D. Darbishire brought with him a Fleetwood trawler as a guide; but some time was spent in dredging on the way, and although we eventually reached the proper region, we were evidently not on the exact ground, as our dredges and trawl failed to bring up any of the desired whelks.

We tried on this occasion a new trawl, made on the pattern of those recommended by Prof. A. Agassiz and by the Prince of Monaco. The runners are double, and both sides of the net are weighted, so that it is a matter of indifference which side the instrument falls on, and the wooden beam is replaced by two iron bars, which can be

unshipped so as to allow of easy transport. This instrument worked well on every occasion on which it has been tried.

We obtained, at about 15 miles N.W. of the bar, a number of specimens of *Philine aperta*, several of the beautiful large Nudibranch, *Eolis tricolor*, some Holothurians (*Cucumaria hynchmanni*) and Ascidians, and also dozens of the strange scabbard-like tubes of *Omuphis conchylega*. Amongst the other worms obtained and since identified by Mr. Hornell, are:—*Owenia jiliformis*, *Nicolea venustula*, *Lumbrineris fragilis*, *Serpula reversa*, *Thelepus cincinnatus*, *Sthenelais limicola*, *Malmgrenia castanea* (on every specimen of *Spatangus purpureus*) and *Hermadion pellucidum*.

On this expedition, and on the previous "Spindrift" trip in July to the same region, Mr. F. Archer took special charge of the testaceous Mollusca, and passed large quantities of the sand and gravel brought up by the dredges through his sieves, in search of the more minute forms. He has now found ten species which were not recorded in the Report on the Mollusca in the first volume of our Fauna, including:—*Pandora inaequalis*, *Venus chione*, *Puncturella noachina*, and *Adeorbis subcarinatus*.

The mud dredged on this trip has been examined for Foraminifera by Mr. F. G. Pearcey and Mr. G. W. Chaster, and has yielded 63 species (see Appendix A, p. 40.) The Zoophytes of this expedition, and of the "Albert" trip on July 5th, have been examined partly by Miss Thornely and partly in the Zoological Laboratory of University College by Mr. W. J. Halls. The "Spindrift" forms include the following additions to our list:—*Hydranthea margarica*, *Bimeria vestita*, *Campanularia hincksii*, *Gonothyraea gracilis* and *Aglaphenia tubulifera*. The surface life on this occasion (Sept. 27th) was very abundant, the tow-nets bringing up great quantities of Copepoda, &c. Amongst these

Mr. Thompson has found several of the rarer forms, *e.g.*, *Euterpe gracilis*, *Pontella wollastoni*, and *Parapontella brevicornis*.

Mr. A. Chopin, of Manchester, spent a week at the end of August in collecting Invertebrata round the southern end of the Isle of Man, and was singularly successful in some groups. He has kindly submitted all his lists, and some of the specimens. to me, and I note that he obtained :—

SPONGES, eight species.

HYDROIDA, twenty-seven species, including *Syncoryne eximia* (dredged off Spanish Head), and *Lafjoea fruticosa* (on *Sertularia abietina*), not previously found in our district. Some members of the Manchester Microscopical Society also obtained in June, *Corymorpha nutans*, (near Shagg Rock, 12 fathoms), and *Coryne pusilla* (Fleshwick Bay), both rare species.

ACTINIARIA, eighteen species and recognised varieties, including *Sagartia nivea* and its variety *immaculata*, not previously recorded.

ECHINODERMATA, eight species.

POLYCHÆTA, five species.

ROTIFERA, *Synchaeta baltica*, Ehr., not previously recorded.

ARACHNIDA, *Halacarus rhodostigma*, Gosse (always on *Bowerbankia imbricata*), not previously recorded.

POLYZOA, twenty species.

CRUSTACEA, twenty species, including *Portunus corruugatus*, not previously recorded.

MOLLUSCA, thirteen species, including *Chiton discrepans*, new to the district.

Mr. Chopin collected at Hilbre Island, in September, the following Sea-Anemones :—*Sagartia viduata*, varieties

*alurops* and *melanops*, and *Sagartia troglodytes*, varieties *scolopacina* and *candida*.

#### THE SHRIMP ENQUIRY.

At the February Meeting of the Biological Society, last Session (see "Proceedings," p. xiv.), I announced my intention of trying to collect statistics during the coming year that would aid in giving us more exact knowledge of the life-history and habits of the common shrimp (*Crangon vulgaris*) in this neighbourhood. It is well known that we are here in the centre of a considerable shrimping industry, and large numbers of shrimps come into the Liverpool market from various points on the adjacent coasts of Lancashire and Cheshire, both in the fresh condition and also potted in butter.

I prepared a circular, asking a few simple questions, such as a fisherman or shrimper would be perfectly well able to answer, and despatched a set of questions with blank spaces for answers, one for each month of the year, to five centres in the district, where I was fortunate enough to find gentlemen who kindly undertook to get the forms filled up by fishermen and returned to me. Mr. T. Comber, F.L.S., undertook Parkgate; Mr. R. L. Ascroft, Lytham; Mr. A. Leicester, Southport; Mr. A. G. Haywood, Crosby; and Mr. Henry Isaacs, Hoylake. Unfortunately I have not received anything like complete returns for the year from all of these fishing centres, but two of them, Lytham and Parkgate, have continued to send me reports during the whole year with the greatest regularity. I have now reduced these reports to a tabular form, which is annexed. I have also received some interesting information from Mr. W. B. Halhed, obtained from Parkgate fishermen. I wish to express my acknowledgments to all these gentlemen for their hearty co-operation.

I have in many cases simplified the wording of the answers, and have left out some irrelevant remarks. The Crosby fishermen complain bitterly of the prejudicial effect of the Liverpool refuse boats upon their industry, and declare that these boats discharge their rubbish much nearer the shore than they are permitted by law.

It will be noticed from the answers\* to the first question that the shrimps are more plentiful on the fishing grounds in summer and autumn than in winter and spring, and there seems to be abundance of evidence that they are directly affected by the weather. In cold or very stormy weather they are said to bury themselves deep in the sand, and several of my correspondents mention having disinterred them when raking for cockles at a depth of more than a foot in the sand. The prawns also disappear in cold weather, but whether they burrow is doubtful as they live on "hard" ground.

There seems to be a general belief that shrimps spawn all the year round, and I have no doubt that out of a great many shrimps some few may be found with spawn at any time, but from the answers to question 4 in the table it is evident that late winter and spring are the spawning times in this neighbourhood. Then nearly all the specimens taken are large and full of spawn, while in summer and autumn "fry" and immature forms make their appearance in quantity, and individuals with spawn are few or absent.

Many of the answers in regard to the food and the enemies of the shrimp were "don't know" and "cannot tell." The greater part of the positive evidence is that they feed upon "shore worms" in "sand pipes" (or their

\* The standard of a good catch appears to vary somewhat with the locality and the time. What is considered "plentiful" at one time is returned as scarcity in another month.

excreta?), which I take to mean *Sabellaria alveolata*; while their enemies are generally said to be cod, whiting, flukes, small thornbacks, weevers, and crabs (especially "white crabs," *Polybius henslowi*). *Pleurobrachia* ("marble blebs"), which is sometimes put down as an enemy, would be very unlikely to be able to injure a shrimp.

It may be of interest perhaps to record a typical week-end visit to Puffin Island in rather wintry weather. Near the end of October four of us (Mr. Thompson, Mr. Gibson, Mr. Leicester, and myself) arrived at the Island on a Saturday, after a spinning sail down from Garth, in the "Bonnie Doon," and found that the new keeper, Thomas Jarrett and his wife, had been busy for some days white-washing and cleaning the station within and without, and had introduced several much-needed improvements in the household arrangements.

This particular expedition to the Island was made partly for the purpose of collecting certain special animals and sea-weeds, and partly in order to establish the new keeper in his place, and give him full directions for making collections and taking observations during the winter. Certainly the biologists have never before been so comfortably housed at Puffin. The arrangements in regard to board and lodging were as satisfactory as could well be in such a delightfully isolated spot, where everything, from a sack of coals to a pat of butter, has to be brought from Bangor, if not further, landed when possible on the rocks or the shingle, and conveyed on one's own back, or the donkey's—usually the former—up a cliff, and over half a mile of island top, consisting chiefly of long grass, limestone rocks, and awkwardly placed rabbit holes, before it reaches the biological station. The new sleeping bunks, fixed in three tiers of





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two each against the wall of one of the rooms, (II. in fig. 3) are found to be a great improvement on the camp beds, especially in cold weather; and a long fixed work-table, with some shelving, has converted another room (III.) into a most useful indoors laboratory, where work can be carried on at night and on very cold days, when the outside laboratory, with its stone floor and many windows, is too uncomfortable, even for the enthusiast.

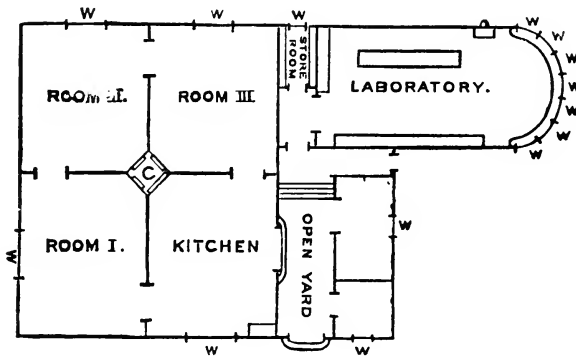


Fig. 3.—Plan of the Biological Station. W.W., windows; C, chimney.

Saturday was bright but showery all day. The afternoon was spent by the whole party on the long south spit at low tide, and the animals and plants collected were arranged, identified, and preserved in the laboratory during the evening. At night the wind rose and blew with great force against the north side of the house, and squalls of hail rattled against the windows at intervals. In the morning we were up at half-past seven, and found a heavy sea rolling in, a keen north wind blowing, and the mountains behind Penmaenmawr and Llanfairfechan white with snow. Mr. I. C. Thompson, with characteristic energy, at once conveyed me off to the cliffs for a morning plunge in the breakers in the middle of a shower of mingled sleet and driven sea foam; while our more sensible com-

panions superintended Mrs. Jarrett's efforts to fry our ham and eggs in the station frying pan, which was found to have a considerable perforation in its centre.

Immediately after eight o'clock breakfast the biological work began, and lasted till dark. Mr. Alfred Leicester explored the Island, high and low, for land mollusca, and succeeded in finding three snails (*Zonites alliarius*, *Z. nitidulus*, and *Helix virgata*) previously unrecorded. Mr. Harvey Gibson followed the retreating tide downwards foot by foot as he searched the shore for Algæ. Mr. Thompson and I initiated the keeper into the mysteries of tow-netting for the purpose of making collections of surface life. We went out in the punt with our nets and bottles, and coasted as far as we dared venture in that frail craft along the lee side of the Island, getting abundant gatherings as we went, and storing up the Copepoda and Diatoms in tubes (duly labelled), which will give many an hour of hard work at the microscope to our specialists before the results are known, and the lists printed in our reports. Later on we all assembled on the reefs opposite



Fig. 4.—View of Puffin Island from the end of the South Spit at low tide. The best collecting ground is amongst the *Laminaria* and boulders shown in the front of the figure.

the Beacon rocks for the last of the ebb, and worked downwards with the tide, trying literally to leave not a stone unturned, for in such a spot the biologist finds his choicest specimens in the sheltered nooks and crevices underneath the boulders and ledges of rock, which have to be turned over—sometimes by the united strength of the party—in order that the treasures beneath may be revealed.

Under one such stone as it rolled back I caught sight of a large cuttlefish, *Eledone cirrhosa*, closely related to the octopus. There it sat in a shallow pool, something like a large yellowish toad, blinking its brilliant eyes, changing, chameleon-like, the colour of its skin, puffing out its fat round body, and squirting water at me with its funnel. I carried it home from Puffin Island next day in a large jar of sea-water, and it was before me on my study table as I wrote these lines, climbing about the jar by means of its eight long tapering arms provided with powerful sucking discs, stretching itself up to the surface of the water, and extending its arms out in all directions like radii—suggesting the appearance of some monstrous spider in which the web is part of the animal's body—and then suddenly collapsing and dropping all in a heap to the bottom.

We found besides many Ascidians, and a few Nudi-branchs; Sponges, Zoophytes, and Polyzoa, were in profusion, and of the new Algæ, which fell to Mr. Gibson's share, there was almost no end. Altogether we were in luck, and when we had followed the tide down to its lowest, and a little beyond, and were driven up the shore by the advancing waves and the approaching darkness, saturated to our knees and elbows, and ordinarily wet over most of the remainder of our bodies, but laden with spoil, we tramped across the Island to our snug little station,

where Mrs. Jarrett was boiling the kettle and frying the fresh herrings for tea, agreeing as we went that there was no place like Puffin, and no pursuit so delightful as marine biology. It is not, as some think, only in the height of summer that the biologist can carry on his field work.

We brought back collections of various groups which have been distributed to our specialists. A small bag of matted algæ and mud from low-water mark has yielded Mr. Archer 16 species of the smaller mollusca, including *Pecten similis*, *Rissoa parva* var. *interrupta*, *Rissoa semistriata* (new to the district), *Chemnitzia elegantissima*, *Jeffreysia opalina*, and *Phasianella pullus*.

It is perhaps worthy of record here that we have found, half hidden in the soil on the S.W. corner of the Island, a slab of stone marking the grave of a sailor who was buried there a century and a quarter ago. The inscription is now only partially legible, but Mr. Thompson found in the Linnean Society's Library a copy of an old work giving an account of excursions in this part of Wales, made in 1798 and 1801 by the Rev. W. Bingley, F.L.S., in which occur the following passages about Puffin Island:—"Tradition respecting Priestholme says that when the now Lavan Sands formed a habitable part of Carnarvonshire a bridge communicated across the channel, and they yet pretend to show the remains of an ancient causeway from there to Penmaenbach, near Conway, for convenience of devotees who made pilgrimages to the Island;" and "On the Island I found an upright stone with the inscription—

Bar<sup>e</sup>. Stout,  
 belonging to the  
 Salley, died in  
 the small pox  
 Nov. ye 3rd, 1767.  
 N.B.—The ship was cast  
 away here."

The present condition of the inscription is this :—

Bar . . .  
 belo . . .  
 Sal . . . .  
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 a w . .

We are to have neighbours on Puffin Island in future. The rabbiting, &c., on the Island has been let by Sir Richard Bulkeley to Jeremiah Griffiths, from Bangor—the use of the house, &c., for scientific purposes, being reserved as before for our Committee, as I am courteously informed by Mr. Preston, the agent for the estate. The ruined cottage at St. Seiriol's old church on the top of the Island is now being repaired as a habitation for Jeremiah Griffiths, and as he and his sons propose to carry on fishing operations of various kinds all the year round in the neighbourhood of the Island, the biologists may regard this industrial invasion with equanimity, and even satisfaction. I am sure that the scientific and the economic exploration of the "Turbot Hole" will go on peacefully side by side, and prove mutually beneficial.

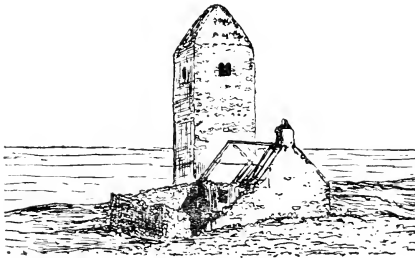


Fig. 5.—St. Seiriol's Church tower and old cottage on Puffin Island. (From a "Kodak" photograph).

Appended to this report will be found :—

- (A.) A list of the Foraminifera identified by Mr. Pearcey from the deposits obtained during the “Hyæna” and “Spindrift” expeditions.
- (B.) A list of the papers on the Fauna and Flora of Liverpool Bay, published since 1886, as the result of the L.M.B.C. investigations.
- (C.) The Hon. Treasurer’s usual statement, containing the list of Subscriptions and Donations to the L.M.B.C. funds, and the Balance Sheet for the year.

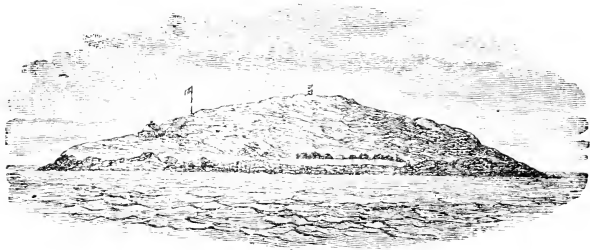


Fig. 6.—Puffin Island from the north.



*Applications to be allowed to work at the Biological Station, or for specimens (living or preserved) for Museums, Laboratory work, and Aquaria should be addressed to Professor Herdman, University College, Liverpool.*

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*Subscriptions and Donations should be sent to Mr. I. C. Thompson, F.L.S., 19, Waverley Road, Liverpool.*

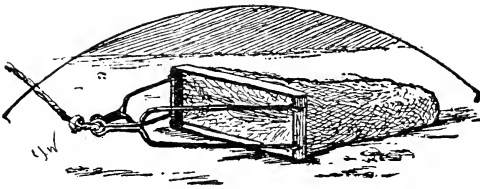


Fig. 7.—The Naturalist's Dredge.

## APPENDIX A.

NOTES on the FORAMINIFERA dredged by the  
L.M.B.C. in LIVERPOOL BAY during 1890.

BY F. G. PEARCEY, Manchester.

In June of this year Professor Herdman was good enough to leave with me to examine for Foraminifera four samples of the residues from bottles containing animals which had been collected from various localities in Liverpool Bay during the cruise of the "Hyæna" in May; and since that I have received through Mr. Standen a further supply of deposit dredged during the "Spindrift" excursion on the 27th of September in the same district. Mr. G. W. Chaster also preserved some samples of deposits from the "Spindrift" expedition, and picked out and identified the Foraminifera. He has, on Professor Herdman's suggestion, submitted the rarer and more critical species to me for confirmation, and his results are now included in my lists. This last is the richest sample I have yet had an opportunity of examining from Liverpool Bay. It is not to be expected that with such a small supply from so large an area, anything very remarkable would be made out; especially after the long continued researches on this particular group of organisms in the same district by Mr. J. D. Siddall of Chester, whose admirable report on the Foraminifera of Liverpool Bay was published in the first volume of reports of the Liverpool Marine Biology Committee in 1886. In that report several representative deep-sea forms are recorded, and therefore I was anxious to have the opportunity of examining some of the deposits from this district.

In accordance with Professor Herdman's request I herewith append the result of my investigation, which although small is sufficient to show that there are a number of interesting forms to be found in the district marked out for exploration by the L.M.B. Committee; and I venture to point out to any Rhizopodists resident in the locality, who may have time to spare, that, from the nature of the deposits which have so far come under my observation, they should search well for the following forms, which I believe may yet be taken, viz., *Astrorhiza limicola*, *Pelosina variabilis*, *Hyperammmina arborescens* and *Hyperammmina vagans*, more especially if carefully looked for along the seaward boundary. Perhaps a word or two here on the method of collecting may not be out of place. Whenever an opportunity occurs a good quantity of the deposit should be carefully washed through sieves in a tub of

sea-water on the spot, especially in cases where a muddy deposit is found. The siftings so collected should be carefully preserved in bottles with spirit, and labelled (inside) with a good B.B. pencil, while a part should be kept as long as possible in sea-water and examined in the fresh state. The water remaining in the tub in which the material has been washed, should be poured through a fine muslin bag or net, made for the purpose, and the contents of this net should also be carefully preserved for future examination, as in this way some of the rarer forms are often taken.

Notwithstanding the small amount of material examined by me, I have been able to add eight new species to the locality, one of which is new to British seas; these are as follows:—*Miliolina pulchella*, d'Orb.; *Haplophragmarum agglutinans*, d'Orb.; *Ammodiscus spectabilis*, Brady; *Textularia trochus*, d'Orb.; *Lagena globosa*, Mont.; *L. clavata*, d'Orb.; *L. laevigata*, Reuss; and *Globigerina bulloides*, var. *triloba*, Reuss. Two of these are worthy of further note, viz.,

*Miliolina pulchella*, d'Orb. (sp).

Mr. H. B. Brady, in his Challenger Report, pl. iii, figs. 10—13, and M. Terquem in his memoir on the Foraminifera of the Upper Pliocene beds of the island of Rhodes, figure this form. Mr. Brady says, *Miliolina pulchella* is not uncommon amongst the larger Miliolæ of comparatively shallow water at depths of less than 100 fathoms. It occurs on the northern portion of our own coast, and occasionally elsewhere in the North Atlantic, in the Mediterranean, and more rarely amongst the East Indian Islands. It is therefore of considerable interest to have met with it in Liverpool Bay.

*Ammodiscus spectabilis*, Brady.

One perfect and one broken specimen of this species were obtained amongst the material dredged off Penrhos, which answer in detail to those described and figured by Mr. Brady (Report on the Challenger Foraminifera, vol ix., pl. xxxviii., figs. 20—22) with the exception merely that those taken off Penrhos are much smaller. This form is only known to have been taken from two other localities, viz., North Atlantic, and off the East Coast of Buenos Ayres in 1900 fathoms. It is therefore now added for the first time to the British Fauna.

It is interesting to find that many of the Foraminifera which we know as inhabitants of the great ocean basins, also occur in the shallow seas round our own coast; and this is of great importance in discussing the Geographical and Bathymetrical distribution of these forms.

I now give a list of the species found in 1890, with the localities, No. 5 being the only one from which what could be called a good sample of a rich deposit was obtained.

GENERA, SPECIES, AND VARIETIES OF FORAMINIFERA.		1.	2.	3.	4.	5.
		Lleinog Menai Straits.	Port Dinor- wic.	Carnar- von Bay.	Off Penrhos	20 Miles N.W. of Bar Light Ship.
<i>Biloculina</i>	<i>depressa</i> , d'Orb.....	...	...	...	...	×
<i>B.</i>	<i>ringens</i> , Faulk.....	...	...	...	...	×
<i>B.</i>	<i>elongata</i> , d'Orb.....	...	...	...	...	×
<i>Spiroloculina</i>	<i>excavata</i> , d'Orb.....	...	...	...	...	×
<i>S.</i>	<i>limbata</i> , d'Orb.....	...	...	...	...	×
<i>S.</i>	<i>planulata</i> , d'Orb.....	...	...	...	...	×
<i>Miliolina</i>	<i>subrotunda</i> , Mont. ....	×	×	×	×	×
<i>M.</i>	<i>bicornis</i> , W. & J. ....	...	...	...	×	×
<i>M.</i>	<i>seminulum</i> , Linn. ....	...	×	×	×	×
<i>M.</i>	<i>agglutinans</i> , d'Orb.....	...	...	×	...	×
* <i>M.</i>	<i>pulchella</i> , d'Orb.....	...	...	...	×	×
<i>M.</i>	<i>oblonga</i> , Mont.....	×	...	...	...	×
<i>M.</i>	<i>trigonula</i> , Lamk.....	...	...	...	...	×
<i>Ophthalmidium</i>	<i>inconstans</i> , Brady.....	...	...	...	...	×
<i>Cornuspira</i>	<i>invovens</i> , Reuss.....	...	×	×	×	...
<i>Dendrophrya</i>	<i>erecta</i> , Str. Wright.....	...	×	×	×	...
<i>Psammosphaera</i>	<i>fusca</i> , Schulze.....	...	...	×	...	×
<i>Haliphysema</i>	<i>tumanowiczii</i> , Bow.....	...	×	×	×	...
<i>Reophac</i>	<i>diffugiiformis</i> , Brady...	×	...	...	×	...
<i>R.</i>	<i>scoopiurus</i> , Mont. ....	...	...	×	...	×
<i>R.</i>	<i>fusiformis</i> , Will.....	...	...	...	...	×
<i>R.</i>	<i>moniliforme</i> , (?) Siddall	...	...	...	...	×
<i>Haplophragmium</i>	<i>canariense</i> , d'Orb. ...	...	×	×	×	×
* <i>H.</i>	<i>agglutinans</i> , d'Orb.....	...	...	×	...	×
<i>Placopsilina</i>	<i>bulla</i> , Brady .. ..	...	×	×	×	...
<i>P.</i>	<i>varians</i> , Carter.....	...	...	×	×	...
* <i>Ammodiscus</i>	<i>spectabilis</i> , Brady.....	...	...	...	×	...
<i>Trochammina</i>	<i>inflata</i> , Mont.....	...	...	...	...	×
<i>Textularia</i>	<i>sagittula</i> , Defrance ...	...	...	...	...	×
* <i>T.</i>	<i>trochus</i> , d'Orb.....	...	...	...	...	×
<i>T.</i>	<i>variabilis</i> , Will.....	...	...	...	...	×
<i>Verneuilina</i>	<i>polystropha</i> , Reuss.....	...	...	×	...	×
<i>Bulimina</i>	<i>elongata</i> , d'Orb.....	...	...	...	...	×
<i>B.</i>	<i>elegans</i> , d'Orb. ....	...	...	...	...	×
<i>Bolivina</i>	<i>punctata</i> , d'Orb.....	...	...	...	×	×
<i>Cassidulina</i>	<i>lavigata</i> , d'Orb.....	...	...	...	...	×
* <i>Lagena</i>	<i>globosa</i> , Montagu.....	...	...	...	...	×
* <i>L.</i>	<i>clavata</i> , d'Orb.....	...	...	...	...	×
* <i>L.</i>	<i>lavigata</i> , Reuss.....	...	...	...	...	×

<i>L.</i>	<i>sulcata</i> , W. & J.....	..	×	×	×	×
<i>L.</i>	<i>sulcata</i> , var. <i>interrupta</i> , Will.	...	...	...	...	×
<i>L.</i>	<i>costata</i> , Will.....	...	...	...	...	×
<i>L.</i>	<i>williamsoni</i> , Alcock.....	...	...	...	...	×
<i>L.</i>	<i>squamosa</i> , Mont.....	...	...	...	×	...
<i>L.</i>	<i>lavis</i> , Mont. ....	×	...	×	...	×
<i>L.</i>	<i>semistriata</i> , Will. ....	...	...	...	...	×
<i>L.</i>	<i>hectagona</i> , Will. ....	...	...	×	...	×
<i>Nodosaria</i>	<i>communis</i> , d'Orb. ....	...	...	×	...	×
<i>N.</i>	<i>pyrula</i> , d'Orb.....	...	...	...	...	×
<i>Cristellaria</i>	<i>rotulata</i> , Lamk .....	...	...	...	...	×
<i>C.</i>	<i>crepidula</i> , F. & M.....	...	...	...	...	×
<i>Polymorphina</i>	<i>gibba</i> , d'Orb.....	...	×	...	...	×
<i>P.</i>	<i>compressa</i> , d'Orb. ....	...	...	×	...	×
<i>P.</i>	<i>concaea</i> , Will.....	...	...	...	...	×
<i>P.</i>	<i>lactea</i> , W. & J.....	...	...	...	...	×
<i>Globigerina</i>	<i>bulloides</i> , d'Orb.....	...	...	...	...	×
* <i>G.</i>	<i>bulloides</i> , var. <i>triloba</i> , Reuss	...	...	...	...	×
<i>Discorbina</i>	<i>rosacea</i> , d'Orb. ....	×	×	...	×	×
<i>D.</i>	<i>globularis</i> , d'Orb. ....	...	×	×	...	×
<i>D.</i>	<i>orbicularis</i> , Terq. ....	×	×	...	×	×
<i>Planorbulina</i>	<i>mediterraneanensis</i> , d'Orb.	...	...	...	×	×
<i>Truncatulina</i>	<i>lobatula</i> , W. & J. ....	...	...	×	...	×
<i>T.</i>	<i>refulgens</i> , Mont.....	...	...	...	...	×
<i>T.</i>	<i>ungeriiana</i> , d'Orb. ....	...	...	×	...	×
<i>Rotalia</i>	<i>beccarii</i> , Linn. ....	×	×	×	×	×
<i>R.</i>	<i>nitida</i> , Will. ....	...	...	...	...	×
<i>Gypsina</i>	<i>inharens</i> , Schultze ...	...	...	...	×	×
<i>Nonionina</i>	<i>depressula</i> , W. & J. ...	...	...	...	×	×
<i>N.</i>	<i>scapha</i> , F. & M.....	...	...	...	...	×
<i>Polystomella</i>	<i>crispa</i> , Linn. ....	...	×	×	...	×
<i>P.</i>	<i>striatopunctata</i> , F. & M.	×	×	×	×	×

Those marked with an \* are additions to the former lists of Foraminifera found in the L.M.B.C. district.

## APPENDIX B.

LIST of PAPERS on the FAUNA and FLORA of  
LIVERPOOL BAY published since 1886 as a  
result of the L.M.B.C. investigations.

1886.

1. Introduction to Vol. I. of "Fauna," by Professor W. A. Herdman D.Sc., F.R.S.E., F.L.S. (Fauna of Liverpool Bay, vol. i., 1886, pp. 1—15, and chart.)
2. Pioneers in local Biology, by Rev. H. H. Higgins, M.A. (Fauna, vol. i., pp. 16—31.)
3. On Shallow-water Faunas, by Professor A. Milnes Marshall, M.A., M.D., D.Sc., F.R.S. (Fauna, vol. i., pp. 32—41.)
4. Report upon the Foraminifera of the L.M.B.C. district, by John D. Siddall, Chester. (Fauna, vol. i., pp. 42—71, and pl. i.)
5. Report upon the Porifera of the L.M.B.C. district, by Thos. Higgin, F.L.S.; with description of a new species of *Aphroceras*, by H. J. Carter, F.R.S. (Fauna, vol. i., pp. 72—94.)
6. Report on the Hydroida of the L.M.B.C. district, by W. R. Melly, J. Sibley Hicks, L.R.C.P., F.L.S., and Prof. Herdman, D.Sc. (Fauna, vol. i., pp. 95—113.)
7. List of the Medusæ and Ctenophora of the L.M.B.C. district, by J. A. Clubb. (Fauna, vol. i., pp. 114—119.)
8. Report on the Alcyonaria of the L.M.B.C. district, by Prof. Herdman, D.Sc. (Fauna, vol. i., pp. 120—122, and pl. ii.)
9. Report on the Actiniaria of the L.M.B.C. district, by John W. Ellis, L.R.C.P., F.E.S. (Fauna, vol. i., pp. 123—130, and pl. ii.)
10. Report upon the Crinoidea, Asteroidea, Echinoidea, and Holothuroidea of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc. (Fauna, vol. i., pp. 131—139.)
11. Report on the Ophiuroidea of the L.M.B.C. district, by Herbert C. Chadwick, Manchester. (Fauna, vol. i., pp. 140—143.)
12. Report on the Vermes of the L.M.B.C. district, by R. J. Harvey Gibson, M.A., F.R.S.E., F.R.M.S. (Fauna, vol. i., pp. 144—160.)
13. Report on the Polyzoa of the L.M.B.C. district, by Joseph Lomas, Assoc. N.S.Sc. (Fauna, vol. i., pp. 161—200, and pl. iii.)
14. Report on the Copepoda of the L.M.B.C. district, by Isaac C.

- Thompson, F.R.M.S. (Fauna, vol. i., pp. 201—208, and pl. iv.)
15. Notes on the Cirripedia of the L.M.B.C. district, by F. P. Marrat, Liverpool Museum. (Fauna, vol. i., pp. 209—211.)
  16. List of the Amphipoda of the L.M.B.C. district, by G. Herbert Fowler, B.A., Owens College; with list of the recorded Isopoda, compiled by Prof. Herdman. (Fauna, vol. i., pp. 212—220, and pl. iv.)
  17. Report on the Podoplthalmata of the L.M.B.C. district, by Alfred O. Walker, F.L.S., Chester. (Fauna, vol. i., pp. 221—226.)
  18. Report on the Pycnogonida of the L.M.B.C. district, by W. B. Halled Liverpool. (Fauna, vol. i., pp. 227—231.)
  19. Report on the Testaceous Mollusca of the L.M.B.C. district, by R. D. Darbishire, Manchester. (Fauna, vol. i., pp. 232—266.)
  20. Report on the Nudibranchiata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., F.L.S. (Fauna, vol. i., pp. 267—277.)
  21. Notes on the Cephalopoda collected by the L.M.B.C. during the summer of 1885, by W. E. Hoyle, M.A., M.R.C.S., F.R.S.E. (Fauna, vol. i., pp. 278—280.)
  22. Report on the Tunicata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., F.L.S. (Fauna, vol. i., pp. 281—311, and pls. v., vi.)
  23. Preliminary list of the Alge of the L.M.B.C. district, by Alfred Leicester, Southport. (Fauna, vol. i., pp. 312—314.)
  24. First Report on the Marine Fauna in the neighbourhood of Penmaenmawr, by Isaac C. Thompson, F.R.M.S. (Fauna, vol. i., pp. 315—317.)
  25. Notes on the Marine Invertebrata of the South End of the Isle of Man, by Prof. W. A. Herdman, D.Sc. (Fauna, vol. i., pp. 318—341, chart.)
  26. Notes on some of the Polycheta collected by the L.M.B.C., by R. J. Harvey Gibson, M.A., F.R.S.E., F.R.M.S. (Fauna, vol. i., pp. 342—353, and pls. vii. and viii.)
  27. Notes on Variation in the Tunicata, by Prof. W. A. Herdman, D.Sc., F.L.S. (Fauna, vol. i., pp. 354—364, and pl. ix.)
  28. On a new species of *Sycandra*, by R. J. Harvey Gibson, M.A., F.R.S.E., F.R.M.S. (Fauna, vol. i., pp. 365—367, and pl. x.)
  29. Note on the possible naturalization of the American Clam, *Venus mercenaria*, on the coasts of Lancashire and Cheshire, by Thomas J. Moore, Liverpool Museum. (Fauna, vol. i., pp. 368—370.)

[The preceding papers, 1—29, form Volume I. of the Reports on the Fauna of Liverpool Bay, published by the Liverpool Marine Biology Committee.]

### 1887.

30. The Liverpool Marine Biology Station on Puffin Island, by Prof. W. A. Herdman. (Nature, vol. xxxvi., pp. 275—277, with cuts, July 21st, 1887.)

31. On *Ascopodaria nodosa*, n.sp., by Joseph Lomas, Assoc. N.S.S. (Proc. Lit. and Phil. Soc., L'pool, vol. xli., p. xlvii.)
32. Notes on the Mysidæ of Liverpool Bay, by A. O. Walker, F.L.S. (Proc. L'pool Biol. Soc., vol. i., pp. 26—28, with cuts.)
33. Notes on the structure of *Alcyonidium gelatinosum*, by Joseph Lomas, Assoc. N.S.S. (Proc. L'pool Biol. Soc., vol. i., pp. 29—33, and pl. iii.)
34. On some Copepoda, new to Britain, found in Liverpool Bay, by Isaac C. Thompson, F.L.S. (Proc. L'pool Biol. Soc., vol. i., pp. 34—39, and pls. iv.—vi.)
35. The Exploration of Liverpool Bay and the neighbouring parts of the Irish Sea by the Liverpool Marine Biology Committee, by Prof. W. A. Herdman, D.Sc., F.L.S. (British Association Report, Manchester, 1887, p. 733.)
36. On some Copepoda, new to Britain, found in Liverpool Bay, by Isaac C. Thompson, F.R.M.S. (British Association Report, Manchester, 1887, p. 734.)
37. The Reproductive Organs of *Alcyonidium gelatinosum*, by Prof. W. A. Herdman. (Nature, vol. xxxvii., p. 213, Dec. 29th, 1887.)

## 1888.

38. The Foundation and First Season's Work of the Liverpool Marine Biological Station on Puffin Island, by Prof. W. A. Herdman, D.Sc. (Proc. L'pool Biol. Soc., vol. ii., pp. 38—62, with cuts.)
39. Second Report on the Copepoda of Liverpool Bay, by I. C. Thompson, F.L.S. (Proc. L'pool Biol. Soc., vol. ii., pp. 63—71, and pls i and ii.)
40. *Cyclista coccinea*, Müll., an Actinarian new to Liverpool Bay, by John W. Ellis, L.R.C.P., &c. (Proc. L'pool Biol. Soc., vol. ii., pp. 72—73.)
41. Report on the Polyzoa of Puffin Island, by Joseph Lomas, Assoc. N.S.S. (Proc. L'pool Biol. Soc., vol. ii., pp. 74—77.)
42. The Geology of Puffin Island, by J. W. Gregory, F.G.S., British Museum. (Proc. L'pool Biol. Soc., vol. ii., pp. 78—94.)
43. Contributions to the Anatomy and Histology of *Limax agrestis*, by Richard Hanitsh, Ph.D. (Proc. L'pool Biol. Soc., vol. ii., pp. 152—170, and pls. x—xii.)
44. Report on the Crustacea of Liverpool Bay 1886-87, by A. O. Walker, F.L.S. (Proc. L'pool Biol. Soc., vol. ii., pp. 171—181, and pl. xiii.)
45. Marine Biology and the Electric Light, by Prof. W. A. Herdman. (Nature, vol. xxxviii., pp. 130—131, June 7th, 1888.)
46. The Utility of Specific Characters, by Prof. W. A. Herdman. (Nature, vol. xxxix., pp. 200—201, Dec. 27th, 1888.)



1889.

47. Second Annual Report of the Liverpool Marine Biological Station on Puffin Island, by Prof. W. A. Herdman, D.Sc. (Proc. L'pool Biol. Soc., vol. iii., pp. 23—45, with chart and cuts.)
  48. Report on the Marine Diatomaceae of the L.M.B.C. district, by Dr. H. Stolterfoth, M.A., Chester. (Proc. L'pool Biol. Soc., vol. iii., pp. 117—127.)
  49. Report on the Marine Alge of the L.M.B.C. district, by R. J. Harvey Gibson, M.A., F.L.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 128—154.)
  50. Second Report on the Porifera of the L.M.B.C. district, by Richard Hanitsch, Ph.D. (Proc. L'pool Biol. Soc., vol. iii., pp. 155—173, and pls. v.—vii.)
  51. Second Report on the Echinodermata of the L.M.B.C. district, by Herbert C. Chadwick. (Proc. L'pool Biol. Soc., vol. iii., pp. 174—180.)
  52. Third Report on the Copepoda of Liverpool Bay (L.M.B.C. district), by Isaac C. Thompson, F.L.S., F.R.M.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 181—191, and pl. viii.)
  53. Appendix to Third Report on the Copepoda of Liverpool Bay (L.M.B.C. district), by Isaac C. Thompson, F.L.S., F.R.M.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 192—194, and pl. ix.)
  54. Third Report on the Higher Crustacea of the L.M.B.C. district, by Alfred O. Walker, F.L.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 195—213, and pls. x. and xi.)
  55. Second Report on the Polyzoa of the L.M.B.C. district, by Joseph Lomas, Assoc. N.S.S. (Proc. L'pool Biol. Soc., vol. iii., pp. 214—224, with cuts.)
  56. Second Report on the Nudibranchiata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., F.L.S., F.R.S.E., and J. A. Clubb. (Proc. L'pool Biol. Soc., vol. iii., pp. 225—239, and pl. xii.)
  57. Second Report on the Tunicata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., F.L.S., F.R.S.E. (Proc. L'pool Biol. Soc., vol. iii., pp. 240—260, and pl. xiii.)
  58. Report on the Seals and Whales (Pinnipedia and Cetacea) of the L.M.B.C. district, by Thomas J. Moore, Corr. Memb. Zool. Soc. Lond. (Proc. L'pool Biol. Soc., vol. iii., pp. 261—278.)
  59. Introduction to Vol. II. of Fauna of Liverpool Bay, by Prof. W. A. Herdman (pp. v—viii, and cut, 1889).
- [Papers 38, 39, 44, and 47—59 form Volume II. of Reports on the Fauna of Liverpool Bay, published by the L.M.B.C. in 1889.]
60. The Liverpool Marine Biology Committee's Easter Dredging Cruise, by Prof. W. A. Herdman. (Nature, vol. xl., p. 47, May 9th, 1889.)

61. On the Structure and Function of the Dorsal Papillæ in Nudibranchiata, by Prof. W. A. Herdman, D.Sc., F.L.S. (British Association Report, Newcastle-upon-Tyne, 1889, pp. 630—633.)
62. On some new and rare Copepoda recently found in Liverpool Bay, by Isaac C. Thompson, F.L.S. (British Association Report, Newcastle-upon-Tyne, 1889, p. 638.)
63. On the Electric Light as a means of attracting Marine Animals, by Prof. W. A. Herdman, D.Sc. (British Association Report, Newcastle-upon-Tyne, 1889, pp. 633—635.)
64. Report of the Committee, consisting of Professors E. A. Schäfer and W. A. Herdman and Mr. W. E. Hoyle (Secretary), appointed to improve and experiment with a deep-sea Tow-net for opening and closing under water. (British Association Report, Newcastle-upon-Tyne, 1889, pp. 111—112.)

## 1890.

65. Third Annual Report of the Liverpool Marine Biological Station on Puffin Island, by Prof. W. A. Herdman, D.Sc., &c.; with first list of the Plants of Puffin Island. (Trans. L'pool Biol. Soc., vol. iv., pp. 36—83, with cuts and chart.)
66. Note on some habits of Crustacea, by A. O. Walker, F.L.S. (Trans. L'pool Biol. Soc., vol. iv., pp. 84—86.)
67. Report on the Land Mollusca of Puffin Island, by Alfred Leicester, Southport. (Trans. L'pool Biol. Soc., vol. iv., pp. 87—90.)
68. On the Structure and Functions of the Cerata or Dorsal Papillæ in some Nudibranchiate Mollusca, by Prof. W. A. Herdman. (Quarterly Journal of Microscopical Science, vol. xxxi., pp. 41—63, pls. vi.—x., 1890.)
69. *Monstrilla* and the Cymbasomatidæ, by I. C. Thompson, F.L.S. (Trans. L'pool Biol. Soc., vol. iv., pp. 115—124, and pl. iv.)
70. Third Report upon the Nudibranchiata of the L.M.B.C. district, by Prof. W. A. Herdman, D.Sc., and J. A. Clubb. (Trans. L'pool Biol. Soc., vol. iv., pp. 131—169., and pls. vi.—ix.)
71. The Sixth Scientific Cruise of the Steamer "Hyæna" with the Liverpool Marine Biology Committee, by Prof. W. A. Herdman. (Nature, vol. xlii., p. 132, June 5, 1890.)
72. Some Experiments on Feeding Fishes with Nudibranchs, by Prof. W. A. Herdman. (Nature, vol. xlii., pp. 201—203, June 26th, 1890.)
73. Report of the Committee, consisting of Professor Haddon, Mr. W. E. Hoyle (Secretary) and Professor W. A. Herdman, appointed for improving and experimenting with a Deep-sea Tow-net for opening and closing under water. (Report of British Association, Leeds, 1890.)

74. Third Report on the Porifera of the L.M.B.C. district, by Richard Hanitsch, Ph.D. (Trans. L'pool Biol. Soc., vol. iv., pp. 192—238, and pls. x—xv.)
75. Report on the Higher Crustacea of Liverpool Bay taken in 1889, by A. O. Walker, F.L.S. (Trans. L'pool Biol. Soc., vol. iv., pp. 239—251, and pl. xvi.)
76. Fourth Annual Report on the Puffin Island Biological Station, by Prof. W. A. Herdman, D.Sc.; with list of the Foraminifera dredged during 1890. (Trans. L'pool Biol. Soc., vol. v., pp. 19-72, with cuts).

## APPENDIX C.

## SUBSCRIPTIONS and DONATIONS.

	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
A Friend (per I. C. Thompson) ...		—		5	0	0
Archer, Francis, B.A., 21, Mulgrave-st.	1	1	0	—		
Banks, Prof. W. Mitchell, 28, Rodney-street ... ..	2	2	0	—		
Bickersteth, Dr., 2, Rodney-street ...	2	2	0	—		
Boodle, L. N., 116, St. Martin's-lane, London, W.C. .. ..		—		0	10	0
Brook, George, 19, Greenhill Gardens, Edinburgh ... ..	1	1	0	—		
Brown, Prof. J. Campbell, University College, Liverpool ... ..	1	1	0	—		
Brown, J. Harvie, Dunipace House, Larbert, N.B. ... ..	0	10	0	—		
Burton, Major, Fryars, Beaumaris ...	2	2	0	—		
Caine, Nath., 10, Orange-court, Castle street ... ..	1	1	0	—		
Caton Dr., 31, Rodney-street... ..		—		1	1	0
Comber, Thomas, Leighton, Parkgate	1	1	0	—		
Davidson, Dr., 2, Gambier-terrace ...	1	1	0	—		
Denny, Prof., Firth College, Sheffield	1	1	0	—		
Derby, Earl of, Knowsley ... ..	5	0	0	—		
Drysdale, Dr., 36A, Rodney-street ...	1	1	0	—		
Dumergue, A. F., 79 Salisbury-road, Wavertree ... ..	0	10	6	—		
Gair, H. W., Smithdown-road, Wavertree ... ..	2	2	0	—		

	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
Gamble, Col. David, C.B., Windlehurst, St. Helens... ..	2	0	0	—		
Gaskell, Holbrook, J.P., Woolton Wood, Much Woolton ... ..	1	1	0	—		
Gibson, R. J. Harvey, 41 Sydenham avenue ... ..	1	1	0	—		
Gifford, J., Whitehouse-terrace, Edin- burgh ... ..	1	0	0	—		
Glynn, Dr., 62, Rodney-street ... ..	1	1	0	—		
Halhed, W. B., Sunnyside, Prince's Park ... ..	1	1	0	—		
Halls, W. J., 35, Lord-street... ..	1	1	0	—		
Henderson, W. G., Liverpool Union Bank ... ..	1	1	0	—		
Herdman, Prof., University College, Liverpool ... ..	2	2	0	—		
Higgin, Thos., Ethersall, Roby ... ..	1	1	0	—		
Holder, Thos., 1, Clarendon-buildings, Tithebarn-street ... ..	1	1	0	—		
Holland, Walter, Mossley Hill-road ... ..	2	2	0	—		
Holt, George, J.P., Sudley, Mossley Hill... ..	1	0	0	—		
Hornell, J., Egremont... ..	1	1	0	—		
Hurst, Dr. C. H., Owens College, Manchester ... ..	—			2	2	0
“Hyæna”—collected on board ... ..	—			3	13	8
Johnstone, Rev. Geo., M.A., 41, Bentley-road ... ..	0	5	0	—		
Jones, Chas. W., Field House, Waver- tree ... ..	5	0	0	—		
Jones, J. Birdsall, 10, St. George's crescent ... ..	1	1	0	—		

	Subscriptions.			Donations.		
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Meade-King, R. R., 4, Oldhall-street...	0	10	0	—		
Meade-King, H. W., Sandfield Park, West Derby ... ..	1	0	0	—		
Melly, George, 90 Chatham-street ...	1	0	0	—		
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Miall, Prof., Yorkshire College, Leeds	1	1	0	—		
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Muspratt, E. K., Seaforth Hall ...	5	0	0	—		
Nicol, W., St. Michael's Mount, St. Michael's ... ..	1	1	0	—		
Oelrichs, W., 3, Wexford-road, Oxtou	1	1	0	—		
Phillips, Prof. R. W., Univ. College, Bangor ... ..	1	1	0	—		
Poole, Sir James, Tower Buildings ...	2	2	0	—		
Rathbone, R. R., Beechwood House, Grassendale ... ..	2	2	0	—		
Rathbone, Theo., the late, Backwood, Neston ... ..	2	2	0	—		
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	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
Shepherd, T., Kingsley Lodge, Chester	1	1	0	—		
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Southport Society of Natural Science	—			0	5	0
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Thornely, James, Baycliff, Woolton...	1	1	0	—		
Thornely, The Misses, Baycliff, Wool- ton ... ..	1	0	0	—		
Toll, J. M., 340, Walton Breck-road	1	1	0	—		
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Walker, Alfred O., Nant-y-glyn, Colwyn Bay... ..	3	3	0	—		
Walker, Horace, South Lodge, Prince's Park ... ..	1	1	0	—		
Watson, A. T., Tapton-crescent, Sheffield ... ..	1	1	0	—		
Westminster, Duke of, Eaton Hall ...	5	0	0	—		
Willmer, Miss J. H., Fernleigh, West- bourne-road, Birkenhead...	0	10	0	—		
	<hr/>			<hr/>		
	100	7	6	12	11	8
Royal Society Grant, per Professor Herdman ... ..				50	0	0
	<hr/>			<hr/>		

# LIVERPOOL MARINE BIOLOGY COMMITTEE.

Dr.

IN ACCOUNT WITH ISAAC C. THOMPSON, HON. TREASURER.

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	£	s.	d.		£	s.	d.
1890.				1890.			
To Balance due Treasurer, 31st December, 1889.....	3		19	By Subscriptions, as per list .....	£99	6	6
„ Salaries of Keeper and Assistant.....	43		10	Arrears paid ... ..	2	2	0
„ Furnishing Rooms at Puffin Island Station .....	3		0		101	8	6
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„ Gosse's "Marine Zoology," &c.....	0		16	Of which £44 3s. 0d. is for Endow- ment and placed to Investment Fund .....	44	3	0
„ Steam Tugs for Dredging .....	23		3		69	17	2
„ Postages and Carriage of Apparatus, Specimens, &c. ....	3		0	„ Grant from Royal Society .....	50	0	0
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„ Printing and Stationery.....	19		8	„ Balance due Treasurer, Dec. 31, 1890	3	13	8
„ Sundries .....	3		4		£126	2	4
	£126		2		80	0	0
			8				

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ALFRED LEICESTER.

LIVERPOOL, 31st December, 1890.



NOTES on some FORAMINIFERA from the RIVER  
MERSEY.

BY E. BURGESS.

[Read November 14th, 1890.]

LAST year Mr. I. C. Thompson gave me a bottle full of a black mud to examine for Foraminifera. The mud had been collected at low-water in the Mersey, near Aigburth, on the Lancashire side, where the exposed part is all soft mud. It is of importance with gatherings of Foraminifera to give the local conditions, and to determine, if possible, which of the forms are associated together in a living state and which have been washed from greater distances and depths. Both J. D. Siddall ("Foraminifera of the River Dee," Proc. Chester Soc. Nat. Sci., part II., 1878) and H. B. Brady (in Brady, Robertson and Brady on "Ostracoda and Foraminifera of Tidal Rivers," Ann. and Mag. Nat. Hist., ser. 4, vol. vi., 1870, pp. 273—306, pls. xi., xii.) have given us information of the greatest importance on the brackish water Foraminifera. The wonderful variety of texture, size, and form that is to be found is surprising. The tests or shells are formed both from the lime to be extracted from the water (where the water seems to contain but very little lime, the envelope becomes of a chitinous character), and also from lime in the shape of minute grains cemented together, along with spicules, grains of sand, and at times smaller foraminiferous shells also agglutinated together, each species having its own peculiar form of shell.

## NOTES ON SOME OF THE FORMS.\*

*Biloculina elongata*, only a few found. There being no other forms would lead one to think that *elongata* under such conditions was a starved variety.

*Spirolocculina*, d'Orb. The few examples of *planulata*, consisting of from three to five or six chambers, would lead one to think them starved also. But when one finds *S. acutimargo* comparatively frequent, having been only found as a great rarity before, it would seem as if it were more at home in brackish water. J. Wright gives as habitat 45, 50 and 25 fathoms; J. D. Siddall, one from estuary of the Dee; H. B. Brady gives from 15 to 1425 fathoms, also shore sand, Madagascar. The Mersey specimens are smaller and not so robust as the "Challenger" specimens.

*Miliolina*, Will. The species *M. seminulum* and *M. subrotunda* are the only ones common in this district, and the latter are principally chitinous examples of *Miliolina*; one example might perhaps have been classed as *M. tricarinata*, but under such altered conditions it was thought better not to include it in the list of species. The *M. sclerotica* was compared with Karrer's plate before naming.

*Adelosina*, d'Orb. *A. bicornis*, the earlier chamber of which is rather rare in this gathering. Mr. C. D. Sherborn has kindly given me a translation of the description of this form from "Note sur le Genre *Adelosina*," Charles Schlumberger, *Bull. Soc. Zool. France*, vol. xi., 1886, p. 546.

"*Adelosina*, shell free, inæquilateral when adult, angular, commencing with a compressed chamber, suborbicular,

\* See list given below, p. 59.

provided with a prolongation; the chambers being placed in a winding series on five opposing faces. The first, circular and compressed, forms a complete whorl; the others occupy a portion of the whorl, rolling themselves round with age, so that it appears that there are five chambers with a simple cavity. Mouth armed with teeth, as in other Agathistéques, and in adults alternately at one or the other extremity of the longitudinal axis."

*Ophthalmidium inconstans*, Br. Here again it would seem as if the ground was adapted for the growth of this species, many having been found here.

*Haplophragmium canariense*, d'Orb. Found in abundance in this mud.

*Ammodiscus gordialis*, J. and P. Of this only one specimen was found. In appearance it is flattened, and like an unwound *Trochammina squamata*, without septation. On the suggestion of Mr. J. D. Siddall I have placed it under the above heading.

*Trochammina*, P. and J. Of this four forms were found, and though marked rather rare, compared with many gatherings, the rather rare might be called frequent in the amount of material to be examined; several of the variety *macrescens* consisted of but very few chambers.

*Textularia*, DeFrance. The few specimens found here named *T. agglutinans* are very small, and might, in some gatherings, but for the earlier chambers, have been mistaken for *T. filiformis*.

*Bulimina*, d'Orb. Of the five species of the above that were found, *B. elegantissima* was the most frequent, except the ever present *B. pupoides*.

*Layena*, Walker and Boys. Seventeen species or varieties of this genus would seem to show that this

locality was favourable to their existence. And, indeed, of all the Foraminifera these were found in greatest abundance.

*Nodosaria*, Lamarek. Both *N. communis* and *N. scalaris* were found of but from two to three chambers, and in great rarity.

*Polymorphina*, d'Orb. *P. lactea* was frequent, but only one specimen of *P. concava* was found, which is not surprising, as it is very small and of great rarity.

*Uvigerina*, d'Orb. *U. angulosa* were frequent, but no other variety found.

*Patellina*, W., *P. corrugata*, are small but of great distinctness in their spiral formation, a form almost peculiar to muddy bottoms.

*Discorbina*, P. and G. The form recently described as *D. ochracea*, both figured and described by Prof. Williamson (Rec. Foram. Gt. Brit., 1858, p. 112; pl. v., fig. 113), has been removed to *Trochammina ochracea*. Of the three forms, *D. globularis* and *D. rosacea* are frequent, but of *D. parisiensis* only two were found.

*Pulvinulina*, Parker and Jones. *P. repanda*, variety *concamerata*, Mont. is figured as a Rotaline shell, both faces convex. But the British forms figured by Williamson (1858, Rec. Foram. Gt. Brit., pl. iv., figs. 101—103), are concave on the inferior side. H. B. Brady (Syn. Brit. Rec. Foram., 1887, p. 921), speaks of there being no record of the above form either on the east coast of England or Scotland, nor in the Irish sea; if the last is correct, this form is new to the latter neighbourhood.

*Nonionina*, d'Orb. *N. depressula* is common, and shows such variety of form and marking that at times it is puzzling to identify it, as it runs so close to other varieties.

*N. scapha* is very rare, and so also is *N. pauperata*, which H. B. Brady describes as "Possibly only the starved condition of *N. scapha*."

*Polystomella*, Lamarck. *P. striato-punctata* is ever present, but *P. crispa* is rather rare.

#### LIST OF THE AIGBURTH (R. MERSEY) FORAMINIFERA.

##### Family II.—MILIOLIDÆ.

*Biloculina elongata*, d'Orb., rare, an elongated variety of *B. ringens*.

*Spiroloculina planulata*, d'Orb., rare, and consisting of only a few chambers.

*S. acutimargo*, Brady, comparatively common, frequent.

*Miliolina oblonga*, Mont., rare.

*M. seminulum*, Linn., common.

\**M. auberiana*, d'Orb., very rare.

\**M. sclerotica*, Karrer, very rare.

*M. subrotunda*, Mont., very common.

*M. fusca*, Brady, rare.

*Adelosina bicornis*, W. and G., rare.

*Ophthalmidium inconstans*, Brady, comparatively common.

*Cornuspira involvens*, Rss., common.

##### Family IV.—LITUOLIDÆ.

*Reophax nodulosa*, Brady, rare.

*Haplophragmium canariense*, d'Orb., common.

*Ammodiscus gordialis*, J. and P., specimen doubtful.

\**Trochammina squamata*, J. and P., rare.

\**T. ochracea*, Will., rather rare.

\* Those species marked with a star are new to the L.M.B.C. district.

*T. inflata*, Mont., rather rare.

do., var. *macrescens*, Brady, rather rare.

Family V.—TEXTULARIDÆ.

*Tertularia agglutinans*, d'Orb., very rare.

*Bigenerina digitata*, d'Orb., very rare.

*Verneuilina polystropha*, Rss., frequent.

*Bulimina pupoides*, d'Orb., frequent.

*B. ovata*, d'Orb., rare.

\**B. fusiformis*, Will., frequent.

*B. marginata*, d'Orb., rare.

*B. elegantissima*, d'Orb., frequent.

*Virgulina schreibersiana*, Csjzek., rare.

*Bolivina punctata*, d'Orb., frequent.

*B. plicata*, d'Orb., frequent.

*B. difformis*, Will., very rare.

*B. dilatata*, Rss., very rare.

*Cassidulina crassa*, d'Orb., very rare.

Family VII.—LAGENIDÆ.

*Lagena globosa*, Mont., rare.

*L. levis*, Mont., very rare.

do., var. *clavata*, d'Orb., common.

\**L. lineata*, Will., rare.

*L. sulcata*, W. & G., frequent.

*L. williamsoni*, Alcock, common.

*L. costata*, Will., very rare.

*L. striata*, d'Orb., common.

*L. gracilis*, Will., very rare.

*L. semistriata*, Will., common.

*L. squamosa*, Mont., frequent.

*L. hexagona*, Will., rare.

*L. melo*, d'Orb., rare.

- L. marginata*, W. & B., frequent.  
*L. lucida*, Will., frequent.  
*L. orbignyana*, Seg., very rare.  
*L. ornata*, Will., very rare.  
*Nodosaria pyrula*, d'Orb., very rare.  
*N. communis*, d'Orb., very rare.  
*N. scalaris*, Batsch., very rare, two to three chambers.  
*Marginulina glabra*, d'Orb., very rare.  
*Cristellaria crepidula*, F. and M., rare.  
*C. rotulata*, Lamk., rare  
 \**C. variabilis*, Rss., very rare.  
*Polymorphina lactea*, W. and J., frequent.  
*P. concava*, Will., very rare.  
*Uvigerina angulosa*, Will., frequent.

Family VIII.—GLOBIGERINIDÆ.

- Globigerina bulloides*, d'Orb., rare.  
*Orbulina universa*, d'Orb., rare, and of a brown colour.  
*Sphæroidina dehiscens*, P. and J., very rare.

Family IX.—ROTALIDÆ.

- Spirillina vivipara*, Ehrenb., very rare.  
*Patellina corrugata*, Will., frequent.  
*Discorbina globularis*, d'Orb., frequent.  
*D. rosacea*, var. *mammilla*, Will., frequent.  
 \**D. parisiensis*, d'Orb., very rare.  
*Planorbulina mediterranensis*, d'Orb., frequent.  
*Truncatulina lobulata*, W. and J., frequent.  
*T. haidingeri*, d'Orb., very rare.  
 \**Pulvinulina repanda* var. *concamerata*, Mont., very rare,  
 concave on inferior side.  
*Rotalia beccarii*, Linn., frequent.  
*R. nitida*, Will., frequent.

## Family X.—NUMMULINIDÆ.

*Nonionina depressula*, W. and J., common.

\**N. pauperata*, B. and W., very rare,

*N. scapha*, F. & M., very rare.

*Polystomella crispa*, Linn., rare.

*P. striato-punctata*, F. and M., common.

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NOTE.—The previously published lists of the Foraminifera of the Liverpool Marine Biology Committee's District are:—Report on the Foraminifera by J. D. Siddall, in "Fauna of Liverpool Bay" vol. I., 1886; and List of Foraminifera dredged during 1890, in Fourth L.M.B.C. Puffin Island Report, App. A., Trans. Biol. Soc., L'pool, vol. V.

[Editor L.M.B.C. Reports].



## NOTES on CUCUMARIA PLANCI.

BY HERBERT C. CHADWICK.

With Plate I.

[Read December 12th, 1890.]

ON June 26th last, while dredging in the Turbot Hole, off Puffin Island, I obtained about twenty specimens of the Holothurian *Cucumaria planci*. The majority of these were of small size, not more than five or six exceeding an inch in length. Selecting three of the largest and most vigorous looking, I placed them in a glass jar holding about a pint of water, in order to watch their habits. Two days later one of the specimens discharged about fifty ova. These were rather less than  $\frac{1}{50}$  of an inch in diameter, pale cream in colour and quite opaque. Each ovum had a mucilaginous investment which, after some hours contact with the surrounding water became distinctly thicker. During the following two or three days I had a number of ova under observation, but beyond the extrusion in one instance of two polar bodies, I saw no signs of development.

On July 6th one of the adult specimens assumed the condition represented in fig. 1, and remained almost motionless until early on the morning of the 8th. The middle portion of the body then became much more attenuated, and a slowly elongating rupture, of which an enlarged representation is given in fig. 2, brought the tightly stretched intestine into view. Then the two ends snapped asunder, and the anterior slowly crawled onward,

leaving the posterior motionless. Fig. 3 represents the condition of things at noon, and immediately afterwards the intestine was detached at its junction with the cloaca in the posterior end *p*, and during the next two or three days was trailed about by the anterior portion *a*. Eventually it decomposed and disappeared in fragments. At no time during the process of division were the tentacles visible. On July 21st I noticed that the posterior end had developed a new mouth and a circlet of minute tentacles. The latter slowly increased in size, but were seldom protruded except after aeration of the water.

On July 26th another specimen repeated the above process of spontaneous division in much the same way and in about the same time, the only variation being that the anterior portion took possession of the whole of the intestine soon after its detachment from the cloaca. This specimen had previously discharged a large number of ova, assisting their dispersion by active play of the tentacles. The process of division was again repeated at the middle of August by the third specimen, and a fortnight later the posterior end of this divided, so that at the end of the month I had seven specimens. *Cucumaria planci* appears to be a hardy species, and well adapted for marine aquaria.

#### EXPLANATION OF PLATE I.

Figs. 1 and 3, show stages in the fission of *Cucumaria planci*, natural size.

Fig. 2, shows rupture of middle of body, enlarged.

Fig. 1.

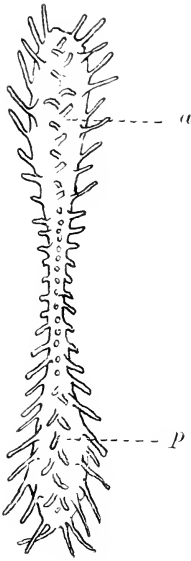


Fig. 2.

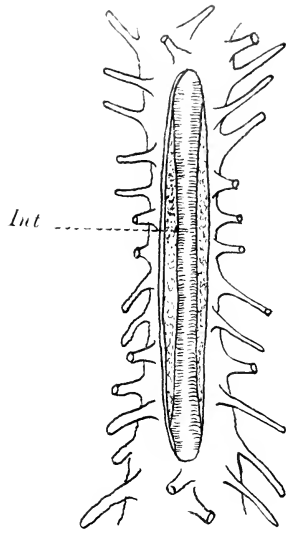
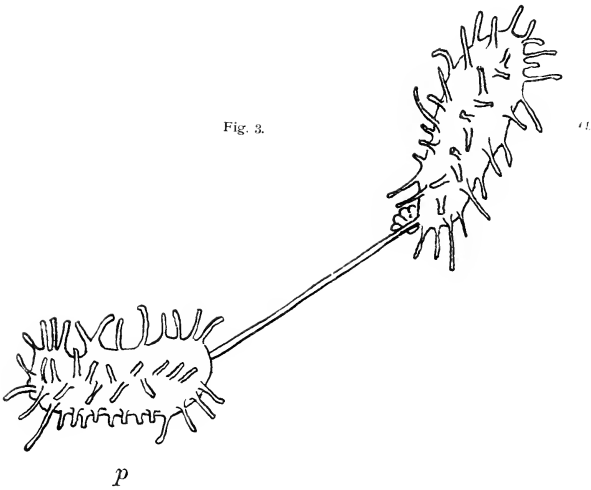


Fig. 3.





A REVISED LIST of the MARINE ALGÆ of the  
L.M.B.C. DISTRICT.

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With Plates II., III., IV., V.

[Read December 12th, 1890, and January 23rd, 1891.]

THE present Report on the Marine Algæ of the district mapped out by the Liverpool Marine Biological Committee as the area of their explorations is a revision and extension of the First Report on the same subject presented to this Society in 1889.\* In that paper I incorporated the observations of previous investigators so far as these seemed of value for the purposes of the Report, and recorded all the species noted by them whether I had myself observed them or not. The list so compiled was necessarily incomplete and faulty—incomplete, seeing that a more careful examination of our coast, keeping in view the very numerous additions to the list of British Marine Algæ since the days of Harvey and Greville, could not but result in a substantial increase to a local list such as the present,—faulty, because many species have been recorded as occurring on our shores almost certainly through mistaken identification, although I was not able at the time to express an opinion on the subject. After consulting algologists like Mr. E. A. L. Batters, Mr. A. W. Bennett and others who have carefully studied the British Marine Flora, I have decided to exclude all such

\* Proc. Biol. Soc., Liverpool, vol. iii., pp. 128—154.

doubtful forms from my list, although I have added an appendix (I) in which these are enumerated, together with the reasons which lead me to suppose that they are very doubtfully natives to our area.

The rapid development of our knowledge of the morphology and life history of Marine Algæ renders necessary many alterations in classification and nomenclature. I have followed the nomenclature and classification used in Messrs. Holmes and Batters' recently published list of the Marine Algæ of Britain.\*

At first I fancied that an appendix containing records of new species and localities, together with abstracts of any observations I had been able to make on certain forms, would meet the present case, but I soon found that scarcely a single line of my former and provisional list expressed precisely what I wished to say with regard to the species therein enumerated, and, moreover, that the additional notes which I desired to insert were so numerous that I felt that it would be much the better way to reprint the entire list, introducing these alterations and additions in their proper places. Where I have altered the name of a species in accordance with more recent views as to its affinities, I have given as well the name (within brackets) by which I designated it in my previous paper. Save in these and other special cases I have not given synonyms nor references to literature. It seemed to me unnecessary to do so, seeing that these are given in full in such easily accessible works as Hauck's *Meeresalgen*, Kjellman's *Algæ of the Arctic Sea*, Farlow's *New England Algæ*, &c.

I have added, with certain necessary modifications, the artificial key to the genera of Marine Algæ, appended to

\* Annals of Botany, vol. v., p. 63.

Prof. Farlow's *List of New England Algæ*, and I have to record my best thanks, not only to Dr. Farlow for his kind permission to use his tables, but also to my friend Mr. E. A. L. Batters, LL.B., F.L.S., for his kindness in adapting the tables to suit our local Marine Flora. I must also express my great indebtedness to Mr. Batters for constant help and advice freely given me during the compilation of this list. My thanks are also due to Mr. George Murray, F.L.S., Mr. A. W. Bennett, F.L.S., and Dr. Edouard Bornet for help in identification of specimens, &c.

My attention has been drawn to certain additional works in which references are made to the Marine Algæ of our district. These are as follows:—

- (1) *Welsh Botany* (1813) by Rev. H. Davies, F.L.S.  
I am indebted to Prof. Phillips of Bangor for a copy of this work;
- (2) *Marine Algæ of the I. of Man*, (*Ann. Nat. Hist.*, vol. vii.) by Dr. G. S. Brady, F.R.S. to whom I beg to return my best thanks for the use of his MS. notes on an interleaved copy of his paper;
- (3) *Marine Algæ of Douglas Bay, I. of Man*, (*Proc. I. of Man Nat. Hist. Soc.*, 1890) by Rev. T. Talbot.
- (4) *Marine Algæ of the I. of Man*, (*Wesley Naturalist*, 1889) by Mr. King.

My own work, since the publication of my former report, has consisted of investigations on the Algæ of Puffin Island during a number of visits to the Biological Station there. On one of these occasions I had the advantage of the company of Mr. Batters and Mr. Murray, when many additional forms new to our list were observed. Mr. Batters and I also paid a visit to Hilbre Island and were successful in making further records. During the Xmas vacation (1890), I paid a visit to Port Erin, I. of

Man, when I was able to confirm many records from that locality made by previous observers. I have incorporated abstracts of two morphological investigations published in the journal of the Linnean Society. I have to record my thanks to the Council of that Society for their kindly granted permission to reprint Plate III.

Much yet remains to be done both on the general Marine Flora and on certain special points in Morphology, Physiology and Distribution. On some of these points I have already prepared a few notes, but they are not in a sufficiently advanced state of preparation to warrant publication at present.

The British Algæ number according to Holmes and Batters over 500 species. The present list includes the names of 256 species and varieties, of which 21 belong to the Cyanophyceæ, 41 to the Chlorophyceæ, 65 to the Phæophyceæ, and 129 to the Rhodophyceæ. Of these 66 were not recorded in my previous list. Several additional species are recorded in Appendix I. as doubtfully natives of our shores.

The following are the names of the species added to the list previously published.

#### CYANOPHYCEÆ.

<i>Dermocarpa prasina</i> , Born.	<i>Symploca hydnoides</i> , Kütz.
<i>D. schousbæi</i> , Born.	<i>Lyngbya spectabilis</i> , Thur.
<i>Spirulina tenuissima</i> , Kütz.	<i>Nodularia harveyana</i> , Mert.
<i>S. pseudotenuissima</i> , Crn.	<i>Calothrix pulvinata</i> , C. Ag.
<i>Oscillaria corallina</i> , Gom.	

#### CHLOROPHYCEÆ.

<i>Prasiola stipitata</i> , Suhr.	<i>Epicladia flustræ</i> , Rke.
<i>Enteromorpha canaliculata</i> , Batt.	<i>Diplonema confervoides</i> , Holm. et Batt.



- Entoderma wittrockii*, Wille.     *Ulothrix implexa*, Kütz.  
*Urospora bangioides*, Holm.     *Codium tomentosum*, Stakh.  
 et Batt.

## PHEOPHYCEÆ.

- Punctaria latifolia*, Grev.     *Asperococcus echinatus*, var.  
*P. latifolia*, f. *zosteræ*, Le Jol.     *vermicularis*, Griff.  
*Desmarestia ligulata*, Lamx.     *Sporochnus pedunculatus*,  
*Stictyosiphon subarticula-*     C. Ag.  
*tus*, Hauck.     *Arthrocladia villosa*, Duby.  
*Ectocarpus terminalis*, Kütz.     *Laminaria hyperborea*, Fos.  
*Isthmoplea sphærophora*,     *Saccorhiza bulbosa*, De la  
 Kjellm.     Pyl.  
*Halopteris filicina*, Kütz.     *Fucus ceranoides*, Linn.  
*Ascocyclus reptans*, Rke.     *Dictyota dichotoma*, var. *im-*  
*Sphacelaria plumigera*,     *plexa*, J. Ag.  
 Holm.     *Taonia atomaria*, J. Ag.  
*Elachista flaccida*, Aresch.     *Phyllitis zosterifolia*, Rke.

## RHODOPHYCEÆ.

- Chantransia secundata*,     *Laurencia obtusa*, Lamx.  
 Thur.     *L. hybrida*, Lenorm.  
*Helminthocladia purpurea*,     *Chondria tenuissima*, C. Ag.  
 J. Ag.     *Polysiphonia urceolata*, var.  
*Helminthora divaricata*,     *patens*, J. Ag.  
 J. Ag.     *P. parasitica*, Grev.  
*Phyllophora traillii*, Holm.     *Dasya arbuscula*, C. Ag.  
 et Batt.     *D. ocellata*, Harv.  
*P. palmettoides*, J. Ag.     *Sphondylothamnion multifi-*  
*Calliblepharis jubata*, Kütz.     *dum*, Næg.  
*Lomentaria clavellosa*, Gaill.     *Spermothamnion turneri*,  
*Champia parvula*, Harv.     Aresch.  
*Bostrychia scorpioides*,     *Rhodochorton membranac-*  
 Mont.     *eum*, Magn.

<i>R. seiriolanum</i> , Gib.	<i>Polyides rotundus</i> , Grev.
<i>Compsothamnion gracillimum</i> , Schmitz.	<i>Schmitziella endoplæa</i> , Born. et Batt.
<i>Callithamnion tetragonum</i> , var. <i>brachiatum</i> , J. Ag.	<i>Lithophyllum lenormandi</i> , Rosan.
<i>Halymenia ligulata</i> , C. Ag.	<i>Chylocladia ovalis</i> , Hook.
<i>Hildenbrandtia prototypus</i> , var. <i>rosea</i> , Kütz.	<i>Melobesia confervoides</i> , Kütz.

In Professor Herdman's Third Report on the Marine Biological Station on Puffin Island,\* reference is made to the presence in the sea of vast numbers of "gelatinous spherical bodies containing minute spicules." The occurrence of these bodies in countless myriads renders the water "foul," and the phenomenon has been observed not only at Puffin Island by members of the L.M.B. Committee, but also at Sheerness by Mr. Shrubsole, at St. Andrew's by Professor McIntosh, and by the naturalists at the Plymouth Station. I have tried to obtain some of this material on several visits to Puffin Island, but hitherto without success. Mr. I. C. Thompson has, however, kindly given me a bottle containing the organisms in question, and this material I handed on to Mr. A. W. Bennett, F.L.S., who is a well known authority on the lower forms of algal life. I am glad to be able to incorporate the following notes which he has kindly sent me.

"The sample sent to me by Mr. Harvey Gibson, from the Menai Straits, contains various diatoms in an interesting condition, but in a very fragmentary state. They belong mostly to the families Melosireæ and Biddulphiæ, and are most nearly allied, as far as I am able to determine, to *Melosira nummuloides* Kütz. and *Biddulphia aurita*, Bréb. (*Odontella aurita*, Ag.) The siliceous coating

\* Liverpool Biol. Soc., vol. iv., p. 40.

is always excessively thin and entirely destitute of markings as far as is shewn by the highest powers at my disposal, though it is probable that under exceptionally good conditions as to light and with still more powerful objectives, the characteristic markings of these families might be detected. But the interesting fact is that the contents of some of the cells are to be found floating free, destitute of any siliceous envelope, and (apparently) in a living condition. This is frequently the case with deep sea species belonging to the allied genus *Rhizosolenia*. I also noticed detached "hones" of *Chaetoceros*, and fronds which I should refer to *Fragilaria striatula*, Lyngb. Besides diatoms there are several other marine algæ, but mostly in a fragmentary condition. There is a *Rhizoclonium*, probably *R. riparium*, Harv. and what I take to be fragments of an epiphytic *Endocladia*."

Mr. Bennett expresses a desire to see further samples of "foul" water, and I take this opportunity of making his desire known, in the hopes that members of the L.M.B. Committee may be able to send him material in a fresh condition.

NOTE.—In using the nomenclature and classification employed by Messrs. Holmes and Batters (*loc. cit.*), I have thought it best to give their authorities for specific nomenclature also. I do so, however, with great reluctance and for the following reasons. In the paper referred to (p. 64) these authors say:—"The authority given for the name of a species is in every case that of the botanist who first employed the name as it now stands, not that of the author who first described the species under another name." Thus, to take an instance, *Urospora bangioides* appears in their list with the authority "Holmes et Batters." This species was, I believe, first described and published

by Harvey under the name of *Conferva bangioides* (Phyc. Brit., pl. 268). Holmes and Batters have on the strength of my observations on the tailed spores of this species, placed it in Areschoug's genus *Urospora*. I think that such a system, substituting as it does the name of the botanist who simply renames for the name of the first discoverer and describer is fundamentally wrong in principle. "Palman qui meruit ferat," and he who discovers and describes is surely much more worthy of honour than he who merely changes the name originally given. If this system be logically followed out by other botanists, we may expect soon to have a flora in which not a single species appears with the name of the first describer appended to it. *Urospora bangioides*, Holm. et Batt. ought, in my opinion to be *Urospora bangioides*, Harv. placed under the genus *Urospora*, Aresch. In the present paper I have used Holmes and Batters' system, only because I do not feel myself competent to say in *all* cases who deserves to be named as the authority, without referring (which I cannot at present do) to the original specimens. In Zoology, I believe, the authority given by almost all authors is the name of the first describer, and that seems to me to be the most just principle on which to go in such matters.

Localities where I have myself collected a species are distinguished by marks of exclamation.

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Series I.—CYANOPHYCEÆ.

Cohort I.—CHROOCOCCINÆ.

Order I.—CHROOCOCCACEÆ.

*Glæocapsa crepidinum*, Thur.

Puffin I. !, Point of Ayr.

## Order II.—CHAMÆSIPHONACEÆ.

*Dermocarpa prasina*, Born.

Puffin I.!, Hilbre I.!

*D. schousbæi*, Born.

Puffin I.!, Hilbre I.!

## Cohort II.—NOSTOCHINÆ.

Section I.—*Homocysteeæ*.

## Order I.—OSCILLARIACEÆ.

## Tribe I.—Oscillariææ.

*Spirulina tenuissima*, Kütz.

Menai Bridge.

*S. pseudotenuissima*, Crn.

Point of Ayr.

*Oscillaria nigroviridis*, Thw.

Eastham.

*O. corallinæ*, Gom.

Point of Ayr.

*Phormidium papyraceum*, Gom.(*Oscillaria spiralis*, Report I.)

Point of Ayr, Eastham, Anglesea.

## Tribe II.—Lyngbyeæ.

*Lyngbya semiplena*, J. Ag.

Point of Ayr, Puffin I.!

*L. æstuarii*, Liebm.

Bromborough Pool, Hilbre I.!, Point of Ayr.

*L. majuscula*, Harv.

Hilbre I., Eastham, Wallasey, Puffin I.!

I found this plant growing at the last mentioned locality in colonies often half a foot or more in diameter.

*L. spectabilis*, Thur. in herb.

Point of Ayr.

*Symploca hydrinoides*, Kütz.

Puffin I.!

## Tribe III.—Vaginarieæ.

*Microcoleus chthonoplastes*, Thur.

Point of Ayr.

Section II.—*Heterocystææ*.

## Order II.—RIVULARIACEÆ.

## Tribe II.—Mastichotricheæ.

*Calothrix confervicola*, C. Ag.

Hilbre I.!, Puffin I.!, I. of Man, Anglesea.

*C. pulvinata*, C. Ag.

Puffin I.!

*C. scopulorum*, C. Ag.

Puffin I.!

*Rivularia biasolettiana*, Menegh.

Eastham!, Hilbre I.!, Point of Ayr.

*R. atra*, Roth.

Hilbre I., Mersey, Anglesea.

## Order V.—NOSTOCHACEÆ.

*Anabæna torulosa*, Lagerh.*(Sphærozyga carmichaelii*, Report I.)

Eastham, Point of Ayr, Anglesea.

*Nodularia harveyana*, Thur.

Point of Ayr.

## Series II.—CHLOROPHYCEÆ.

## Cohort II.—CONFERVINÆ.

## Order I.—BLASTOSPORACEÆ.

*Prasiola stipitata*, Suhr.

Hilbre I.!

## Order II.—ULVACEÆ.

*Monostroma grevillei*, J. Ag.Puffin I.!, I. of Man!. *Enteromorpha intestinalis*,  
var. *cornucopia*, Ahln. recorded from the I. of  
Man, is only a form of this species.*Diplonema confervoides*, Hohn. et Batt.

Point of Ayr.

*Enteromorpha clathrata*, J. Ag.

Eastham, Hilbre I.!, Puffin I.!, I. of Man.!

*E. ralfsii*, Harv.

Bangor. Though a rare species I retain it on the authority of Mr. Ralfs. Marrat records it as "general," which is very unlikely.

*E. erecta*, J. Ag.

New Brighton.

*E. ramulosa*, Harv.

Hilbre I.!

*E. percursa*, C. Ag. var. *ramosa*, J. Ag.

(*E. percursa*, Report I.)

Point of Ayr.

*E. compressa*, Grev.

Hilbre I.!, Puffin I.!, I. of Man.!, Mersey and Dee estuaries!

*E. linza*, J. Ag.

Puffin I.!, Hilbre I.!, Anglesea, I. of Man.

*E. intestinalis*, Link.

Puffin I.!, Hilbre I.!, Anglesea.

*E. canaliculata*, Batt.

Point of Ayr.

*Ulva latissima*, J. Ag.

(*Ulva lactuca*, var. *genuina*, Report I.)

Hilbre I.!, New Brighton, Puffin I.!, Anglesea, I. of Man.

## Order III.—ULOTHRICHACEÆ.

*Ulothrix implexa*, Kütz.

Point of Ayr.

## Order IV.—CHÆTOPHORACEÆ.

*Entoderma wittrockii*, Wille.

Puffin I.!

*E. flustræ*, Rke.

Puffin I.!, Hilbre I.! I have found this species

more frequently on zoophytes than polyzoa, and especially on *Diphasia pumila*.

Order V.—CLADOPHORACEÆ.

*Urospora pencilliformis*, Aresch.

(*Conferva youngana*, Report I.)

Puffin I.!, Anglesea!

*U. flacca*, Holm. et Batt.

(*Ulothrix flacca*, Report I.)

I. of Man, Anglesea, Puffin I.!

*U. bangioides*, Holm. et Batt.

Puffin I.!, Anglesea!

I found this form growing in considerable quantity at the situations named, in the spring of 1890, and thinking at the time that I had found the rare species *Urospora collabens*, I made a careful study of its structure and life history. Through the kindness of Professor E. P. Wright I was enabled to compare my plant with the type specimen of *U. collabens* in the Harveyan Herbarium at Dublin, with the result that my plant proved to be not that species but *Urospora bangioides*. I publish, however, my observations on the species, although in doing so I in great measure repeat Areschoug's work\* on the allied *U. pencilliformis*. The filaments vary greatly in length according to age, an average full grown frond being 6—10 cm. long. The frond is unbranched and tapers to base and apex. Narrower regions also occur in the course of its length. The base is an irregular disc formed by the terminal cell, and frequently two or more cells above the terminal cell. The cell wall is markedly two layered. Cell division is usually regular, but frequently irregular. I have found that this oblique mode of division is associated with a peculiar method of vegetative multiplication.

\* *Observationes Phycologicae*, Pt. I.



Separation of pale green or colourless portions of the protoplasm first of all takes place, followed by oblique septation of the green central portion. One of the tapering cells thus formed then grows outwards, forming a pseudo-branch. The filament then separates into two parts, the isolated portion fixing itself by means of the pale thick-walled process, whilst the already attached part is terminated by a tapering pale green or colourless filament.

Two kinds of zoospores are formed, large and small. The megazoospore is pear-shaped, with a long, tapering hyaline tail, and a large, often distinctly knobbed, colourless but granular head, from the centre of which arise four long flagella, which project at right angles and bend backwards along the sides of the conical body when at rest. When in motion all four flagella move together with a paddling movement. The megazoospores are more plentiful than the zoogametes. Their mode of development is as follows:—A cell usually about the middle of a filament enlarges, the chlorophyll retreats to the centre, and a broad, granular, colourless layer is seen lying nearest to the wall. Radial segmentation then takes place, and the chlorophyll again spreads outwards, still leaving, however, a narrow outer portion colourless or only faintly green, more difficult to see at this stage owing to the spores being crushed against the wall by their rapid increase in size. When ripe the cuticular layer of the cell-wall bursts, and the entire inner wall, with the enclosed spores, escapes. The inner wall speedily deliquesces and the spores are set free. They move slowly, and after a time settle down on some adjacent rough surface. I have watched them settle on a sporiferous filament of *Bangia fuscopurpurea*, and observed the first stages in the development of new filaments. In the course of examination of hundreds of

filaments I have never seen fewer than 32 megazoospores in a cell.

The microzoospores, or zoogametes, are much smaller. They are ovate biciliate, actively motile cells, very pale green at the broader end, and colourless at the point of attachment of the two long cilia. They are produced in vegetative cells, and, so far as I could make out, in other filaments than those which produce megazoospores. The contained mass of zoogametes is much paler in colour than is the content of a megasporangium. The number of zoogametes is 64 or more. Their movements are so rapid that it is almost impossible to count them as they escape, the calculation "64 or more" is based, therefore, on the appearance of the gametangium previous to their escape. I have no doubt that conjugation takes place between cells of the same filament. The mode of conjugation does not differ from that described for *Ulothrix zonata*, by Dodel Port,\* although the tailed megazoospore and the number of these produced in a sporangium places this species in the genus *Urospora*, Aresch. I have not been able to trace the after history of the zygote.

The extrusion of mega- or micro-zoospores from a cell lying between two others whose contents have not been shed is followed by the protusion of the special cell-wall of one of the lateral cells into the cavity, the gametes, or spores of the latter escaping by the rupture already formed in the outer wall of the empty cell. (See Pl. III.)

*Chætomorpha tortuosa*, Kütz.

Prince's Pier, I. of Man, Anglesea.

*C. linum*, Kütz.

Anglesea!, Puffin I.!

*C. melagonium*, Kütz.

Puffin I. I. of Man. Marrat records this spe-

\* Pringsheim's Jahrb. f. wiss. Bot., Bd. X.

cies as "general." He probably mistook *C. linum* for it.

*C. ærea*, Kütz.

Mersey, I. of Man, Puffin I.!

*Rhizoclonium riparium*, Harv.

Hilbre I.!, Puffin I.!, Eastham.

*Cladophora pellucida*, Kütz.

Hilbre I., I. of Man, Puffin I.!

*C. hutchinsiae*, Kütz.

New Brighton, Anglesea, I. of Man, Hilbre I.

*C. utriculosa*, Kütz. var. *lætevirens*, Hauck.

New Brighton, Anglesea, I. of Man, Puffin I.!

*C. rupestris*, Kütz.

Hilbre I.!, I. of Man!, Puffin I.!, Anglesea!

*C. glaucescens*, Griff.

Puffin I.!, Hilbre I.!

*C. fracta*, Kütz.

Bromborough Pool, Anglesea.

*C. flexuosa*, Griff.

New Brighton, Hilbre I., Eastham, Anglesea,  
I. of Man, Puffin I.!

*C. albida*, Kütz.

Eastham, Puffin I.!, I. of Man.

var. *refracta*, Holm. et Batt.

Puffin I., I. of Man.

*C. arcta*, Kütz.

Bromborough Pool, Eastham, Wallasey Pool,  
Hilbre I., I. of Man, Puffin I.!

*C. lanosa*, Kütz.

Puffin I.!, I. of Man, Anglesea.

var. *uncialis*, Thur.

Puffin I., I. of Man.

## Cohort III.—SIPHONINÆ.

## Order I.—BRYOPSIDACEÆ.

*Bryopsis hypnoides*, Lamour.

Hilbre I., I. of Man, Puffin I.

*B. plumosa*, C. Ag.

I. of Man!, Hilbre I., Puffin I.! Anglesea! New Brighton.

## Order III.—VAUCHERIACEÆ.

*Vaucheria dichotoma*, Lyngb. var. *marina*, C. Ag.New Brighton. I have found *Vaucheria* filaments frequently, but as none were in fruit it is impossible to say to what species they belonged.*V. thuretii*, Woron.

Eastham.

## Order IV.—CODIACEÆ.

*Codium tomentosum*, Stackh.

I. of Man!

## Series III.—PHÆOPHYCEÆ.

## Cohort I.—ECTOCARPINÆ.

## Order I.—DESMARESTIACEÆ.

*Desmarestia viridis*, Lamx.

I. of Man, Puffin I.!

*D. aculeata*, Lamx.

I. of Man!, Puffin I.!

*D. ligulata*, Lamx.

I. of Man, Abergele.

## Order II.—DICTYOSIPHONACEÆ.

*Dictyosiphon feniculaceus*, Grev.

Hilbre I.!, Puffin I.!, Penmon Point!, Isle of Man.

## Order III.—PUNCTARIACEÆ.

*Litosiphon pusillus*, Harv.

Hilbre I., Bangor, I. of Man, Puffin I.!

*Stictyosiphon subarticulatus*, Hauck.

Carnarvon.

*Punctaria plantaginea*, Grev.

Hilbre I.!, Puffin I.!, I. of Man!

*P. latifolia*, Grev.

I. of Man.

var. *zosteræ*, Le Jol.

I. of Man.

Order IV.—ASPEROCOCCACEÆ.

*Myriotrichia clavæformis*, Harv.

I. of Man, Hilbre I.!

var. *filiformis*, Farl.

(*M. filiformis*, Report I.)

Hilbre I.!

*Asperococcus echinatus*, Grev.

Hilbre I.!, Puffin I.!, I. of Man.

var. *vermicularis*, Griff.

Puffin I.!

*Streblonema velutinum*, Thur.

(*Ectocarpus velutinus*, Report I.)

Puffin I.!

Order V.—ECTOCARPACEÆ.

*Ectocarpus terminalis*, Kütz.

Puffin I.!, I. of Man.

*E. confervoides*, Le Jol.

var. *siliculosus*, Kjellm.

Puffin I.!, Hilbre I.!, New Brighton, I. of Man.

*E. fasciculatus*, Harv.

Hilbre I.!, Puffin I.!

*E. granulatus*, C. Ag.

New Brighton, Puffin I.!, Hilbre I.!

*E. tomentosus*, Lyngb.

Puffin I.!, Hilbre I.!, New Brighton, I. of Man.

*Isthmoplea sphaerophora*, Kjellm.

Puffin I.!

*Pylaiella litoralis*, Kjellm.

Puffin I.!, I. of Man!

Order VI.—ARTHROCLADIACEÆ.

*Arthrocladia villosa*, Duby.

Anglesea.

Order VII.—ELACHISTACEÆ.

*Elachista scutulata*, Duby.

I. of Man.

*E. fucicola*, Fries.

Puffin I.!, Anglesea!, Hilbre I.!, I. of Man!

*E. flaccida*, Aresch.

Penmon Point!

Marrat records this species on *Cystoseira barbata* at Puffin I., though the host plant does not occur in his list nor on the island.

Order VIII.—SPHACELARIACEÆ.

*Sphacelaria radicans*, Harv.

Mersey, New Brighton, Hilbre I.!, Puffin I.!, I. of Man!

A specimen which I collected in Nov., 1890, at Hilbre I. is, I am informed by Mr. Batters, a monosiphonous variety of this species.

*S. cirrhosa*, C. Ag.

Eastham, Hilbre I.!, Puffin I.!, I. of Man!

var. *fusca*, Holm. et Batt.

(*S. fusca*, Report I.)

Hilbre I.!, Puffin I.!, I. of Man, Anglesea.

*S. plumigera*, Holm.

Carnarvon (*vide* Holmes).

*Chætopteris plumosa*, Kütz.

I. of Man!, Anglesea, Hilbre I.!, Puffin I.!

*Halopteris filicina*, Kütz.

Anglesea, I. of Man!

*Stypocaulon scoparium*, Kütz.

(*Sphacelaria scoparia*, Report I.)

Hilbre I.!, Puffin I.!, I. of Man!, Anglesea.

*Cladostephus spongiosus*, C.Ag.

Puffin I.!, Hilbre I.!, I. of Man!, Anglesea.

*C. verticillatus*, C.Ag.

Puffin I., Anglesea, I. of Man.

Order IX.—MYRIONEMACEÆ.

*Myrionema strangulans*, Grev.

Puffin I.!, I. of Man.

var. *punctiforme*, Thur.

(*M. punctiforme*, Report I.)

Hilbre I.

*Ascocyclus leclancherii*, Magn.

(*Myrionema leclancherii*, Report I.)

Hilbre I., I. of Man.

*A. reptans*, Rke.

Puffin I.!

*Ralfsia verrucosa*, Aresch.

Puffin I.!, Hilbre I.!

Order X.—CHORDARIACEÆ.

*Chordaria flagelliformis*, C.Ag.

Hilbre I., Eastham, I. of Man!, Puffin I.!

*Mesoglaea vermiculata*, Le Jol.

Puffin I.!, Hilbre I.!, I. of Man.

*Castagnea virescens*, Thur.

I. of Man.

*Leathesia difformis*, Aresch.

Hilbre I., Anglesea, I. of Man, Puffin I.!

Cohort II.—LAMINARINÆ.

Order I.—SCYTOSIPHONACEÆ.

*Phyllitis zosterifolia*, Rke.

Puffin I.!, Hilbre I., I. of Man.

*Scytosiphon lomentarius*, J. Ag.

Hilbre I.!, Puffin I.!, I. of Man!

Order II.—CHORDACEÆ.

*Chorda filum*, Stackh.

Hilbre I.!, Puffin I.!, I. of Man.

Order III.—LAMINARIACEÆ.

*Laminaria saccharina*, Lamx.

I. of Man!, Puffin I.!, Anglesea.

*L. hieroglyphica*, J. Ag.var. *phyllitis*, Le Jol.

New Brighton, Puffin I.!

*L. digitata*, Edm.

Puffin I.!, Anglesea!, I. of Man! Hilbre I.!

*L. hyperborea*, Fos.

Puffin I.!, Anglesea!, I. of Man!, Hilbre I.!

For a discussion of this and the preceding species, usually grouped under *L. digitata*, see Foslie's *Contribution to Knowledge of the Marine Algæ of Norway*, Tromsø, 1890, p. 80 *et seq.*, or Batters' *Algæ of Berwick-on-Tweed*, p. 77.

*Saccorhiza bulbosa*, De la Pyl.

I. of Man!

*Alaria esculenta*, Grev.

I. of Man!, Hilbre I., Anglesea.

I have never met with this species either at Hilbre I. or Puffin I., though it occurs in abundance at the I. of Man.

Cohort III.—SPOROCHNINÆ.

Order I.—SPOROCHNACEÆ.

*Sporochnus pedunculatus*, C. Ag.

Anglesea, I. of Man, Puffin I.!

I found only a few fragments of this species at the last-named locality. These were kindly identified for me by Mr. Batters.



## Cohort IV.—CUTLERINÆ.

## Order I.—CUTLERIACEÆ.

*Cutleria multifida*, Grev.

Hilbre I.!, Puffin I.!, I. of Man.

## Cohort V.—FUCINÆ.

## Order I.—FUCACEÆ.

*Fucus ceranoides*, Linn.

Hilbre I.!, Anglesea.

*F. vesiculosus*, Linn.

All rocky parts of the coast!

*F. serratus*, Linn.

All rocky parts of the coast!

*F. platycarpus*, Thur.

Puffin I.!, Hilbre I.!, Point of Ayr.

*Ascophyllum nodosum*, Le Jol.

All rocky parts of the coast!

*Himanthalia lorea*, Lyngb.Anglesea, I. of Man! and cast up on the beach  
at Southport.*Halidrys siliquosa*, Lyngb.

Puffin I.!, Anglesea!, I. of Man!

*Pelvetia canaliculata*, Decne. et Thur.

Hilbre I.!, Puffin I., Anglesea! I. of Man!

I have gathered this species in situations considerably above high water mark. The plants were in a quite healthy condition, although a dash of spray or an occasional wave at high tide must have furnished them with their entire supply of salt water for twelve hours at a time. I have no doubt that the canaliculate nature of the frond enables them to retain what little water they obtain on these occasions to serve them until the recurrence of high tide. It is worth noting that *Enteromorpha canaliculata* is also a characteristically high water species.

## Cohort VII.—DICTYOTINÆ.

## Order I.—DICTYOTACEÆ.

*Dictyota dichotoma*, Lamx.

I. of Man, Puffin I., Anglesea.

var. *implexa*, J. Ag.

Puffin I.!

*Taonia atomaria*, J. Ag.

Anglesea.

## Series IV.—RHODOPHYCEÆ.

## Cohort I.—PORPHYRINÆ.

## Order I.—PORPHYRACEÆ.

*Porphyra laciniata*, C. Ag.

Puffin I.!, Hilbre I.!, I. of Man!

*Bangia fuscopurpurea*, Lyngb.

Puffin I.!, Anglesea!

## Cohort II.—NEMALIONINÆ.

## Order I.—HELMINTHOCLADIACEÆ.

## Tribe I.—Chantransiæ.

*Chantransia virgatula*, Thur.

Hilbre I.!, Puffin I.!, Eastham, I. of Man!

*C. secundata*, Thur.

Puffin I.!

*C. daviesii*, Thur.

Puffin I.!, I. of Man, Anglesea, Mersey.

## Tribe II.—Nemalieæ.

*Helminthocladia purpurea*, J. Ag.

I. of Man.

I leave this species in the list, and do not place it among the "doubtfuls" in Appendix I., because the flora of the I. of Man appears to include many rare forms which one would not expect so far north. I have my doubts, however, as to its being a native of our district. This record stands on Mr. Talbot's authority.

*Helminthora divaricata*, J. Ag.

Anglesea (*vide* Ralfs).

Order III.—GELIDIACEÆ.

Tribe III.—Wrangelieæ.

*Naccaria wiggii*, Endl.

I. of Man.

Tribe IV.—Gelideæ.

*Gelidium corneum*, Lamx.

I. of Man!, Puffin I.!, Hilbre I.!

*G. crinale*, J. Ag.

Eastham, Hilbre I., I. of Man.

Cohort III.—GIGARTININÆ.

Order I.—GIGARTINACEÆ.

Tribe I.—Gigartineæ.

*Chondrus crispus*, Stackh.

Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!,  
Eastham.

*Gigartina mamillosa*, J. Ag.

Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!

Tribe II.—Tylocarpeæ.

*Phyllophora rubens*, Grev.

Hilbre I.!, Puffin I.!, I. of Man!

*P. membranifolia*, J. Ag.

Hilbre I.!, Puffin I.!, I. of Man!, Anglesea.

*P. traillii*, Holm. et Batt.

Puffin I.!

*P. palmettoides*, J. Ag.

I. of Man.

*Gymnogongrus griffithsia*, Mart.

New Brighton, I. of Man.

*G. norvegicus*, J. Ag.

Hilbre I., I. of Man, Rhyl.

*Ahnfeltia plicata*, Fries.

Hilbre I., I. of Man, Puffin I.!

## Tribe III.—Callymenieæ.

*Callophyllis laciniata*, Kütz.

Anglesea!, Puffin I.!

## Order II.—RHODOPHYLLIDACEÆ.

*Cystoclonium purpurascens*, Kütz.Anglesea!, Puffin I.!, Hilbre I.!, New Brighton,  
I. of Man.*Catenella opuntia*, Grev.

Hilbre I.!, Puffin I.!, Eastham, I. of Man,

In the end of October, 1890, whilst on a visit to the Biological Station on Puffin I., I devoted part of my time to collecting *Catenella opuntia*, which grows there in abundance on the protected faces of rocks near high water mark. On examining the plants on my return to Liverpool I was glad to find many, if not all, bearing cystocarps, antheridia and tetraspores. The structure of the cystocarps is practically unknown, indeed they have seldom been seen. I believe that this is the third time they have been found in Britain, and Prof. Schmitz alone has found them abroad. Mr. Buffham found some at Sidmouth in 1886, and Harvey says he received specimens from Mrs. Griffiths. Harvey's figure and description are totally wrong, and as no detailed account of their structure exists anywhere, I examined them minutely, and the conclusions I arrived at were communicated to the Linnæan Society in Dec., 1890. I may here briefly summarise the main points in that paper. The cystocarpic ramuli are borne on erect branches, each articulation bearing one or two such ramuli. The ramulus is spherical and has imbedded in it 50 to 200 carpogenic systems. Only a few of these (10—30) however come to maturity, although most seem to be fertilized. A large placental cell occupies the centre of the ramulus, and radiating from it are numerous branched filaments, which on approaching the surface become short rows

of bead-like cells. From several of these filaments there arise the female organs, each consisting of a carpogenous cell, a unicellular trichophore and a long delicate trichogyne which passes outwards and appears on the surface of the ramulus as a short hair. After fertilization the carpogenous cell produces a mulberry-like mass of carpospores which gradually increase in size and deepen in colour. Pollinoids

Since the printing off of the pages on which the accompanying account of the cystocarps of *Catenella apuntia* occurs, better sections of very young cystocarpic ramuli, together with critical remarks kindly furnished me by Prof. Schmitz, have led me to considerably modify my interpretation of the structure of the "fruit" of this species. In place therefore of the sentences from "The ramulus is spherical" on page 88 to "with that genus" on page 89, read:—"The ramulus is spherical and shortly stalked. When young it consists of a central axial filament composed of four or five cells, surrounded by a reticulum of short hyphæ from which branched chains of coloured cells arise as in the ordinary vegetative ramulus. In the inner rind of the ramulus there arise very numerous trichophoric systems, each composed of a long and delicate trichogyne which appears on the surface of the ramulus as a short process, and a trichophoric portion of one or sometimes two cells. After fertilization of the trichogynes (many or all) chains of carpospores are given off from the reticulum of hyphæ surrounding the axis, and the terminal cell of the axial row enlarges to become a nourishing cell for the carpogenous reticulum. Frequently secondary vegetative cells appear round the trichophoric cells, but these do not (as I at first thought) become carpospores. After fertilization the trichogynes wither and the carpospores are seen forming a dense spherical layer among the sterile hyphæ which lie between the rind cells and the inner reticulum."

For further details I would refer the reader to my Linnæan paper soon to be published. I may add that Plate II. is drawn in accordance with this revised account.

I. OF MAN, ANGIKSEA, TUMBU L., INDIA.

*C. jubata*, Kütz.

I. of Man.

\**System. über d. Florideen*, Flora, 1889.

Tribe III.—Callymenieæ.

*Callophyllis laciniata*, Kütz.

Anglesea!, Puffin I.!

Order II.—RHODOPHYLLIDACEÆ.

*Cystoclonium purpurascens*, Kütz.

Anglesea!, Puffin I.!, Hilbre I.!, New Brighton,  
I. of Man.

however come to maturity, although most seem to be fertilized. A large placental cell occupies the centre of the ramulus, and radiating from it are numerous branched filaments, which on approaching the surface become short rows

of bead-like cells. From several of these filaments there arise the female organs, each consisting of a carpogenous cell, a unicellular trichophore and a long delicate trichogyne which passes outwards and appears on the surface of the ramulus as a short hair. After fertilization the carpogenous cell produces a mulberry-like mass of carpospores which gradually increase in size and deepen in colour. Pollinoids may be seen in the act of fusing with the apex of the trichogyne. The carpogenous cells nearest the placental cell most frequently develop carpospores, though rudimentary cystocarps are common nearer the periphery. The conclusion come to by Schmitz\* is that *Catenella* belongs to the *Cystoclonium* group of the Rhodophyceæ, although the great number of carpogenic systems, it seems to me, does not point to a very close relationship with that genus. I have represented some of the more important features on Plate II. (see explanation of Plates).

Tribe II.—Rhodophyllideæ.

*Rhodophyllis bifida*, Kütz.

Puffin I.!, I. of Man.

Cohort IV.—RHODYMENINÆ.

Order I.—SPHÆROCCACEÆ.

Tribe I.—Sphærocceæ.

*Sphærococcus coronopifolius*, Grev.

I. of Man.

Tribe II.—Gracilarieæ.

*Gracilaria confervoides*, Grev.

I. of Man, Coast of Wales, Hilbre I.!

*Calliblepharis ciliata*, Kütz.

I. of Man, Anglesea!, Puffin I.!, Hilbre I.!

*C. jubata*, Kütz.

I. of Man.

\**System. über d. Florideen*, Flora, 1889.

## Order II.—RHODYMENIACEÆ.

## Tribe I.—Rhodymenieæ.

*Rhodymenia palmata*, Grev.

Puffin I.!, Hilbre I.!, I. of Man!

*R. palmetta*, Grev.

Puffin I.. Anglesea.

*Lomentaria articulata*, Lyngb.*(Chylocladia articulata*, Report I.)Hilbre I.!, New Brighton, Puffin I.!, Eastham,  
I. of Man!*L. clavellosa*, Gaill.

I. of Man.!

*Champia parvula*, Harv.

I. of Man.

*Chylocladia kaliformis*, Grev.

I. of Man, Anglesea.

*C. ovalis*, Hook.

I. of Man.

## Tribe II.—Plocamieæ.

*Plocamium coccineum*, Lyngb.Puffin I.!, Anglesea!, Hilbre I.!, I. of Man!  
New Brighton.

## Order III.—DELESSERIACEÆ.

## Tribe I.—Nitophylleæ.

*Nitophyllum punctatum*, Grev.New Brighton (*vide* Marrat), I. of Man.*N. laceratum*, Grev.

Puffin I.!, Hilbre I.!, I. of Man!

## Tribe II.—Delesserieæ.

*Delesseria alata*, Lamx.

Puffin I.!, Hilbre I.!, I. of Man!, Anglesea!

*D. sinuosa*, Lamx.

Puffin I.!, Anglesea!, Hilbre I.!, I. of Man!



*D. hypoglossum*, Lamx.

Hilbre I.!, Puffin I.!, I. of Man!

*D. ruscifolia*, Lamx.

I. of Man,

*D. sanguinea*, Lamx.

(*Hydrolapathum sanguineum*, Report I.)

Puffin I.!, Anglesea!, I. of Man!

Order IV.—BONNEMAISONIACEÆ.

*Bonnemaisonia asparagoides*, C. Ag.

I. of Man.

Order V.—RHODOMELACEÆ.

Tribe I.—Rhodomeleæ.

*Bostrychia scorpioides*, Mont.

Point of Ayr!, Anglesea.

*Rhodomela subfusca*, C. Ag.

Hilbre I.!, Puffin I.!, I. of Man!, Anglesea.

*R. lycopodioides*, C. Ag.

Puffin I.!, Hilbre I., Eastham, I. of Man.

*Odonthalia dentata*, Lyngb.

I. of Man!, Hilbre I., Puffin I. I have not seen this plant at the two latter localities, but it may occur there as it is fairly common at the I. of Man.

Tribe II.—Laurenciæ.

*Laurencia obtusa*, Lamx.

I. of Man.

*L. hybrida*, Lenorm.

Puffin I.!

*L. pinnatifida*, Lamx.

Puffin I.!, Hilbre I.!, I. of Man!

Tribe IV.—Polysiphoniæ.

*Chondria tenuissima*, C. Ag.

I. of Man.

*Polysiphonia sertularioides*, J. Ag.

(*P. pulvinata*, Report I.)

Puffin I., Eastham, New Brighton, Hilbre I.  
All these localities are on Marrat's authority,  
but I have not been able to confirm his record.

*P. fibrata*, Harv.

Puffin I.!, Hilbre I.!, I. of Man.

*P. urceolata*, Grev.

Puffin I.!, I. of Man.

var. *patens*, J. Ag.

Puffin I.!

var. *formosa*, J. Ag.

Puffin I.!

*P. elongella*, Harv.

Puffin I.!, Anglesea, I. of Man.

*P. elongata*, Grev.

Puffin I.!, I. of Man!

*P. violacea*, Wyatt.

Carnarvon, I. of Man.

*P. fibrillosa*, Grev.

Anglesea!, I. of Man.

*P. fastigiata*, Grev.

Puffin I.!, Hilbre I.!, Anglesea!, I. of Man!  
Mersey!

This species is an almost constant epiphyte on *Ascophyllum nodosum*; I have found it however more than once on *Fucus vesiculosus*. Some notes of observations which I made on the minute structure of the frond and on the origin and development of the tetraspores will be published in an early number of the Journal of Botany.

*P. atrorubescens*, Grev.

I. of Man.

*P. nigrescens*, Grev.

Anglesea!, Puffin I., Hilbre I., I. of Man!,  
Eastham, New Brighton.

*P. parasitica*, Grev.

I. of Man.

*P. byssoides*, Grev.

I. of Man. I have not found this species  
growing, but have often met with it in rejecta-  
menta and in dredgings at Puffin I.

*P. brodiaei*, Grev.

Puffin I., I. of Man.

*P. thuyoides*, Harv.

(*Rhytiphlaea thuyoides*, Report I.)

Puffin I., Hilbre I., I. of Man.

*P. fruticulosa*, Spreng.

(*Rhytiphlaea fruticulosa*, Report I.)

Puffin I., Hilbre I., I. of Man.

Tribe V.—Dasyeæ.

*Dasya coccinea*, C. Ag.

Puffin I., Hilbre I., I. of Man!, Anglesea!

*D. arbuscula*, C. Ag.

I. of Man.

*D. ocellata*, Harv.

I. of Man.

Order IV.—CERAMIACEÆ.

Tribe I.—Spermothamnieæ.

*Sphondylothamnion multifidum*, Näg.

Port Jack, I. of Man (1876) (*vide* Talbot).

*Spermothamnion turneri*, Aresch.

I. of Man.

var. *repens*, Le Jol.

Puffin I., Hilbre I.!

Tribe II.—Griffithsieæ.

*Griffithsia corallina*, C. Ag.

I. of Man.

*G. setacea*, C. Ag.

I. of Man!, Hilbre I.!, Puffin I.!, New Brighton.

*Halurus equisetifolius*, Kütz.

(*Griffithsia equisetifolia*, Report I.)

North Wales (*vide* Ralfs).

Tribe III.—Monosporeæ.

*Monospora pedicellata*, Solier.

Hilbre I.!, Puffin I.!

*Pleonosporium borneri*, Næg.

I. of Man, Hilbre I., New Brighton.

Tribe IV.—Callithamnieæ.

*Rhodochorton rothii*, Næg.

Puffin I.!, Anglesea!, Hilbre I.!, I. of Man!

Mersey.

*R. floridulum*, Næg.

Puffin I.!, Hilbre I.!, Anglesea!, I. of Man!

*R. membranaceum*, Magn.

Puffin I.!, Hilbre I.!, I. of Man!

*R. seiriolanum*, Gib.

This species of *Rhodochorton* I have ventured to record as new to science.\* In character it seems intermediate between the genera *Callithamnion* and *Rhodochorton*. The erect filaments are unbranched and spring from a membranous disc. The tetrasporangia are borne secundately near the apex of the filaments, the oldest near the apex. The species is a very minute one, the filaments being on an average less than 1 mm. long. I found it as an epiphyte on the main stems of *Polysiphonia urceolata* var. *patens*, in the Beacon Channel, West Spit, Puffin I. In the same paper (*l.c.*) I described the mode of formation of sporangia in the genus *Rhodochorton* by a process of innovation, a phenomenon which has been observed in

certain Phæophyceæ also. After the tetraspores have been shed the cell next below the empty sporangium grows up within the empty cell-wall and by abstriction and segmentation of its contents forms a new sporangium. This process may be repeated several times. For permission to reprint Plate III. I am indebted to the courtesy of the Council of the Linnæan Society.

*Callithamnion polyspermum*, C. Ag.

Hilbre I.!, Puffin I.!, Anglesea!, I. of Man.

*C. roseum*, Harv.

Hilbre I.!, I. of Man.

*C. hookeri*, C. Ag.

Puffin I.!, New Brighton, I. of Man.

*C. arbuscula*, Lyngb.

I. of Man.

*C. tetragonum*, C. Ag.

Puffin I.!, I. of Man.

var. *brachiatum*, J. Ag.

I. of Man.

*C. corymbosum*, Lyngb.

Hilbre I.!, Puffin I.!, I. of Man.

*C. granulatum*, C. Ag.

Puffin I.!, I. of Man!

*C. seirospermum*, Griff.

Hilbre I.!, I. of Man.

Tribe V.—Compsothamnieæ.

*Compsothamnion thuyoides*, Schmitz.

I. of Man.

*C. gracillimum*, Schmitz.

Beaumaris (*fide* Gulson).

Tribe VI.—Ptiloteæ.

*Ptilota plumosa*, C. Ag.

Puffin I.!, Hilbre I.!, I. of Man!, Holyhead.

*Plumaria elegans*, Schmitz.

(Ptilota elegans, Report I.)

Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!

Tribe VII.—Crouanieæ.

*Antithamnion cruciatum*, Näg.

Hilbre I.!

*A. plumula*, Thur.I. of Man (*fide* Brady, Gatty).

Tribe VIII.—Spyrideæ.

*Spyridea filamentosa*, Harv.Holyhead (*fide* Marrat).

Tribe IX.—Ceramieæ.

*Ceramium tenuissimum*, J. Ag.

Hilbre I.!, Puffin I.!, I. of man.

*C. fastigiatum*, Harv.

Hilbre I., I. of Man.

*C. deslongchampsii*, Chauv.

Hilbre I.!, Puffin I.!, New Brighton, I. of Man!

*C. strictum*, Harv.var. *divaricata*, Holm. et Batt.(*C. diaphanum*, Report I.)

New Brighton, Hilbre I., Puffin I.!, I. of Man.

*C. circinatum*, J. Ag.(*C. decurrens*, Report I.)

Hilbre I.!, Puffin I.!, I. of Man.

*C. rubrum*, C. Ag.

Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!

var. *proliferum*, J. Ag.

I. of Man.

*C. ciliatum*, Ducluz.

Puffin I.!, I. of Man.

*C. cchionotum*, J. Ag.

Puffin I.!, I. of Man.

*C. flabelligerum*, J. Ag.

Puffin I.!, I. of Man.

*C. acanthonotum*, Carm.

Hilbre I.!, Puffin I.!, I. of Man!

Cohort V.—CRYPTONEMINÆ.

Order I.—GLÆOSIPHONIACEÆ.

*Glæosiphonia capillaris*, Carm.

I. of Man, Anglesea.

Order II.—GRATELOUPIACEÆ.

*Halymenia ligulata*, C. Ag.

Anglesea, I. of Man.

Order III.—DUMONTIACEÆ.

*Dumontia filiformis*, Lamx.

Hilbre I., I. of Man, Anglesea!, Puffin I.!

*Dilsea edulis*, Stackh.

(*Sarcophyllis edulis*, Report I.)

Puffin I.!, I. of Man!, Anglesea.

Order IV.—NEMASTOMACEÆ.

Tribe II.—Halarachmiæ.

*Furcellaria fastigiata*, Lamx.

I. of Man!, Hilbre I.!, Eastham, New Brighton, Rock Ferry. The last three localities stand on Marrat's authority. I have never met with it in these situations.

Order V.—RHIZOPHYLLIDACEÆ.

*Polyides rotundus*, Grev.

Puffin I.!, Anglesea!, I. of Man!

Order VI.—SQUAMARIACEÆ.

Tribe I.—Cruoriæ.

*Petrocelis cruenta*, J. Ag.

Puffin I.!, Hilbre I.!, Mersey, New Brighton.

Tribe II.—Squamariæ.

*Peyssonnelia dubyi*, Crn.

I. of Man (*vide* Leicester).

## Order VII.—HILDENBRANDTIACEÆ.

*Hildenbrandtia prototypus*, Nardo.var. *rosea*, Kütz.

Puffin I.!, I. of Man!

## Order VIII.—CORALLINACEÆ,

*Schmitziella endophlæa*, Born. et Batt, MS.

Puffin I.!

“This very interesting endophytic alga, which forms rose-red, membranous, veined expansions within the outer cell-wall of the articulations of *Cladophora pellucida*, was first noticed on the coast of France by Dr. E. Bornet, in 1854. Dr. Bornet delayed publishing a description of the plant as he wished to more thoroughly examine it in a living state. Meanwhile I found the plant at Torquay, in 1885, and, believing it to be an undescribed alga, proposed to call it *Erythrocelis cladophora*, but on learning that Dr. Bornet had previously found and provisionally named the plant, I discarded my manuscript name of *Erythrocelis* in favour of his name of *Schmitziella*, and we propose to publish a description of the plant under that name very shortly. The alga has been found at various places in France and England, and I may here mention that Mr. G. Murray has kindly called my attention to the fact that in Edw. Forbes’s collection of Algæ, now in the British Museum, there is a specimen of *Cladophora pellucida* apparently gathered by Dillwyn at Yarmouth which has this curious alga endophytic in it. Dr. Bornet informs me that he has seen similar specimens gathered by Ralfs.” (E. A. L. Batters).

*Melobesia confervoides*, Kütz.

I. of Man.

*M. pustulata*, Lamx.

Puffin I.!, I. of Man.



- M. farinosa*, Lamx.  
Puffin I.!
- M. membranacea*, Lamx.  
Puffin I.!, I. of Man.
- M. verrucata*, Lamx.  
Puffin I.!
- Lithophyllum lichenoides*, Phil.  
I. of Man!
- L. lenormandi*, Rosan.  
Puffin I.!, I. of Man!
- Lithothamnion polymorphum*, Aresch.  
I. of Man!
- L. calcareum*.  
Dredged from the Irish Sea!
- Corallina officinalis*, Linn.  
Hilbre I.!, Puffin I.!, Anglesea!, I. of Man!
- C. rubens*, Ellis et Sol.  
Puffin I.!, I. of Man!
-

## APPENDIX I.

I have thought it best to add in an appendix species recorded by previous collectors which require confirmation, or are almost certainly recorded through mistaken identification.

## CYANOPHYCEÆ.

*Rivularia nitida*, Ag., recorded by Brady and Talbot from the I. of Man.

## CHLOROPHYCEÆ.

*Enteromorpha granulosa*,—? recorded by Marrat from New Brighton is not a species of *Enteromorpha* known to science.

*Rhizoclonium casparyi*, Harv., recorded by Marrat from Eastham must be considered as doubtful. Harvey himself was doubtful of its specific value, and Holmes and Batters make it a variety of *R. riparium*.

*Cladophora rudolphiana* (Ag.) Harv. Hilbre I. (Marrat), very doubtful and certainly wants confirmation.

## PHEOPHYCEÆ.

*Litosiphon laminarie*, Harv., is recorded by Marrat as epiphytic on *Chorda filum* at Bangor and Hilbre I. This species is an epiphyte on *Alaria esculenta*. Marrat records *Alaria esculenta* from these localities, but, as I have stated above, I have not been able to confirm his observation.

*Striaria attenuata*, Grev., is recorded by Marrat, but he gives no locality.

*Asperococcus bullosus*, Lamx., is recorded by Marrat without locality.

*Aglaozonia parvula*, (Grev.) Zanard. "General" (Marrat)!

The "general" occurrence of the species (which is *A. reptans*, Kütz.) is, I fear, not correct. Even its local occurrence is doubtful and requires confirmation.

*Sargassum linifolium*, (Turn.) Ag., recorded in my last report, is of course an ocean waif, and has no place amongst British Algæ.

*Ascophyllum nodosum*, var. *scorpioides*, Hauck., was recorded in my last Report. I withdraw it as my plant turned out on further examination to be only a dwarf specimen of the type.

*Cystoseira*, Ag. Four species of this genus, viz.: *ericoides*, *feniculaceus*, *fibrosa*, and *barbata*, are recorded by Garner and Marrat from I. of Man and Hilbre I. It is certainly remarkable that these species should be found growing with *Odonthalia dentata* at the I. of Man, and I prefer to place them in this list of "doubtfuls" until authentic specimens are forthcoming.

*Dictyopteris polypodioides*, (Desf.) Lamx. is recorded by Garner from I. of Man. This must also be confirmed before it can be received as a known native of our coast.

#### RHODOPHYCEÆ.

*Nemalion multifidum*, (Web. et Mohr.) J. Ag., recorded as "general" by Marrat!

*Callithamnion brodiaei*, Harv. I. of Man (Marrat) is probably a mistake for *C. hookeri*.

*Callithamnion pluma* (Dillw.) Ag. A mistaken identification of my own for *Spermothamnion turneri*, var. *repens*.

*Griffithsia barbata*, (Eng. Bot.) Ag. New Brighton! (Marrat). This is almost certainly a mistake.

*Microcladia glandulosa*, (Soland.) Grev., recorded by Garner from the I. of Man requires confirmation.

*Euthora cristata* (Linn.) J. Ag., recorded by Talbot from I. of Man, but marked doubtful.

*Rhytiphlæa pinnastroides*, Harv., which has now been placed in the genus *Halopithys*, is recorded without locality by Marrat.

*Melobesia rubra*, Menegh., recorded by Marrat, is a name unknown to me and to other algologists to whom I mentioned it.

*Lithothamnion fasciculatum*, (Lamx.) Aresch. Puffin I. (Marrat), requires confirmation.

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## APPENDIX II.

### LITERATURE dealing with the LOCAL MARINE FLORA.

1. Welsh Botanology (1813), by Rev. H. Davies, F.L.S.
2. Algæ of the I. of Man, &c., by Dr. G. S. Brady, F.R.S. *Ann. Nat. Hist.*, Jan., 1861.
3. Articles by F. P. Marrat of the Liverpool Museum. *Liverpool Nat. Scrapbook*, 1863—4.
4. Preliminary list of Algæ of L. M. B. C. District, by Alf., Leicester. *First Report upon the Fauna of Liverpool Bay*, 1886.
5. Algæ of Puffin I., by C. S. Gregson. *Naturalist*, Vol. II.
6. First Report on the Marine Algæ of the L. M. B. C. District by R. J. Harvey Gibson, M.A., F.L.S. *Proc. Liv. Biol. Soc.*, Vol. III.
7. Marine Algæ of Douglas Bay, by Rev. T. Talbot. *Yn Lioar Manninagh.*, April, 1890.
8. Records in Greville's *Alge Britannicæ*, Croall and Johnstone's *British Seaweeds*, Harvey's *Phycologia Britannica*, &c.

## APPENDIX III.

I have subdivided the coastline of the district into four sections:—(1) The Mersey and Dee Estuaries, (2) Hilbre I., (3) Anglesea and Puffin I., (4) I. of Man. The first is characterised by mud flats and sand banks with occasional rocks; Hilbre Island has many forms not found in the estuary which prefer caves and rock shelves; Anglesea and Puffin I. have a rich flora, the coastline being precipitous and more favourable to Rhodophyceæ and Phæophyceæ, whilst the I. of Man is peculiar on account both of its isolated position and also of its climate, which permits of an approximation of northern and southern forms.



Map of the L. M. B. C. District. H, Hilbre I.; P, Puffin I. (The island itself is not marked); D, Douglas; R, Ramsey; E, Port Erin; C, Calf of Man.

The tables of distribution indicate only records of observed occurrence, and are not to be taken as indicating negative as well as positive distribution.

	1	2	3	4
<b>CYANOPHYCEÆ.</b>				
<i>Glæocapsa crepidinum</i> .....	×			
<i>Dermocarpa prasina</i> .....		×	×	
<i>D. schousbæi</i> .....		×	×	
<i>Spirulina tenuissima</i> .....				
<i>S. pseudotenissima</i> .....	×			
<i>Oscillaria nigroviridis</i> .....	×			
<i>O. coralline</i> .....	×			
<i>Phormidium papyraceum</i> .....	×			
<i>Lyngbya semiplena</i> .....	×			
<i>L. æstuarii</i> .....	×			
<i>L. majuscula</i> .....	×			
<i>L. spectabilis</i> .....	×			
<i>Symploca hydroides</i> .....				
<i>Microcoleus chthonoplastes</i> .....	×			
<i>Calothrix confervicola</i> .....		×		
<i>C. pulvinata</i> .....				
<i>C. scopulorum</i> .....				
<i>Rivularia biasolettiana</i> .....	×	×	×	
<i>R. atra</i> .....	×	×	×	
<i>Anabena torulosa</i> .....	×	×	×	
<i>Nodularia harveyana</i> .....	×	×	×	
<b>CHLOROPHYCEÆ.</b>				
<i>Prasiola stipitata</i> .....				
<i>Monostroma grevillei</i> .....		×		×
<i>Diplonema confervoides</i> .....	×			
<i>Enteromorpha clathrata</i> .....	×			
<i>E. ralfsii</i> .....	×			
<i>E. erecta</i> .....	×			
<i>E. percursa</i> , var. <i>ramosa</i> .....	×			
<i>E. compressa</i> .....	×			
<i>E. linza</i> .....	×			
<i>E. intestinalis</i> .....	×			
<i>E. canaliculata</i> .....	×			
<i>Ulva latissima</i> .....	×			
<i>Ulothrix implexa</i> .....	×			
<i>Entoderma wittrockii</i> .....		×		
<i>E. fluviæ</i> .....				
<i>Urospora pectiniformis</i> .....				
<i>U. fluviæ</i> .....				
<i>U. bangioides</i> .....				
<i>Chætomorpha tortuosa</i> .....	×			
<i>C. linum</i> .....				
<i>C. melagonium</i> .....				
<i>C. ærea</i> .....				
<i>Rhizocolonium riparium</i> .....	×			
<i>Gladophora pellucida</i> .....	×			
<i>C. hutchinsiae</i> .....	×			
<i>C. utriculosa</i> , var. <i>laetevirens</i> .....	×			

	1	2	3	4
<i>C. rupestris</i> .....	X	X	X	X
<i>C. glaucescens</i> .....	X	X	X	X
<i>C. fracta</i> .....	X	X	X	X
<i>C. flexuosa</i> .....	X	X	X	X
<i>C. albida</i> .....	X	X	X	X
" <i>var. refracta</i> .....	X	X	X	X
<i>C. arcta</i> .....	X	X	X	X
<i>C. lanosa</i> .....	X	X	X	X
" <i>var. unciatilis</i> .....	X	X	X	X
<i>Bryopsis hypnoides</i> .....	X	X	X	X
<i>B. plumosa</i> .....	X	X	X	X
<i>Vaucheria dichotoma</i> , <i>var. marina</i> ..	X	X	X	X
<i>V. thuretii</i> .....	X	X	X	X
<i>Codium tomentosum</i> .....	X	X	X	X
PHEOPHYCÆ.				
<i>Desmarestia viridis</i> .....	X	X	X	X
<i>D. aculeata</i> .....	X	X	X	X
<i>D. ligulata</i> .....	X	X	X	X
<i>Dictyosiphon feniculaceus</i> .....	X	X	X	X
<i>Litosiphon pusillus</i> .....	X	X	X	X
<i>Stictosiphon subarticulatus</i> .....	X	X	X	X
<i>Punctaria plantaginea</i> .....	X	X	X	X
<i>P. latifolia</i> .....	X	X	X	X
" <i>var. zostere</i> .....	X	X	X	X
<i>Myriotrichia clavaformis</i> .....		X	X	X
" <i>var. filiformis</i> .....		X	X	X
<i>Asperococcus echinatus</i> .....		X	X	X
" <i>var. vermicularis</i> .....		X	X	X
<i>Streblonema retulinum</i> .....		X	X	X
<i>Ectocarpus terminatus</i> .....		X	X	X
<i>E. confertoides</i> , <i>var. siliculosus</i> .....		X	X	X
<i>E. fasciculatus</i> .....		X	X	X
<i>E. granulatus</i> .....		X	X	X
<i>E. tomentosus</i> .....		X	X	X
<i>Isthmoplea sphaerophora</i> .....		X	X	X
<i>Pylaiella littoralis</i> .....		X	X	X
<i>Arthrocladia villosa</i> .....		X	X	X
<i>Elachista scutulata</i> .....		X	X	X
<i>E. fucicola</i> .....		X	X	X
<i>E. flaccida</i> .....		X	X	X
<i>Sphaercharia radicans</i> .....		X	X	X
<i>S. cirrhosa</i> .....		X	X	X
" <i>var. fusca</i> .....		X	X	X
<i>S. plumigera</i> .....		X	X	X
<i>Chactopteris plumosa</i> .....		X	X	X
<i>Halopteris filicina</i> .....		X	X	X
<i>Styopocaulon scoparium</i> .....		X	X	X
<i>Cladostephus spongiosus</i> .....		X	X	X

	1	2	3	4
<i>C. verticillatus</i> .....			X	X
<i>Myrionema strangulans</i> .....			X	X
" <i>var. punctiforme</i>		X		
<i>Ascocyclus leclancheri</i> .....		X		
<i>A. reptans</i> .....		X		
<i>Ralfsia verrucosa</i> .....		X	X	X
<i>Chordaria flagelliformis</i> .....	X	X	X	X
<i>Mesoglea vermiculata</i> .....		X	X	X
<i>Castagnea virescens</i> .....		X	X	X
<i>Leathesia difformis</i> .....		X	X	X
<i>Phyllitis zosterifolia</i> .....		X	X	X
<i>Scytosiphon lomentarius</i> .....		X	X	X
<i>Chorda filum</i> .....		X	X	X
<i>Laminaria saccharina</i> .....		X	X	X
<i>L. hieroglyphica, var. phyllitis</i> .....	X			
<i>L. digitata</i> .....		X	X	X
<i>L. hyperborea</i> .....		X	X	X
<i>Saccorhiza bulbosa</i> .....		X	X	X
<i>Alaria esculenta</i> .....		X	X	X
<i>Sporochuus pedunculatus</i> .....		X	X	X
<i>Cutleria multifida</i> .....		X	X	X
<i>Fucus ceranoides</i> .....		X	X	X
<i>F. vesiculosus</i> .....	X	X	X	X
<i>F. serratus</i> .....	X	X	X	X

	1	2	3	4
<i>F. platycarpus</i> .....	X	X		
<i>Ascophyllum nodosum</i> .....	X	X		
<i>Himanthalia lorea</i> .....		X	X	X
<i>Halidrys siliquosa</i> .....		X	X	X
<i>Pelvetia canaliculata</i> .....		X	X	X
<i>Dictyota dichotoma</i> .....		X	X	X
" <i>var. implexa</i> .....		X	X	X
<i>Taonia atomaria</i> .....		X	X	X
RHODOPHYCEÆ.				
<i>Porphyra laciniata</i> .....		X	X	X
<i>Bangia fuscopurpurea</i> .....		X	X	X
<i>Chantreusia virgatula</i> .....	X			
<i>C. secundata</i> .....		X		
<i>C. daviesii</i> .....	X			
<i>Helminthocladia purpurea</i> .....		X	X	X
<i>Helminthora divaricata</i> .....		X	X	X
<i>Naccaria wigghii</i> .....		X	X	X
<i>Gelidium cornutum</i> .....	X	X		
<i>G. crinale</i> .....	X	X		
<i>Chondrus crispus</i> .....		X	X	X
<i>Gigartina mamillosa</i> .....		X	X	X
<i>Phyllophora rubens</i> .....		X	X	X
<i>P. membranifolia</i> .....		X	X	X
<i>P. traillii</i> .....		X	X	X





	1	2	3	4
<i>P. parasitica</i> .....			X	X
<i>P. byssoides</i> .....			X	X
<i>P. brodiaei</i> .....			X	X
<i>P. thuyoides</i> .....		X	X	X
<i>P. fruticulosa</i> .....		X	X	X
<i>Dasya coccinea</i> .....		X	X	X
<i>D. arbuscula</i> .....			X	X
<i>D. ocellata</i> .....			X	X
<i>Sphondylorhamnion multifidum</i> .....			X	X
<i>Spermothamnion turneri</i> .....			X	X
" <i>var. repens</i> .....				
<i>Griffithsia corallina</i> .....		X	X	X
<i>G. setacea</i> .....	X	X	X	X
<i>Haburus equisetifolius</i> .....			X	X
<i>Monospora pedicellata</i> .....		X	X	X
<i>Pleonosporium barreri</i> .....	X	X	X	X
<i>Rhodochorton rothii</i> .....	X	X	X	X
<i>R. floridulum</i> .....		X	X	X
<i>R. membranaceum</i> .....		X	X	X
<i>R. seivolanum</i> .....			X	X
<i>Callithamnion polyspermum</i> .....		X	X	X
<i>C. roscum</i> .....		X	X	X
<i>C. hookeri</i> .....	X		X	X
<i>C. arbuscula</i> .....			X	X
<i>C. tetragonum</i> .....			X	X
" <i>var. brachiatum</i> .....			X	X
<i>C. corymbosum</i> .....		X	X	X
<i>C. granulatum</i> .....		X	X	X
<i>C. seirospermum</i> .....		X	X	X
<i>Compsothamnion thuyoides</i> .....		X	X	X
<i>C. gracillimum</i> .....		X	X	X
<i>Ptilota plumosa</i> .....		X	X	X
<i>Phumaria elegans</i> .....		X	X	X
<i>Antithamnion cruciatum</i> .....		X	X	X
<i>A. plumula</i> .....		X	X	X
<i>Spyridia filamentosa</i> .....		X	X	X
<i>Ceramium tenuissimum</i> .....		X	X	X
<i>C. fastigiatum</i> .....		X	X	X
<i>C. deslongchampsii</i> .....	X	X	X	X
<i>C. strictum, var. divaricata</i> .....	X	X	X	X
<i>C. cinctatum</i> .....		X	X	X
<i>C. rubrum</i> .....		X	X	X
" <i>var. proliferum</i> .....			X	X
<i>C. ciliatum</i> .....			X	X
<i>C. echionotum</i> .....			X	X
<i>C. flabelligerum</i> .....			X	X
<i>C. acanthonotum</i> .....			X	X
<i>Glaosiphonia capillaris</i> .....		X	X	X

ANALYSIS OF TABLES.

	1	2	3	4
<i>Halymenia ligulata</i> .....		X	X	X
<i>Dumontia filiformis</i> .....		X	X	X
<i>Dilsea edulis</i> .....		X		X
<i>Furcellaria fastigiata</i> .....	X		X	X
<i>Polyides rotundus</i> .....	X	X	X	X
<i>Petrocelis eruenta</i> .....				X
<i>Peyssonelia dubyi</i> .....			X	X
<i>Hildebrandtia prototypus</i> , var. <i>rosea</i>			X	X
<i>Schmitziella endophlœa</i> .....			X	X
<i>Melobesia confervoides</i> .....			X	X
<i>M. pustulata</i> .....			X	X
<i>M. farinosa</i> .....			X	X
<i>M. membranacea</i> .....			X	X
<i>M. verrucata</i> .....			X	X
<i>Lithophyllum lichenoides</i>			X	X
<i>L. lenormandi</i> .....			X	X
<i>Lithothamnion polymorphum</i>			X	X
<i>L. calcareum</i> .....			X	X
<i>Corallina officinalis</i> .....	X		X	X
<i>C. rubens</i> .....			X	X

	1	2	3	4
CYANOPHYCEÆ .....	14	7	13	1
CHLOROPHYCEÆ .....	21	16	31	21
PHÆOPHYCEÆ .....	11	36	54	46
RHODOPHYCEÆ .....	23	57	91	109
	69	116	189	177

## APPENDIX IV.

ARTIFICIAL KEY to the GENERA of MARINE  
ALGÆ found within the L.M.B.C. District.

(Adapted by Mr. E. A. L. Batters, F.L.S., from the Artificial Key appended to Prof. Farlow's *New England Algæ*.)

NOTE.—“As far as possible the characters used are those which can be seen by the naked eye, but in many cases the generic distinctions absolutely depend on microscopic characters. It should, of course, be understood that the key is entirely artificial and does not represent the true botanical relations of our genera.” Moreover, in many cases the characters given refer only to the species found in the L.M.B.C. District.

- 
- |                                                                                                                                                                            |                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 1. Colour bluish or purplish green* ; Algæ of small size, usually more or less gelatinous                                                                                  | (CYANOPHYCEÆ) 5   |
| 2. Colour grass green ... ..                                                                                                                                               | (CHLOROPHYCEÆ) 14 |
| 3. Colour from yellowish brown to olive green or nearly black ... ..                                                                                                       | (PHÆOPHYCEÆ) 25   |
| 4. Colour red or reddish purple, rarely blackish, in fading becoming at times greenish                                                                                     | (RHODOPHYCEÆ) 56  |
| 5. Cells arranged in filaments ... ..                                                                                                                                      | 7                 |
| Cells in colonies, but not forming filaments ...                                                                                                                           | 6                 |
| 6. Cells grouped in twos or multiples of two... <i>Glæocapsa</i><br>Cells wedge-shaped or spherical, united into hemispherical or irregular colonies ... <i>Dermocarpa</i> |                   |
| 7. Filaments ending in a hyaline hair ... ..                                                                                                                               | 13                |
| Filaments not ending in a hair ... ..                                                                                                                                      | 8                 |

\* *Glæocapsa crepidinum* is an exception ; it is yellowish brown in colour.

8. Filaments provided with heterocysts ... .. 9  
 Filaments destitute of heterocysts ... .. 10
9. Filaments with a thin gelatinous sheath, spores  
 not adjacent to the heterocysts ... *Nodularia*  
 Filaments without a sheath, spores next to the  
 heterocysts . . . . . *Anabana*
10. Filaments with a gelatinous sheath ... .. 12  
 Filaments without a gelatinous sheath ... .. 11
11. Filaments spirally twisted ... .. *Spirulina*  
 Filaments not spirally twisted ... .. *Oscillaria*
12. Filaments free ... .. *Lyngbya*  
 Filaments adherent in meshes ... .. *Symploca*  
 Filaments united into a membranous layer  
*Phormidium*  
 Filaments united in bundles and surrounded by  
 a general gelatinous sheath ... *Microcoleus*
13. Filaments free... .. *Calothrix*  
 Filaments imbedded in a mass of jelly ... *Rivularia*
14. Fronds unicellular ... .. 15  
 Fronds multicellular... .. 17
15. Cells free ... .. 16  
 Cells united into a branched spongy frond *Codium*
16. Cells large, filamentous, pinnately branched *Bryopsis*  
 Cells very long, cylindrical with irregular or sub-  
 dichotomous branches, spores large, solitary,  
 in special lateral or terminal cells ... *Vaucheria*
17. Minute endophytic algæ, growing in the  
 cell-walls of *Pylaiella* ... .. *Entoderma*  
 Algæ not endophytic... .. 18
18. Fronds tubular ... .. *Enteromorpha*  
 Fronds membranaceous ... .. 19  
 Fronds filamentous ... .. 21
19. Fronds formed of a single layer of cells ... .. 20  
 Fronds composed of two layers of cells ... *Ulva*

20. Fronds minute, stalked, cells quadrate *Prasiola*  
 Fronds saccate when young, more or less lacinate when old, not distinctly stalked, cells irregular in shape ... .. *Monostroma*
21. Fronds simple ... .. 29  
 Fronds branched ... .. 24
22. Fronds composed of a double row of elongated cells ... .. *Diplonema*  
 Fronds composed of a single row of elongated cells (monosiphonous) ... .. 23
23. Small algæ, filaments soft and flaccid, megazospores, not tailed ... .. *Ulothrix*  
 Megazospores tailed ... .. *Urospora*  
 Rather coarse algæ, filaments more or less rigid, often twisted together ... .. *Chaetomorpha*
24. Branches small and root-like ... .. *Rhizoclonium*  
 Branches distinct ... .. *Cladophora*
25. Fronds irregularly globose, hollow, gelatinous, sporangia at the base of the coloured cortical filaments ... .. *Leathesia*  
 Fronds cup shaped, fruit on very long strap-shaped receptacles ... .. *Himanthalia*  
 Fronds forming crusts or expanded pellicles ... 26  
 Fronds small, tufted, composed of a dense basal portion and an outer portion composed by free filaments ... .. *Elachista*  
 Fronds tubular ... .. 28  
 Fronds filamentous ... .. 30  
 Fronds membranaceous, expanded ... .. 42
26. Fronds densely parenchymatous throughout, fruit in external spots ... .. *Ralfsia*  
 Fronds minute, thin, formed of a basal horizontal layer of cells with short vertical filaments, between which the sporangia are borne ... 27

27. Fronds furnished with colourless hairs, plurilocular sporangia formed by the transformation of vertical filaments ... .. *Ascocyclus*  
 Fronds not provided with colourless hairs, unilocular sporangia oval, plurilocular sporangia unknown ... .. *Myrionema*
28. Fronds simple, hollow throughout, substance thin ... .. 29  
 Fronds simple, cylindrical, somewhat cartilaginous, with numerous diaphragms ... *Chorda*
29. Sporangia densely covering the surface *Scytosiphon*  
 Sporangia external in scattered spots *Asperococcus*
30. Fronds capillary, branching, formed of a single row of cells (monosiphonous) ... .. 31  
 Fronds cylindrical, solid or occasionally becoming partially hollow with age... .. 32
31. Both unilocular and plurilocular sporangia formed by transformation of special branches, plurilocular sporangia in the form of pod-like branches, unilocular sporangia globose, sessile or shortly stalked ... .. *Ectocarpus*  
 Both forms of sporangia formed from the cells in the continuity of the branches and not by a transformation of special branches *Pylaiella*  
 Filaments partly polysiphonous, unilocular sporangia partly immersed in the frond, plurilocular sporangia formed by direct transformation of the cells of the branches ... .. *Isthmoplea*  
 Primary branches creeping in the substance of other Algæ, secondary and fructifying ramuli erect ... .. *Streblonema*
32. Fronds slimy, composed of an axial layer of elongated filaments and a distinct cortical layer of short horizontal filaments ... .. 33

- Fronds composed of elongated internal cells,  
which become smaller at the surface ... 35
- Fronds, at least in the younger portions, formed  
of cells of nearly uniform length, arranged in  
transverse bands, without any proper cortical  
layer ... .. 39
33. Fronds tough and dense ... .. *Chordaria*  
Fronds soft and flaccid ... .. 34
34. Outer cells of cortex producing plurilocular  
sporangia ... .. *Castagnea*  
Outer cells of cortex not producing plurilocular  
sporangia ... .. *Mesoglaea*
35. Fronds traversed by a central filament formed of  
larger cylindrical cells ... .. 36  
Fronds destitute of axial filament ... .. 38
36. Sporangia inconspicuous, formed from the cor-  
tical cells ... .. *Desmarestia*  
Sporangia conspicuous external ... .. 37
37. Plurilocular sporangia moniliform, attached to  
branching, monosiphonous filaments which  
form tufted whorls on the branches... *Arthrocladia*  
Unilocular sporangia spheroidal, accompanied by  
club-shaped paraphyses, in stalked, knob-like,  
lateral receptacles ... .. *Sporochnus*
38. Frond simple, beset with pellucid hairs, spores  
formed from the cortical cells ... *Litosiphon*  
Fronds branching ... .. 39
39. Unilocular sporangia covering the surface in  
dense patches, at maturity projecting above  
the surface of the frond ... .. *Stictyosiphon*  
Unilocular sporangia scattered, immersed *Dictyosiphon*
40. Fronds minute, ending in a hyaline hair, mon-  
osiphonous below, densely beset above with



- very short branches between which are the  
 sporangia ... .. *Myriotrichia*
- Fronds ending in a large, single cell, the cells of  
 the lower part giving off descending filaments,  
 which become interwoven and form a false cortex 41
41. Rhizoidal filaments few and limited to base of  
 plant, branching irregularly pinnate... *Sphacelaria*
- Rhizoidal filaments numerous ... .. 42
42. Branches whorled ... .. *Cladostephus*
- Branches not whorled ... .. 43
43. Spores formed in the axils of the ultimate ramuli 44
- Spores on special branches arising from the  
 cortical layers of the main axis, branches dis-  
 tichously pinnate ... .. *Chætopteris*
44. Lower part of main stem imperfectly corticated  
 with rhizoidal filaments, spores solitary in the  
 axils ... .. *Halopteris*
- Lower part of main stems covered with a dense  
 felt of interlaced rhizoidal filaments, spores  
 clustered in the axils ... .. *Stypocaulon*
45. Fronds simple or occasionally proliferous ... 46
- Fronds branching ... .. 50
46. Midrib present ... .. *Alaria*
- Midrib wanting ... .. 47
47. Fronds thin, sessile ... .. 48
- Fronds thick and coriaceous, distinctly stipitate 49
48. Sporangia densely covering the surface of the  
 frond ... .. *Phyllitis*
- Sporangia immersed or partly immersed in the  
 frond, in scattered spots ... .. *Punctaria*
49. Cryptostomata present, stem flat, arising from a  
 hollow warty base ... .. *Saccorhiza*
- Cryptostomata wanting, stems cylindrical attached  
 by branching rhizoids ... .. *Laminaria*

50.	Midrib present	...	...	...	...	<i>Fucus</i>
	Midrib wanting	...	...	...	...	51
51.	Fronds destitute of air bladders	...	...	...	...	52
	Fronds furnished with air bladders	...	...	...	...	55
52.	Fronds thick and coriaceous, channelled, fruit in terminal receptacles	...	...	...	...	<i>Pelvetia</i>
	Fronds thin, membranaceous	...	...	...	...	53
53.	Sporangia sessile	...	...	...	...	54
	Sporangia, and antheridia stalked, collected in spot-like tufts on the surface of the frond	...	...	...	...	<i>Cutleria</i>
54.	Fronds regularly dichotomous, spores scattered irregularly over the surface of the frond	...	...	...	...	<i>Dictyota</i>
	Fronds more or less fan-shaped, deeply and irregularly laciniate, sporangia arranged in undulating transverse bands	...	...	...	...	<i>Taonia</i>
55.	Air-bladders simple, immersed in the frond	...	...	...	...	<i>Ascophyllum</i>
	Air-bladders stalked, furnished with numerous diaphragms, fruit terminal	...	...	...	...	<i>Halidrysa</i>
56.	Fronds calcareous	..	...	...	...	57
	Fronds not calcareous	...	...	...	...	59
57.	Fronds erect, filiform, articulated	...	...	...	...	<i>Corallina</i>
	Fronds thin, horizontally expanded	...	...	...	...	58
	Fronds thick, horizontally expanded, but rising at intervals in irregular knobs	...	...	...	...	<i>Lithothamnion</i>
58.	Epiphytic Algæ	...	...	...	...	<i>Melobesia</i>
	Algæ growing on rocks	...	...	...	...	<i>Lithophyllum</i>
59.	Fronds horizontally expanded or membranaceous	...	...	...	...	60
	Fronds erect or umbilicate	...	...	...	...	62
60.	Minute alga endoϕhytic in <i>Cladophora pellucida</i> , fruit in hemispherical nemathecia	...	...	...	...	<i>Schmitziella</i>
	Fronds cartilagino-membranaceous	...	...	...	...	61
	Fronds gelatino-coriaceous, tetraspores cruciate	...	...	...	...	<i>Petrocelis</i>

61. Spores in external warts, tetraspores cruciate  
*Peyssonnelia*  
 Spores in cavities sunk in the frond, tetraspores  
 zonate ... .. *Hildenbrandtia*
62. Fronds tubular ... .. 63  
 Fronds filamentous or slightly compressed ... 65  
 Fronds membranaceous ... .. 85
63. Fronds brownish-purple, thick, soft, hollow, fruit  
 immersed in the frond, tetraspores cruciate  
*Dumontia*  
 Fronds more or less gelatinous, compressed or  
 cylindrical, branches much contracted at the  
 base, often constricted at intervals with pseudo-  
 articulations, tetraspores tripartite ... .. 64  
 Fronds purple or nearly black, constricted at  
 intervals, tetraspores zonate ... .. *Catenella*
64. Fronds slender, much contracted at the joints,  
 but without diaphragms, tetraspores tripartite  
 in depressed cavities ... .. *Lomentaria*  
 Fronds slender, nodose, with diaphragms at the  
 nodes, tetraspores tripartite in the cortical  
 layer ... .. *Champia*  
 Fronds contracted at the joints, but without  
 diaphragms, tetraspores tripartite in the corti-  
 cal layer ... .. *Chylocladia*
65. Fronds formed of a single row of cells (monosi-  
 phonous) without proper cortex... .. 66  
 Fronds with distinct axial and cortical layers ... 75
66. Fronds monosiphonous throughout ... .. 67  
 Fronds composed below of a single row of  
 cells, becoming densely cellular above, spores  
 formed by the division of any of the cells, fila-  
 mentous simple, gelatinous, dark purple *Bangia*

- Fronds composed of a single row of cells above, but below with a false cortex formed by the growth of descending filaments given off from the cells ... .. 72
- Fronds formed of large cells placed end on end, with bands of smaller cells at the nodes, in some cases the nodal cells extending in a thin layer over the internodal cells ... .. 73
67. Spores on short pedicels distinct undivided ... 68
- Fronds composed of prostrate, creeping filaments from which arise erect, dichotomous or irregularly branched filaments ... .. *Rhodochorton*
- Both tetraspores and cystocarps present... .. 69
68. Spores terminating short lateral branches *Chantransia*
- Spores axillary ... .. *Monospora*
69. Cystocarps terminal, involucrate, spores irregularly grouped not surrounded by a common gelatinous envelope when mature ... .. 70
- Cystocarps terminal or lateral, spores irregularly grouped at maturity, covered by a general gelatinous envelope ... .. 71
70. Fronds formed of prostrate filaments from which arise erect pinnate filaments *Spermothamnion*
- Fronds pinnate, ramuli whorled *Sphondylothamnion*
71. Fronds dichotomous formed of delicate vesicular cells, tetraspores in involucrate whorls at the nodes or on the inner side of short fascicled branches ... .. *Griffithsia*
- Fronds dichotomous or pinnate, branches alternate, tetraspores tripartite, favellæ binate, lateral ... .. *Callithamnion* (in part)
- Fronds pinnate, favellæ terminal, involucrate; tetraspores polysporic ... .. *Pleonosporium*

- Branches opposite or whorled, tetraspores cruciate ... .. *Antithamnion*
- Fronds with a monosiphonous axis, partly concealed by the densely whorled branches, cystocarps terminal on short branches, tetraspores in whorls one above another on special branches ... .. *Halurus*
72. Fronds capillary or bushy, densely branching, cortications confined to the larger branches, and evidently formed of vein-like descending filaments ... .. *Callithamnion* (in part)
- Fronds compressed, ancipital, branches, pectinate-pinnate, covered everywhere, except at the tips, by polygonal areolated cells ... .. 74
73. Fronds dichotomous, tips usually incurved *Ceramium*
- Fronds pinnate, main branches corticated throughout with cells arranged in transverse bands, secondary branches corticated only at the nodes ... .. *Spyridia*
74. Opposite pinnæ of equal size, cystocarps terminal on the branches, tetraspores solitary on the ends of the branches ... .. *Plumaria*
- Pinnæ of unequal sizes, one being short and simple the opposing one comparatively long and pinnately divided or compound, cystocarps on special short pinnæ or on the upper margins of the ultimate branches, tetraspores clustered ... .. *Ptilota*
75. Fronds dark-red or nearly black, substance dense 76
- Fronds rose-red or purple, rather succulent or gelatinous, sometimes capillary ... .. 78
76. Fronds compressed, fringed with minute ramuli, cystocarps terminal on the ramuli *Sphaerococcus*
- Fronds dichotomous, cylindrical, cartilaginous 77

- Fronds pinnate or pinnatifid, compressed or cylindrical, cartilaginous, purple or yellowish tetraspores tripartite, cystocarps external sessile ... .. *Laurencia*
- Fronds filiform, rigid, irregularly branching forming dense intricate bundles... .. *Ahnfeltia*
- Fronds cylindrical slightly compressed, cartilaginous, sparingly and irregularly branching, composed of an inner layer of very large angular colourless cells, and a cortical layer of small coloured cells, tetraspores cruciate, immersed in the frond, cystocarps external sessile *Gracilaria*
- Fronds small compressed, pinnate, forming small tufts, spores borne on an axial placenta in the enlarged terminal branches ... .. *Gelidium*
77. Root an expanded disc, spores borne in external flesh-coloured warts, tetraspores cruciate, immersed in the frond ... .. *Polyides*
- Root attached by branching rhizoids, cystocarps and tetraspores immersed in the swollen tufts of the branches, tetraspores zonate *Furcellaria*
78. Cystocarps immersed in frond ... .. 79
- Cystocarps internal, ovate or urceolate, fronds traversed by a distinct central filament ... 82
79. Fronds gelatinous, composed internally of a dense mass of slender longitudinal filaments which give off short corymbose, lateral branches which form the cortex ... .. 80
- Fronds soft, succulent, consisting of an internal layer of slender longitudinal filaments and a cortex composed of polygonal cells, becoming smaller towards the surface ... *Cystoclonium*
80. Cortical filaments throughout the frond free ... 81
- Cortical filaments of ramuli (only) free, main

stem solid, ramuli tapering at both extremities

*Naccaria*

81. Axis composed of loosely woven, elongated vertical filaments, peripheral filaments composed of large pear-shaped cells. Fronds undivided, beset with numerous simple or slightly branched tapering branches ... .. *Helminthocladia*

Axis composed of oblong cells, surrounded by slender, long-jointed filaments, from which the dichotomously radiating peripheral filaments arise. Fronds very much and irregularly branched ... .. *Helminthora*

82. Branches much contracted at the base *Chondria*

Branches not contracted at base ... .. 83

Fronds red-brown, hollow below, branches tapering to both extremities, spores arranged in irregular masses ... .. *Glæosiphonia*

83. Fronds rose-red, stems slender, ramuli simple, subulate, acute, apices not involute, cystocarps stalked alternate with the ramuli *Bonnemaisonia*

Fronds dark-red, much branched, rather robust, superficial cells small, polygonal, irregularly placed, apices of branches not involute, tetraspores in the young branches or palmately divided receptacles (stichidia) ... .. *Rhodomela*

Fronds purple or brownish purple, superficial cells quadrate, apices of the branches strongly involute, tetraspores in swollen pod-like branches (stichidia) ... .. *Bostrychia*

Fronds purple or red, occasionally blackish, articulated either throughout or at least in the young branches, the articulations longitudinally striate ... .. 84

84. Fronds brown-red (turning bright red in fading)  
 main stems corticated with irregularly shaped  
 cells, densely clothed with bright red hairs,  
 young branches naked, tetraspores in swollen  
 pod-like branches (stichidia) ... .. *Dasya*  
 Fronds purple or dark-red, tetraspores borne in  
 young branches ... .. *Polysiphonia*
85. Fronds gelatinous but firm ... .. 86  
 Fronds cartilaginous or rigid, sometimes dense 87  
 Fronds delicate or somewhat coriaceous ... 90
86. Fronds purplish, composed of a single layer of  
 cells, spores in marginal bands or spots *Porphyra*  
 Fronds rose-red, composed of a double layer of  
 cells connected by a loose network of colour-  
 less anastomosing filaments, spores attached to  
 the inner surface of the membrane *Halymenia*
87. Fronds formed internally of numerous anasto-  
 mosing filaments which divide corymbosely  
 at the surface ... .. 88  
 Fronds formed of roundish angular cells throughout 90
88. Fronds plain or slightly channelled ... *Chondrus*  
 Fronds beset with small papillæ in which the  
 spores are borne ... .. *Gigartina*
89. Fronds with a more or less evident stipe which  
 passes into a proliferous lamina, cystocarps  
 external ... .. *Phyllophora*  
 Fronds linear, regularly dichotomous, cystocarps  
 immersed ... .. *Gymnogongrus*
90. Midrib present ... .. 91  
 Midrib wanting ... .. 92
91. Fronds rose-red, leaf-like ... .. *Delesseria*  
 Fronds dark brownish purple, narrow, dentate,  
 midrib scarcely distinct ... .. *Odonthalia*



92. Fronds narrow, much divided, ultimate ramuli  
 pectinate ... .. *Plocamium*  
 Fronds palmately or dichotomously divided ... 93  
 Fronds undivided, dull red, tetraspores and  
 cystocarps immersed ... .. *Dilsea*
93. Fronds very thin and delicate ... .. 94  
 Fronds thickish, sub-cartilaginous or sub-  
 membranaceous ... .. 95
94. Fronds rose-red or purplish, margins entire,  
 usually more or less veined, tetraspores cruciate  
 in scattered spots (sori) ... .. *Nitophyllum*  
 Fronds dark red, ciliate, tetraspores zonate  
*Rhodophyllis*
95. Tetraspores cruciate ... .. 96  
 Tetraspores zonate ... .. *Calliblepharis*
96. Fronds deep red broadly palmate or dichotom-  
 ous, sometimes repeatedly laciniate with  
 narrow segments, margin proliferous *Rhodymenia*  
 Fronds bright red, broadly palmate or dichotom-  
 ously divided, spores immersed in minute  
 marginal cilia ... .. *Callophyllis*

## EXPLANATION OF PLATES.

## PLATE II.

- Fig. 1. Two fronds of *Catenella opuntia*, shewing root-  
 branch, and cystocarps, terminal and lateral.  
 × 10.
- Fig. 2. Trichophoric apparatus with one trichophoric cell,  
 arising from cortical filament. × 450.
- Fig. 3. Trichophoric apparatus with two trichophoric  
 cells. × 450.
- Fig. 4. Terminal cell of the axial row from which arise the  
 filaments which bear the carpospores. × 450.

- Fig. 5. Vegetative cells, with trichophoric cell and part of trichogyne.  $\times 450$ .
- Fig. 6. Mature carospores in the cortex of a cystocarpic ramulus, two trichophoric systems nearer the periphery.  $\times 350$ .
- Fig. 7. Very young stage in the development of a cystocarpic ramulus.  $\times 350$ .
- Fig. 8. Young stage in the development of an ordinary vegetative frond.  $\times 350$ .

## PLATE III.

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- Figs. 1—5. *Rhodochorton seiriolanum*; figs. 6—11, *R. rothii*; fig. 12, *R. floridulum*.
- Fig. 1. Part of a branch of *Polysiphonia urceolata* with *R. seiriolanum* epiphytic upon it.  $\times 55$ .
- Fig. 2. The same, shewing terminal and secund sporangia.  $\times 350$ .
- Fig. 3. The basal layer from which the upright filaments arise.  $\times 350$ .
- Fig. 4. Innovation of a vegetative filament after the escape of the tetraspores from a terminal sporangium.  $\times 450$ .
- Fig. 5. Terminal sporangium with tetraspores, and innovation of a subterminal sporangium.  $\times 450$ .
- Figs. 6, 7, 10. Various stages in the development of sporangia formed by innovation.  $\times 450$ .
- Figs. 8, 9. Innovation in vegetative filaments.  $\times 350$ .
- Fig. 11. Development of sporangia from buds of subapical cells; in one case the spores have escaped and a second bud is developing in the cavity of the empty sporangium.  $\times 350$ .



Fig. 2.



Fig. 3.



Fig. 4.

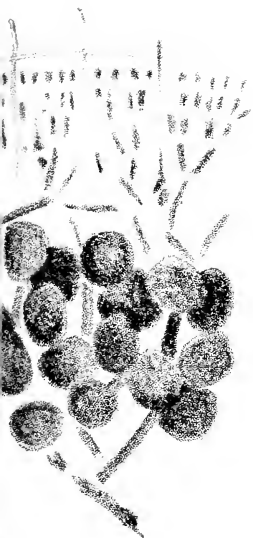


Fig. 6.

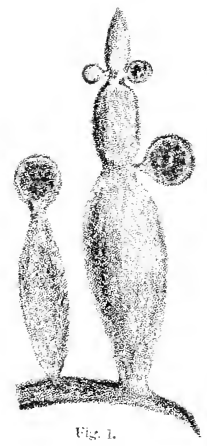


Fig. 1.



Fig. 5.

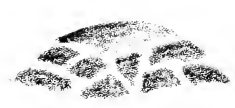


Fig. 7.



Fig. 8.

R. J. H. G., del.

CATENELLA OPUNTIA.









Fig. 2.

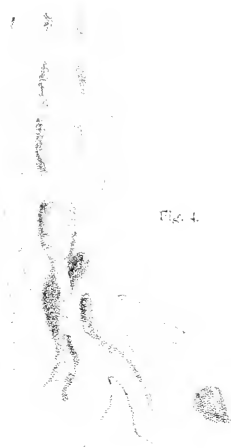


Fig. 4.



Fig. 6.



Fig. 8.



Fig. 5.



Fig. 1.



a



b



c



d

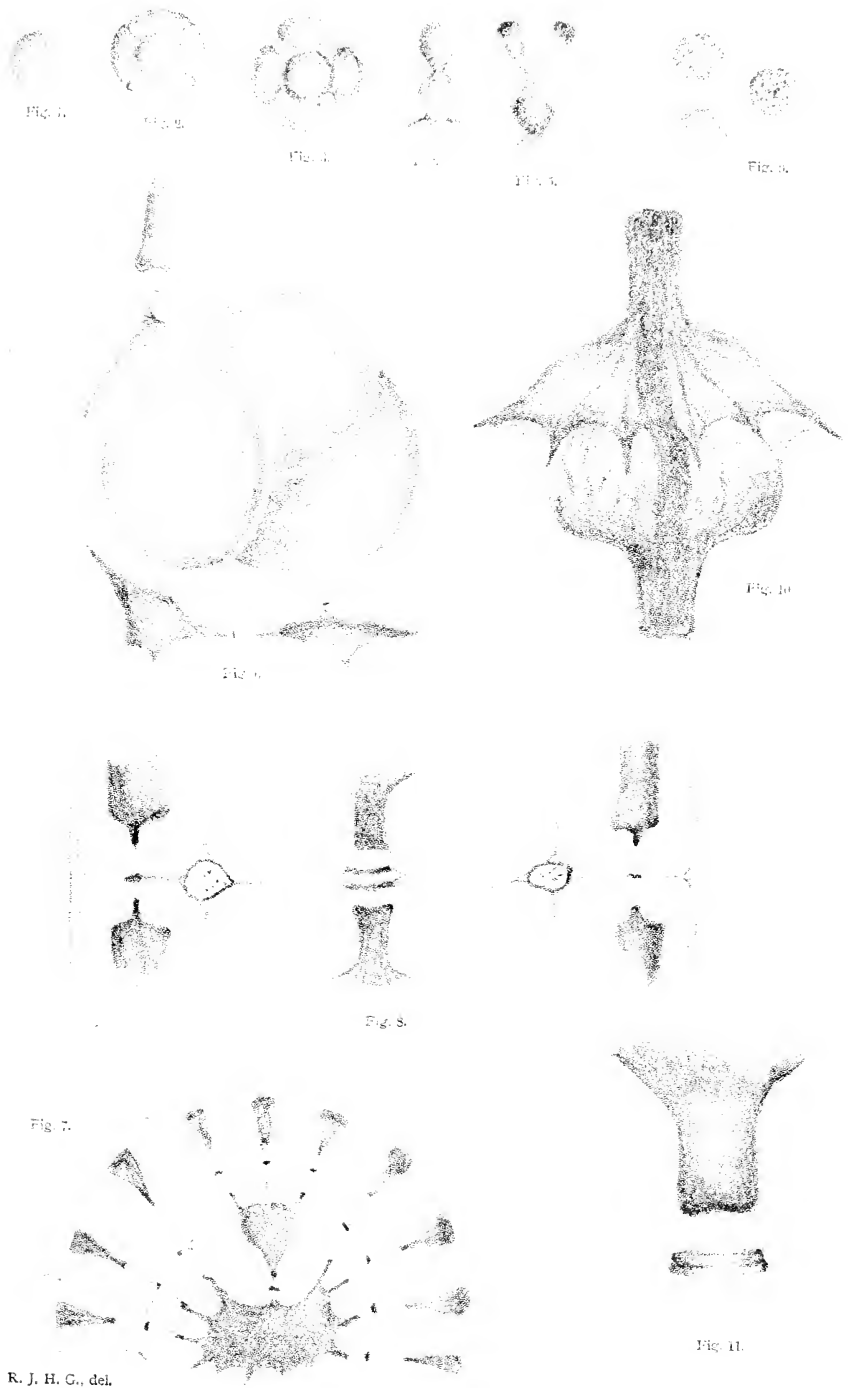
Fig. 7.

R. J. H. G., del.

UROSPORA BANGIOIDES.







R. J. H. G., del.

POLYSIPHONIA FASTIGIATA.



## PLATE IV.

- Fig. 1. Filaments of *Urospora bangioides*. (Nat. size.)  
Figs. 2, 3. Vegetative multiplication by pseudo-branching.  $\times 350$ .  
Fig. 4. Base of filament.  $\times 350$ .  
Fig. 5. Micro-zoosporangia and micro-zoospores.  $\times 450$ .  
Fig. 6. Mega-zoosporangia and mega-zoospores.  $\times 450$ .  
Fig. 7. Stages in the germination of a mega-zoospore.  $\times 350$ .

## PLATE V.

- Figs. 1—5. Stages in the development of the peripheral cells and mother-cell of sporangium of *Polysiphonia fastigiata*, seen from above.  $\times 350$ .  
Fig. 6. Tetraspores in the act of escaping from the sporangium.  $\times 350$ .  
Fig. 7. Transverse section of a frond at the level of a sporangium shewing basal cell in connection with three peripheral cells.  $\times 450$ .  
Fig. 8. Longitudinal section of a frond, shewing the arrangement of intercellular spaces and the "plugs" closing the canals of communication between the cells of the frond.  $\times 350$ .  
Fig. 9. Isolated plugs, not yet closed by callus.  $\times 450$ .

REPORT on the POLYCHÆTOUS ANNELIDS  
of the L.M.B.C. DISTRICT.

BY JAMES HORNELL.

With Plates XIII., XIV., XV.

[Read 13th March, 1891.]

INTRODUCTION.

THE dredged material with which the following report deals was collected in great part on the various dredging cruises instituted by the Liverpool Marine Biology Committee during the years 1886—90; while the littoral species were mostly obtained by myself during 1890 from selected local centres. Great help was in addition rendered by the keeper of the Biological Station on Puffin Island, especially during the past winter.

I offer hearty thanks to Professor Herdman for the uniform kindness he has shown in facilitating my labours. Indeed to one with my limited leisure, his words of encouragement and advice furnished an incentive I could ill have spared. Messrs. A. O. Walker, I. C. Thompson, F. Archer, and Dr. Chaster have also at various times kindly procured specimens for me, and I gladly avail myself of this opportunity to express my thanks. Finally, I have to express my obligation to Professor M'Intosh for help in the determination of a few of the more critical species.

In the arrangement and nomenclature of the larger divisions I have followed Claus,\* but with the generic

\* *Traité de Zoologie*, 1884

nomenclature I have used a free hand—especially among the Polynoïnæ, the Syllidæ, and the Nereidæ where I have followed the example set by Théel, Hansen, and other recent authors in suppressing many of the genera instituted by Malmgren and adopted by Professor M'Intosh in his "Challenger" Report and elsewhere. Lists of synonyms are dispensed with, as such can be found by reference to the *Nordiska Hafvs-Annulater* and the *Annulata Polychæta* of Malmgren, and to the memoir on the *Polychæta Sedentaria of the Firth of Forth* by Cunningham and Ramage. The specific nomenclature of these works I follow closely; the few exceptions being noted.

To make the present report as far as possible, a complete chronicle of the Polychætous fauna of the district, such species as I have not met with, but which appear in previous lists and are well authenticated, have been inserted. Re-examination, however, of some of the material described by Mr. R. J. Harvey Gibson in his paper upon the Vermes of the district, (*Fauna of Liverpool Bay*, vol. I., p. 144) shows that he had fallen into the following errors, viz. :—(a) His "*Malmgrenia castanea*" found in the ambulacral groove of *Astropecten* turns out to be nothing more than the usual *Astropecten* commensal *Acholoe astericola*; (b) his "*Spiochætopterus typicus*" is the diagnostic portion of the body of *Chætopterus insignis*; (c) his (new British species) "*Iphione muricata*" is in reality the not uncommon *Nychia cirrosa* from the tube of *Chætopterus*; (d) his *Nereis viridis* is one form of *N. pelagica*; while (e) the identity of *Pectinaria auricoma* with *P. belgica* which he tried to prove, is, as has been shown by Cunningham and Ramage, founded upon oversights and erroneous premises. There are some other cases where I suspect Mr. Gibson's identification to be at fault, and in this uncertain category I am inclined to place

*Sthenelais zetlandica*—the original specimen of which unfortunately I cannot discover.

This list—including the last mentioned doubtful species—enumerates 88 species and two varieties. Both the latter—*Polynoë haliæti* var. *hyænæ*, and *Sabella pavonia* var. *bicoronata* are hitherto undescribed: while of the former, one—*Dasychone herdmani*—is new to science; three are new to British waters, viz. :—*Polynoë (Lagisca) extenuata*, *Autolytus alexandri*, and *Ampharete grubei*; and 39 have been found for the first time in this district. Of these the most important are *Polynoë castanea*, *P. johnstoni*, *Halosydna gelatinosa*, *Hermadion pellucidum*, *Sthenelais boa* and *S. limicola*, *Spinther oniscoides*, *Eunice harassii*, *Onuphis conchilega*, *Nereis virens*, *Syllis tubifex*, *Psamathe fusca*, *Castalia punctata*, *Phyllodoce maculata*, *Glycera goësi*, *Ammotrypane aulogaster*, *Capitella capitata*, *Nicomache lumbricalis*, *Axiothea catenata*, *Scoloplos armiger*, *Cirratulus tentaculatus*, *Nerine cirratulus*, *Amphitrite figulus*, *Nicolea venustula*, *Amphicora fabricia*, and *Serpula reversa*. Species recorded for the first time in this district are prefixed by an asterisk, thus:—\**S. boa*. At the end a table is given showing the world-distribution of local species side by side with details of the distribution of these forms in our own area. The bathymetrical range is also supplied so far as the often scanty data permit of. I fear the details of distribution outside our local area are not so complete as could be wished—several memoirs being out of my reach for consultation. However, so little has been done in the way of tabulating records of distribution that I venture to think that the present may prove useful to students of the group.

From my observations on the vertical range of local Annelids, I would divide them under three heads—(a) littoral forms, (b) deep water forms, i.e., ranging down-

wards from low water mark, and (c) species extending from the littoral to considerable depths, i.e., indefinite. The following short list embodies these observations.

LITTORAL.	DEEP WATER.	INDEFINITE.
	Hermioninæ	
* <i>Polynoë imbricata</i>	<i>Polynoë haliæti</i>	<i>Polynoë propinqua</i>
	„ <i>castanea</i>	„ <i>impar</i>
	„ <i>lunulata</i>	
	„ <i>johnstoni</i>	
	<i>Acholoë astericola</i>	<i>Nychia cirrosa</i>
	<i>Hermadion assimile</i>	<i>Lep. squamatus</i>
	„ <i>pellucidum</i>	
<i>Sthenelais boa</i>	<i>Sthenelais limicola</i>	
	<i>Spinther oniscoides</i>	
	Eunicinæ	Nereidæ generally
	Lumbrinerinæ	
	<i>Nephtys cæca</i>	<i>Nephtys hombergi</i>
<i>Psamathe fusca</i>	<i>Castalia punctata</i>	<i>Ephesia gracilis</i>
* <i>Eulalia viridis</i>		
<i>Capitella capitata</i>	<i>Ophelia limacina</i>	
<i>Arenicola marina</i>	<i>Ammotry. aulogaster</i>	<i>Scoloplos armiger</i>
<i>Axiothea catenata</i>		<i>Owenia filiformis</i>
Cirratulidæ		Chlorhæmidæ
Spionidæ		Terebellidæ
<i>Sabellaria alveolata</i>	<i>Sab. spinulosa</i>	
		<i>Sabella pavonia</i>
	<i>Filigrana implexa</i>	
	<i>Serpula vermicularis</i>	<i>Pomatoc. triqueter</i>
<i>Spirorbis borealis</i>	<i>Spirorbis lucidus</i>	

Although I put the foregoing forward provisionally, I believe it to be accurate in the main, and I would draw attention to the graphic manner in which it depicts the

\* Occasionally found in deep water.

fact that where a species has (in the same district) one nearly related form only, the one is nearly always found to be littoral, the other to belong to deep water. It was only very gradually as I gained in familiarity with annelid life that there dawned upon me the full significance of the fact that every organism occupies its own particular niche in nature. It was as though a key to nature had been placed in my hands. For instance, in this district *Sthenelais boa* lives under stones between tide-marks; its near neighbour *S. limicola*, characterised by but very minute though constant differences, invariably frequents deep water. *Sabellaria alveolata* is littoral; *S. spinulosa* is always dredged. *Polynoë castanea* is only met with among the spines of *Spatangus purpureus*, *Acholoë astericola* never elsewhere than in the ambulacral groove of *Astropecten*. *Nereis virens* burrows in boulder clay, while its congener *N. fucata* lives commensally with Hermit-crabs (*Pagurus*).

A few notes on embryology will be found under the names of several species. Those on the development of *Arenicola marina* are of the greatest interest, as they deal with points hitherto undescribed.

The following numbers and letters will be employed to indicate the stations where the species were collected, viz. :—

SHORE COLLECTING.

- S. Southport and Formby (sand)
- E. Egremont (sand, clay and stones)
- N.B. New Brighton and Leasowe (sand)
- H. Hilbre Island (sandstone)
- L. Lavan sands, Bangor (mud and stones)
- B. Beaumaris (mud and stones)
- P. Puffin Island (limestone)
- M. Port Erin, Isle of Man (Schist)
- Mp. Peel, Isle of Man (Schist)



## DREDGINGS.

1. Mouth of Mersey (sand)	-	-	-	1—8 fathoms.
2. Mouth of Dee (sand)	-	-	-	1—9 „
3. Colwyn Bay	-	-	-	3—5 „
4. Turbot Hole, Beaumaris Bay	-	-	-	14 „
5. Menai Straits	-	-	-	5—10 „
6. Off Puffin Island	-	-	-	5—7 „
7. Off N.E. Coast of Anglesey	-	-	-	10—16 „
8. Off N.	„	„	-	16—20 „
9. 20 miles N.W. of Holyhead	-	-	-	45—57 „
10. Off S.W. coast of Holy Id., Anglesey	-	-	-	16—18 „
11. W. and S.W. of Port Erin	-	-	-	15—18 „
12. 25 miles N.W. of Bar Lightship,	-	-	-	20—22 „
(“ Spindrift ” cruise, 12 July, 1890).				
13.	do.		do.	
(“ Spindrift ” cruise, 27 Sept., 1890).				
14. 20 miles S.E. of I. of Man	-	-	-	20—25 „
(“ Weathercock ” cruise, 28 Aug., 1886).				

Stations 12, 13 and 14 proved the most productive in results; stations 1 and 2 the most meagre.

## Section I.—ERRANTIA.

## Family.—APHRODITIDÆ.

## Sub-Family.—HERMIONINÆ.

*Aphrodita aculeata*, Linn.

Stations:—1, 6, 7, 8, 10, 13, 14. (From low water to 40 fms.)

This worm is generally obtained from ground of a sandy or muddy character, thus differing markedly in habit from the closely allied species *Hermione hystrix* which I have found to prefer rougher surroundings—shell-debris, gravel and the like. As is the case with so many of the Hermioninæ *A. aculeata* has a very considerable deep water range. A specimen was brought up from a depth of 530

fathoms from oozy bottom in the Farøe Channel, "Knight Errant" expedition, 1880.\*

*Hermione hystrix*, (Savigny).†

Stations:—8, 10, 11, 14 (15—40 fms.). Never found in this district in purely sandy or muddy localities.

Sub-Family.—POLYNOINÆ.

The genera of this division stand greatly in need of revision. Since Malmgren's publication in 1865 of his valuable *Nordiska Hafs-Annulater*, with the erection therein made of many new genera, there has been great confusion and changing of boundaries. Indeed when a new species turned up, it was almost certain not to fit with any of Malmgren's narrow generic definitions, and consequently had to have a brand new genus formed for its special reception. In my belief, Malmgren, misled by his great capacity for perceiving minute differences, attached too much generic value to what were often altogether secondary divergences—the result being that he erected a host of needless new genera. To this class, I am of opinion, belong the genera *Lagisca*, *Harmothoë*, *Evarne*, and *Lanilla*. All are characterized by the possession of 15 pairs of elytra, stout notopodial setæ, and bidentate apex to the setæ of the neuropodium.‡ These I have placed

\* McIntosh, "Challenger" Report, p. 34.

† Brackets round author's name signifies that the generic designation of the species is different to that originally used by said author.

‡ As Moquin-Tandon remarks (Claus "Traité de Zoologie"), great confusion reigns in the nomenclature of the appendages of Polychætes, and as a guide I now append the following list of synonyms:—

HUXLEY.	M'INTOSH & MALMGREN.	GRUBE.
Parapodium	= Foot	
Neuropodium	-- Ventral branch of the foot	
Notopodium	-- Dorsal Branch of the foot	
Præstomial tentacle	-- Tentacle	-- Unpaired tentacle
Superior præstomial cirri	= Antennæ	-- Middle tentacles
Inferior     ,,             ,,	-- Palpi	Lateral     ,,
Peristomial cirri	-- Tentacular cirri	-- Tentacular cirri

together in the old genus *Polynoë*, together with Johnston's *Polynoë scolopendrina* which however might perhaps with advantage be removed to a separate genus.

COMMENSALISM. This favourite habit of the Polynoïnae is well illustrated in the following pages. To summarize the local facts on this point we have *Nychia cirrosa* and *Polynoë setosissima* living in the tube of *Chatopterus insignis*; *Polynoë castanea* upon the test of *Spatangus purpureus*; *P. lunulata* and *Acholoë astericola* in the ambulacral groove of *Astropecten irregularis*; *P. johnstoni* in the tube of *Thelepus cincinnatus*; *Hermadion assimile* close to the mouth of *Echinus esculentus*, and finally the nearly allied species *H. pellucidum* has been found upon three different kinds of star-fishes.

*Lepidonotus squamatus*, (Linn.).

Stations:—6, 7, 8, 10, 12, 13, 14; H, P, M. (From between tide marks to 22 fms).

This widely distributed form is more frequently found in deep water than *Polynoë propinqua*. The most prolific ground was in 18—20 fathoms, Porthwen Bay, Anglesey, where a large number were dredged. These were of a greater size than any elsewhere procured, and the largest were very strongly marked on the elytra. Many of the warts towards the postero-internal direction were filled with very conspicuous black pigment.

*Nychia cirrosa*, (Pallas).

Hab: B, 5, 7. Low water of spring tides to 18 fms.; sometimes commensal with *Chatopterus insignis* and *Thelepus cincinnatus*.

Malmgren (*loc. cit.*) was the first authority to recognise this to be an undoubted British species. He found that certain British Museum specimens named *Lepidonotus cirratus* v. *parasiticus*, W. Baird, and hailing from Beaumaris, N. Wales, in the majority of cases belonged

in reality to Pallas' *Aph. cirrosa*, the remainder pertaining to *P. setosissima*, Sav. (*Lanilla glabra*, Mgrn.). Both species had been found living commensal within the tubes of *Chytopterus insignis*, Baird. Curiously enough, the first example I obtained was dredged from 5 fathoms in the Menai Straits within a few miles of the spot whence came Baird's specimens in 1864. It came up from ground covered with the valves of dead mussels, and when first noticed it was crawling from the broken end of a *Terebella* tube, probably *Thelepus cincinnatus*—thus denoting a wider range of its commensal habit. The *Iphione muricata* of Mr. Gibson's report is this species, as I can certify from an examination of the original very fine specimen now in the Zoological Museum of University College, Liverpool.

*Polynoë (Harmothoë) imbricata*, (Linn.).

Hab: 6, P. M, Mp, under stones. Abundant at low water.

But few of my specimens were dredged, and these were from shallow water; the great majority were shore collected. Hj. Théel however records dredging it as deep as 80—100 metres.\* The species is predominant and exceedingly abundant under stones on the south side of Port Erin Bay, attracted and provisioned—directly or indirectly—by the large quantity of fishing refuse present at the quay. In colouration of the elytra *P. imbricata* is the most variable of our Polynoïnæ—from black and blue-black it grades to grey and light rose. Usually the colouration is more or less over the whole surface of the elytron, but sometimes it is restricted to the inner third or half of each elytron leaving the outer portion colourless. Several Puffin Island specimens and others from Port Erin with this peculiar marking are especially beautiful. The inner black margins of the elytra to the eye appear to coalesce and thus give the animals the appearance of having

\* Les Ann. polych. des Mers de la N. Zemble." 1879.

a black band extending medianly from head to tail, being edged with a pale uncoloured margin on either side.

Théel is correct in saying that only the largest individuals possess on the scales any notable rounded processes and I cannot imagine how so able a naturalist as Möbius could for a moment confound the species in question with *P. impar*. Indeed the globosely tuberculated elytra of *P. imbricata* approach much more closely to those of *P. propinqua*, but otherwise the differences between these two are striking. (Pl. XIII, fig. 2).

*Polynoë (Harmothoë) haliæti*, (M'Intosh), var. *hyæne*, n.

Hab: Port Erin, Isle of Man, 15 fms.

The specimens described by Mr. Gibson (*loc. cit.*) unfortunately wanted the scales, but in one recently obtained ("Hyæna" cruise of Easter, 1889) a few scales were present. These differ considerably from Professor M'Intosh's description.\* Instead of the margin being "quite smooth throughout," it is densely fimbriated after the manner seen in *Lepidonotus squamatus* otherwise they agreed closely with the characters given. (Pl. XIII, fig. 5).

\**Polynoë (Ecarne) impar*, Johnston.

Hab: 10, 12, S, H, L, P. From littoral to 22 fms.

The number of large pear shaped tubercles on the margin of the scales varies greatly, but few have so many as Malmgren gives in his figure. Many have only one very large one, others none whatever, while again a few of the largest approach Malmgren's engraving—having 3, 4, 5, and 6 tubercles. The number varies even on adjacent scales of the same individual—some with none, others overlapping these with one or more. A number of the largest of these remarkable processes are made even more so by the presence on the broad summit of numer-

\* "Challenger" Report, p. 96.

ous tiny spines, (Pl. XIII, fig. 6). The inferior cirrus is shortly and sparsely ciliated, not smooth as represented in Malmgren's plate. The largest specimens were from Southport—33 mm. long—and in these the bristle bearing segments sometimes reached 37. Malmgren gives 34—35 for the oldest. Notopodial seta, Pl. XIII, fig. 3.

\* *Polynoë (Lagisca) extenuata*, Grube.

Hab: Port Erin, Puffin Id., and Colwyn Bay; under stones.

A single specimen was found at each of the above localities. This is the first record of its occurrence in British seas. Superficially it has considerable resemblance to *Polynoë (Evarne) impar*. The serration of the dorsal bristles is however distinctly finer. (Pl. XIII, fig. 4). The bristles are nearly colourless and without the brilliant golden hue so noticeable in those of the last-named species. The tips of the ventral bristles are very characteristic and reliable, especially among the strongly bifid superior bristles of the bundle. Their angle of incision is formed by nearly straight lines, wherein it differs from what is seen in *P. imbricata*, *impar* and *propinqua*, where the angle is made by curved lines. The upper median ones, however, possess curved bifid apices, while the inferior bristles show curved entire tips. These specimens agree closely with the plates in Marenzeller's "*Zur Kenntniss der Adriatische Anneliden*" except in one point in the structure of the scale. In mine, the surface of the scale is mapped out into a large number of separate areas, each containing usually several papillæ, giving the appearance of a line having been drawn around every three or four papillæ, thus forming the latter into groups (see Pl. XIII, fig. 8). All the specimens show this very peculiar marking, which is not to be found in Marenzeller's figures.

This species must be classed close to *P. impar* and *P.*

*propinqua*, between which it is intermediate in many respects.

*Polynoë (Lagisca) propinqua*, (Malmgren).

Hab: 6, 8, 9, 12, 13, S, P, M, and Mp. Abundant from mid-tide to 57 fms. Beneath stones and in rock cavities.

This species, which Malmgren constituted to receive a single individual received from Bohus, and which M'Intosh has sometimes found in the debris of fishing boats at St. Andrews, is here one of the most constant and abundant of the Polynoïne—present at the greatest depth yet dredged in our local area viz:—45-57 fathoms, 20 miles N.W. of Holyhead, ("Spindrift" cruise, 20 July, 1889), as well as being taken in profusion on the rocky shores of Puffin Island, Hilbre Island and the Isle of Man. At Puffin Island it is especially plentiful and is undoubtedly the characteristic Polynoë of the island.

Malmgren's figures absolutely tally with the majority of my specimens. A few deviate in that the outer edges of the elytra bear a few weak and inconspicuous cilia, and occasionally some of the smallest show none of the characteristic globose processes on the elytron edge. (Pl. XIII, fig. 7). In colour, as in most other points, my specimens agree closely with Malmgren's, while differing markedly from that described by M'Intosh from St. Andrews (Trans. Zool. Soc., vol. IX, p. 375).

The structure of the bristles is identical with that of those belonging to *Polynoë floccosa* as figured by M'Intosh. Were it not that all the specimens examined possess 15 pairs of elytra, the margins of which are unfurnished with aught save a row of sub-globular processes, in contrast with the more numerous and ciliate elytra of *P. floccosa* I should incline to unite the two species. (Pl. XIII, fig. 1 and 9).

*Polynoë (Lænilla) setosissima*, Savigny.

Hab: Beaumaris. Low water mark, commensal with *Chaetopterus insignis*, Baird.

Ray Lankester\* records it under the name of *Harmothoë malmgreni* living with the same host on the shores of Herm, one of the Channel Islands. His remark anent its commensalism—"It appears to be only met with in this habitat" I am able to confirm, as under the guidance of my good friend Mr. J. Sinel, of Jersey, I have dug up in Herm a number of *Chaetopteri* and have found this *Polynoë* invariably present. It is the *L. glabra* of Malmgren.

\* *Polynoë (Malmgrenia) castanea*, (M'Intosh).

Hab: 7, 12, 13 in 20-22 fms. Commensal with *Spatangus purpureus*.

Every living *Spatangus* I have examined—and this Echinoderm was several times dredged in considerable numbers on the "Spindrift" cruises 1890—has had one of these worms clinging to the test close to the mouth. All Prof. M'Intosh's examples were obtained from the same host. The curious fact noted in the first Report on the Vermes by Mr. Gibson† of finding this worm in the ambulacral groove of *Astropecten* turns out to be erroneous—for having occasion to refer to Mr. Gibson's specimen, I discovered it to be the ordinary *Acholoë astericola*, which Carrington recorded long ago as a common guest of the starfish named. This species is very unlike *P. castanea*.

*Polynoë floccosa*, Savigny.

Hab: The South of the Isle of Man.

I give this as a member of our local fauna on Mr. Gibson's authority. I have searched long and carefully for it without success. Prof. Ray Lankester observes that in the Channel Islands this form—his *H. sarniensis*—seems

\* "On New Brit. *Polynoina*." Trans. Linn. Soc. vol. xxv.

† *Fauna of Liverpool Bay*, p. 119.



to take the place of *P. imbricata* so common in more northern localities.

*Polynoë (Harmothoë) lunulata*, Delle Chiaje.

Hab: Southport.

Found in company with *P. astericola* D.Ch., occupying the ambulacral grooves of *Astropecten irregularis* cast ashore by storms.

\* *Polynoë johnstoni*, Marenzeller.

Hab: 8, 10 (numerous).

During the "Hyæna" expedition, Whitsuntide, 1890, nearly every haul of the dredge (12-20 fathoms) off the S.W. coast of Holy Island, Anglesey, brought up at least one specimen of this Polynoë. In one case, an individual emerged from an inhabited tube of *Thelepus cincinnatus*, suggesting another instance of the habit of commensalism so frequently noticed among the Polynoïna. Quatrefages was the first to point out the presence of certain differences between Johnston's and Savigny's *P. scolopendrina*. Subsequently Marenzeller (*loc. cit.*) gave this belief definite form, by separating the two and giving separate diagnoses of each thus:—

*P. scolopendrina*, Savigny. Tentacle much shorter than the palps. The tentacular cirri longer than the palps. No wart-like tubercles projecting from the dorsum of the segments.

*P. johnstoni* (the *P. scolopendrina* of Johnston, Malmgren and M'Intosh.) The tentacle longer than the palps. The tentacular cirri shorter than the palps. Three wart-like tubercles on the dorsal aspect of each segment.

*Acholoë astericola*, (Delle Chiaje).

Hab:—Southport, and 6 m. N. of Gt. Ormes Head 14 fms.

I have to thank Dr. G. W. Chaster, of Southport, for a number of specimens of this interesting annelid which, together with *P. lunulata*, he procured in the above

named locality from the ambulacral grooves of *Astropecten irregularis* cast upon the beach. This worm ranges from the Mediterranean to Galway in Ireland. At Naples, Claparède found it in company with *Ophiodromus flexuosus* on *Astropecten aurantiacus*, while *A. aurantiacus*, *bispinosus*, *platyacanthus* and *pentacanthus* from Trieste all furnished to Marenzeller (*loc. cit.*) the same two guests.

Examples of this worm were identified as *M. castanea* by Mr. Gibson in his "Report on the Vermes" of this district. I note that in the "Challenger" Report the generic name is spelled *Achloö*.

\**Halosydna (Alentia) gelatinosa*, (Sars).

A very large specimen was found under a stone at extreme low water at Puffin Island, October, 1887. It measured  $6\frac{1}{2}$  cm. by 16 mm. (including the bristles).

*Hermadion assimile*, McIntosh.

Hab: 12 (21 fms.) and 11 (10 fms.).

One small specimen was found crawling among the spines of an *Echinus esculentus* dredged from 21 fathoms in the Irish Sea, 25 miles N.W. of Liverpool Bar, and Mr. Gibson recorded two from the same host dredged near Port Erin.

\**Hermadion pellucidum*, (Ehlers).

Hab: 6, 10, 12, 13, (16-22 fms.)

This species was taken for the first time locally at Station 12, ("Spindrift," September, 1890), when three small specimens were dredged. All were commensal with Echinoderms. One was in the ambulacral groove of *Astropecten irregularis*; another upon *Solaster papposa* and the third was upon a brittle-star—*Ophiothrix rosula*. Marenzeller (*loc. cit.*) speaks of obtaining a specimen from *Ophiothrix alopecurus* from the Bay of Muggia, near Trieste.

One of these specimens was perhaps the most beautiful

*Polynoë* I have ever met with. Each of the pellucid body scales had on the hinder margin a crescent of orange-hued pigment, varied on the two head scales by the orange margin being carried completely round as a resplendent girdle.

Sub-family.—SIGALIONINÆ.

\* *Sthenelais boa*, (Johnston).

Hab: P, M, Mp, under stones from mid-tide to low-water.

Malmgren (*loc. cit.*) stated his belief that Rathke's *S. idunæ* is synonymous with Johnston's *S. boa*, a view with which I unreservedly concur. He, however, in his list of synonyms, gives Cat. Br. Mus. 1865 as date of Johnston's name, and omits reference to the British author's prior description and naming of the species in question, viz: 1833, in Loudon's Mag. of Nat. Hist. In this way Rathke's nomenclature, dating from 1843, is wrongly given priority and I gladly follow Prof. M'Intosh's lead in the retention of our countryman's title.

*S. boa* is in this district essentially a shore species. I have never taken it in the dredge but always littoral. The nearly related species *S. limicola* on the other hand is characteristic of a lower zone, being invariably obtained by dredging. The fact that in "Invert. Fauna of St. Andrew's" M'Intosh notes that storms cast up abundance of the latter species, and gives the habitat of *S. boa* as between tide mark would point to this limitation of vertical range as a constant feature.

\* *Sthenelais limicola*, Ehlers.

Hab: 12, 13.

As noted all specimens without exception were taken in the dredge, at depths varying from 18-22 fathoms. The present is the first recorded instance of the occurrence of either the present or the preceding species in this district.

*Sthenelais zetlandica*, M'Intosh.

The mutilated fragment mentioned by Mr. Gibson\* as dredged from 20 fathoms off Port Erin remains without successors.

*Pholoë minuta*, (Fabricius).

Dredged, Whitsuntide, 1890, in Menai Straits. Car-  
rington records it as rare at Southport.

Webster and Benedict† record it from Massachusetts, U.S.A. and it has an exceedingly wide range within the Arctic circle. This is an interesting form, as through the structure of its falcate compound setæ it hints at the not distant relationship of the Syllidæ with the Polynoidæ.

Family.—APHINOMIDÆ.

Sub-Family.—HIPPOXOINÆ.

\**Spinther oniscoides*, Johnston.

Six specimens of the usual yellow hue were dredged during the "Hyana" cruise, Whitsuntide, 1890, from about 17 fathoms, off Holy Island, Anglesey. As they were picked from off the yellow hydroid *Antennularia ramosa* and also from the yellow *Halichondria panicea*—to both of which they assimilate absolutely in colouring—they furnish another addition to the long list that is accumulating of protectively coloured animals.

Family.—EUNICIDÆ.

Sub-Family.—EUNICINÆ.

\**Eunice harassii*, Au. and M. Ed.

Hab: 12. Dredged from 21 fms.

I refer this single specimen to the above species with some hesitation as in the spirit preparation the characteristic spots on the dorsum do not show, and again the filaments to the largest branchia are more numerous—(20)—than is given in previous diagnoses of this species.

Report on Vermes, Fauna Liverpool Bay, Vol. i.

† Annel. Chact. from Princetown, &c., 1884.

To facilitate future reference, a figure is given of the branchia pertaining to the 21st setigerous somite. (Pl. XIII, fig. 10).

\**Onuphis (Northia) conchilega*, Sars.

Great numbers of this widely distributed worm were taken on the "Spindrift" cruise (September 27th, 1890), 25 miles N.W. of Liverpool Bar—depth, 21 fathoms—for the first time in this district. The animals are very irritable when expelled from their homes; breaking into fragments at once. The anterior part of the body is firm; the middle and posterior soft and indefinite. The scabbard shaped tubes which *O. conchilega* constructs bears some analogy to the stick or stone encrusted tubes of the larvæ of the caddis-fly. Like the latter, they are unattached to any fixed object and can be dragged from place to place by their owners, who can turn themselves if they please in the tube. All sorts of shell fragments and bits of echinid tests are requisitioned and fitted into place. When we remember the diversity in shape and size of the material and that when completed neither are the edges of adjoining fragments allowed to overlap, nor are any unarmoured spaces left in the tough membranous tissue forming the framework of the tube we must concede a considerable amount of ingenuity and skill to *Onuphis conchilega*. Such a tube is protective both by reason of its strength and great relative size as compared with the worm itself and also on account of the admirable way in which it assimilates to the general appearance of the sea-bottom where it is found.

M'Intosh in the "Challenger" Report (where he uses the form *Nothria* for *Northia* as the name of this genus) says—"The Onuphididæ are distinguished from the Eunicidæ by their bathymetrical distribution for while the latter are often found between tide-marks, the Onuphididæ

are characteristic of deep water, many of them ranging to very great depths. Even in our own seas they frequent the deeper waters of the coralline ground." None of the "Challenger" series came from a less depth than 100 fathoms, and only one at that. Two came from 2225 fathoms.

Sub-Family.—LUMBRICONEREINÆ.

*Lumbriconereis fragilis*, O. F. Müller.

Hab: 12—13; from 20—22 fms.

True to name this beautiful iridescent annelid broke into pieces immediately on capture on the only two occasions on which I was fortunate enough to procure it. There is no doubt in my mind that this is a habit acquired and practised with the aim to save its existence when seized by enemies, as I noticed that the pieces broken off were in both cases short lengths from the posterior end. The piece left with the head was by far the longest and probably sufficient to start life afresh with had the animal escaped capture.

Family.—NEREIDÆ.

*Nereis pelagica*, L.

Hab: 13, H, P, M, Mp.

Met with at all depths and on rocky or stony ground, with as high a vertical range as *Arenicola* displays on a sandy or muddy shore.

\**Nereis (Hediste) diversicolor*, Müller.

Hab: S, 2.

A large number were found burrowing in the peat at Hightown at the mouth of the Mersey.

*Nereis (Leontis) dumerilii*, Aud. and M. Edw.

Hab: E, P, M, 6, 7, 8 (numerous).

Specimens of this worm are frequently obtained lying in cocoon-like structures composed of hardened grey mucus, often with foreign bodies attached to the outside.

In one case, an individual had seized upon a shore blown beech leaf, constructing on its surface a mucus tunnel in which it lay hid—very similar in appearance to the cocoons of many insects. A species of pycnogonid is frequently found parasitic (?) clinging to the outside of these mucus tubes.

*Nereis (Nereilepas) fucata*, (Savigny).

Hab: 4, 8, 10, 11, S, M, Mp.

The *Nereis bilineata* of Carrington. It is frequently met with in dead *Fusus* and whelk shells. Also in about 90% of such shells which have been taken possession of by Hermit-crabs (*Pagurus*). If a shell containing one of these strangely assorted couples be watched in an aquarium, the forepart of the worm's body will be seen to emerge slowly from the interior depths and sway gently from side to side, above the back of the crab, surveying keenly the environment. The fellow-lodgers together dwell in amity, though what the mutual relationship existing between the two is I have never seen explained. My own opinion—seeing how often the worms occupy otherwise uninhabited shells—is that *Nereis fucata* is the first tenant and that it tolerates the intrusion of the Hermit-crab chiefly because it can easily steal morsels of the plentiful supply of food which the latter can generally manage to procure. Besides the *Pagurus* furnishes means of locomotion unattended with danger, and his presence in the mouth of the shell prevents other intruders who might be unwelcome from getting entrance. The Hermit-crab on the other hand, I believe, derives no benefit from the partnership and takes no notice of the worm as long experience has taught him that he cannot dislodge the latter, who occupies the coign of vantage, possesses superior agility and a pair of stout mandibles. Indeed the worm can easily turn the Hermit out if so disposed.

*N. fucata* is sometimes taken free. Such specimens, as well as those forcibly taken from their refuge in shells, display a very peculiar mode of swimming. Turning on their side they assume the outline of an S much drawn out, and move through the water with a gentle undulating shivering motion with a weakness suggesting want of training, and without any of the vigorous lashing seen in *Nephtys* and in *Nereis virens*, *N. pelagica*, &c. These latter swim upon the ventral surface of the body. Used for bait sometimes by the Manx fishermen.

\* *Nereis (Alitta) virens*, Sars.

Hab: E, NB.

Abundant between tide-marks along the Mersey shore from Egremont to New Brighton, burrowing in patches of very stony boulder clay. Its extensive burrows are mucus lined. This mucus is secreted by enormous numbers of tubules found along the dorsum and in the lobes of the feet, especially in the great leaf-like upper lobe of the notopodium, the so-called "branchia" of Kinberg. This lobe seems pre-eminently modified to act as a great secretive organ, its great expanse and lamellar form giving the maximum of available surface while occupying the minimum of room. Each is richly supplied with blood vessels and its substance is crowded with masses of tubuli opening on the surface. The cirri (dorsal and ventral) contain no tubules. Immense quantity of mucus is thrown off very rapidly after capture, so filthy and dense that it is difficult to make out the presence of the worms at all.

*N. virens* (the *N. Yankiana* of Quatrefages) is the most esteemed of bait worms in this district. The fishermen have given it the name of "Creeper."



## Family.—NEPHTHYDÆ.

\* *Nephtlys cæca*, (Fabr.).

Hab: "Hyæna" and "Despatch" expeditions, 1886.

In this district much less common than *N. hombergi*. Its range is also more restricted than the latter, having been taken only by the dredge.

*Nephtlys hombergi*, Aud. and M. Edw.

Hab: S, E, NB, L, 3, 6, 10, 13, "Despatch" exped., 1886.

The characteristic *Nephtlys* of the Irish Sea, common along the N. Welsh, English and Scottish coasts bordering this basin, wherever sand occurs. Together with this constancy on all our shores it possesses a wide bathymetrical range, having been taken frequently with the dredge at varying depths. Thecate Infusoria are frequently met with parasitic upon the bristles. This is the *N. assimilis* of Malmgren and *N. longisetosa* of Oersted.

## Family.—GLYCERIDÆ.

*Glycera capitata*, Oersted.

Hab: P, S, 10. The *G. alba* of previous local lists.

\* *Glycera nigripes*, Johnston.

Hab: Puffin Island; 5 fathoms.

\* *Glycera dubia*, Blainville.

I have several times found traces of a large species—referred provisionally to *G. dubia*—within the stomachs of Cód. The length would be nearly six inches and the four stout black teeth present within each were of corresponding size.

\* *Glycera goësi*, Mgrn.

Hab: B, 10; common.

## Family.—SYLLIDÆ.

\* *Syllis (Eusyllis) tubifex*, Gosse.

Hab: 3, 12, 13, 10, 6.

Common in dredged material—3 to 21 fms.

*Syllis armillaris*, (O. F. Müller).

Found at low water Puffin Island, August, 1889.

Specific characters:—Dorsal cirri quite short, of 8—10 joints. Setæ falcate with entire apex. Two more or less interrupted transverse markings on the dorsum of each segment.

\* *Autolytus alexandri*, Malmgren.

Hab: Tow-netted off Puffin Island.

A single specimen, a male as shown by possessing the curious forked palps characteristic, as Verrill remarks, of the sex in this genus. The anterior falcate setæ-bearing segments numbered 14. The dorsal cirri were somewhat shorter than depicted by Verrill\* Length of body 12·5 mm.

This species has not before been recorded from British waters.

*Autolytus proliifer*, (O. F. Müller).

Recorded by Carrington as abundant at Southport.

*Ephesia gracilis*, H. Rathke.

Hab: S, P, 12, 14.

This aberrant annelid is not uncommon under stones at low water mark at Puffin Island. It is the *Spharodorum flavum* of Oersted and the *Pollicita peripatus* of Johnston and Carrington.

Family.—HESIONIDÆ.

\* *Psamathe fusca*, Johnston.

Hab: Puffin Id., and Lavan sands. Bangor: under stones.

Two large specimens. The feet are uniramous, with compound bristles.

\* *Castalia punctata*, (Müller).

Dredged off Anglesey, Whitsuntide, 1890.

The foot is biramous, the notopodial setæ being simple, the neuropodial compound, thus sharply marking the animal off from the preceding.

\* New England Annelida, 1881.

## Family.—PHYLLODOCIDÆ.

\* *Phyllodoce maculata*, (O. F. Müller).

Hab: Egremont, under stones in clay, near low water mark, and dredged of S. W. coast of Anglesey.

Malmgren's exclusion of Johnston's *P. maculata* is, I believe, incorrect. Many of the latter author's figures are very poorly drawn and in the case in question the figure does not agree with the letterpress, the markings on the back being represented while the dot on each lamellar process of the feet is omitted. I can easily reconcile my specimens with both author's figures and descriptions. Length 3·5 cm.

*Phyllodoce laminosa*, Sav.

Hab: P and M. Under stones, Laminarian zone.

Of a most lovely delicate yellow-tinged green in life. It is able to secrete very great quantities of mucus—from the large leaf-like lobes of the feet as in *Nereis virens*—which in spirit becomes very tough, enveloping and binding together the body and feet as in a web.

*Eulalia viridis*, (Müller).

Hab: P, M, Mp. Over the entire tidal zone.

This bright, dark grass-green *Phyllodoce* is unquestionably the characteristic errant annelid of Puffin Island, finding in the weathered and molluscan bored (*Saxicava rugosa*, L.) cavities and tunnels of the limestone rocks and boulders, the perfection of sheltering places always at hand to which to retreat on sign or suspicion of danger.

From my observations of annelid life characteristic of localities having different geological formations, I arrive at the inference that this species can appear in great abundance only in spots where its environment provides innumerable retreats always open. The honeycombed surface of limestone rocks answers such requirements admirably, and in this district such spots—of which

Puffin Island is typical—are homes of *Eulalia viridis*. The only other rock surroundings where I have found this species in any number was on rock surfaces encrusted with large *Balani* shells, many of which being dead and empty formed fairly good hiding places.

I cannot think that its bright green colour is in any way mimetic and protective as has been suggested. For it is most numerous on brown *Fucus*-covered rocks where green algæ are conspicuous by their absence. Besides its activity is incessant, and this alone prevents its enemies passing it unnoticed. Protectively coloured animals as far as I know, are usually sluggish in their movements, as for instance *Porcellana platycheles* as noted by Professor Herdman.

Family.—TOMOPTERIDÆ.

*Tomopteris onisciformis*, Esch.

Tow-netted off Puffin Island and Port Erin.

Section.—SEMENTARIA.

Family.—OPHELIADÆ.

\* *Ophelia limacina*, Rathke.

Hab: “Despatch” expedition, 1886, from 18 fms.

The dredge, during this expedition (“central area”) brought up two individuals—the only ones I have been able to obtain in this district, although the species is not uncommon in the stomachs of Cod.

\* *Ammotrypane aulogaster*, H. Rathke.

Hab: 3, 6, 12. Dredged from 3—21 fms.

To judge by the great number of examples dredged at each of the above stations, this worm seems to be very plentiful in our local area. The great majority were collected in May, and these were in all cases minute, not exceeding 4 mm. in length.

## Family.—CAPITELLIDÆ.

\* *Capitella capitata*, (Fabr.).

Hab: Port Erin, and Lavan sands, Bangor.

Very numerous amid decaying *Fucus* under overturned boulders.

## Family.—TELETHUSIDÆ.

*Arenicola marina*, (Linn.).

Hab: S, E, NB, H, L, B, P, M, Mp.

Abundant everywhere, between tide marks wherever a patch of sand or mud occurs.

NOTE on the Embryology of *Arenicola* and *Scoloplos*  
(Plate XIV.)

Max Schultze in 1856 (*Entwickelung von Arenicola*) described certain egg-masses and embryos found on the Cuxhaven shore as belonging to *Arenicola*. In 1887 Cunningham and Ramage figured and described identical embryos in the Trans. Roy. Soc. of Edinburgh, Vol. XXXIII, part 3, (*Polychæta Sedentaria* of the Firth of Forth), but in the text they point to certain facts, chiefly connected with characteristics of form in the larvæ, which inclined them to believe that the parent was in reality *Scoloplos armiger* and not *Arenicola* as Schultze averred. These authors were, however, unable to describe either the embryos or the manner of spawning of *Arenicola*, though they give a sketch of immature ova taken from the body cavity in February. This gap I am fortunate enough to be able to fill up from observations made in 1890—91, and I am also able to confirm in its entirety, Cunningham and Ramage's correction of Schultze.

On 2nd March, 1890, I procured on the sandy beach at Egremont several small pear-shaped brownish egg-masses and a few larger green ones about the size and shape of a large grape. The latter were invariably associated with

*Arenicola* castings, while wherever I found the smaller the worm *Scoloplos armiger* was sure to be present. Both kinds of egg-cocoons were anchored in the sand by a gelatinous cylindrical stalk descending some two or three inches into the sand. In the case of the green cocoons the stalk soon became ragged and shredded; in the brown, it continued perfectly cylindrical and entire for most of the distance traced.

I. Development of *Scoloplos*:—The small brown cocoons certainly appertain to this animal, for besides the fact that this worm is always found close to the egg masses—animals examined February 21st contained ova identical with those least developed in the cocoons. The size of the cocoons differed somewhat; the largest being 2 cm. by 1 cm., stalk 10 cm. at least. The later stages of development are well figured by Cunningham and Ramage and also by Schultze, and I have nothing to add to their descriptions. As to the progress of segmentation, hitherto undescribed, the following is a summary of what I have observed:—The ova are 0·25 mm. in diameter. Each shows a very distinct germinal vesicle. Two polar bodies are excluded and following quickly is the division of the vitellus into macromere and micromere (Pl. XIV, fig. 3). The latter very rapidly sub-divides into very small cells which gradually overspread the few large cells derived from the primitive macromere, until finally only a small opening—the blastopore—is left in the enveloping layer of micromeres. Usually the number of derived macromeres is either two or four at the stage of enclosure by the micromeres. These latter are, I believe, not all derived from the primitive micromere, being added to from time to time by small cells fissioned off from certain of the macromeres. (Salensky observed a similar process during his elaborate investigation of the embryology of *Nereis*

*cultrifera* and of *Psygmorebranchus protensus*). This being so, it is evident that the primitive micromere in this case contains a part only, of the entire epiblastic material. The cocoons were found at various dates ranging from March 2nd to April 18th. (Pl. XIV, figs. 1—11).

II. Development of *Arenicola marina*:—The ova are deposited in vast numbers within a grape-shaped gelatinous matrix furnished with an anchoring stalk as described. The mass is delicate ulva-green in hue due to the colouration of the contained ova, the matrix being transparent and colourless. In size the masses vary from 2 to 2.5 cm. in length by 1.75 to 2 cm. in breadth. The ova are spherical and 0.08 mm. in diameter. Segmentation is unequal and a cephalotrochous embryo is the result. I was anxious to watch the stages of segmentation but beyond the bare fact noted nothing could be made out, owing to the opacity of the vitellus.

To describe the embryo (Pl. XIV, figs. 12—21):—The first appearance of cilia is in the form of an equatorial zone, and a tuft of long cilia at the anterior pole or apex of what eventually develops into the præoral segment. With the advent of these organs the embryo begins to rotate slowly within the gelatinous matrix of the cocoon; and shortly two reniform pinkish eye-spots appear on opposite sides above the zonal band of cilia: soon after this the embryo become free-swimming. Either upon liberation or it may be a little prior thereto, a ciliated pit—which eventually becomes the mouth—makes its appearance a little behind the zone of cilia, and this again becomes connected with the posterior pole by a band of short cilia. In this advanced stage—the latest I was able to observe—it is noteworthy that what was the apical tuft of cilia in the first stage has changed its position, moving a little distance ventrally; one of the cilia of this tuft has become extremely elongated

while the rest are shortened. When freed from the investing mass of the cocoon, this trochosphere moves through the water with a rotary motion, the long cilium of the anterior tuft conspicuously directed stiffly forwards, and apparently forming a larval sense organ. The most advanced embryos showed a decided lengthening of the body, chiefly of the post-oral part, and the beginning of a constriction a little behind the mouth.

Last year I observed these egg-masses of *Arenicola* about the middle of March, on the Egremont shore; April 4th, at Port Erin, L.O.M., and April 24th, at Hilbre Island. Mr. Sinel, of Jersey, has also sent me specimens gathered in that Island on February 29th. This year, on April 11th, I found large numbers of the usual bright green hue in sandy pools among the sandstone rocks of Hilbre Island associated with numerous castings. I noted on the last mentioned occasion and also in the Isle of Man, that no cocoons were to be seen on the exposed sandy flats, though castings innumerable were there, and in the pools where they were abundant were masses of *Urea* and of *Enteromorpha* to which the cocoons assimilated exactly in colour. On the other hand, the cocoons of *Scoloplos* were frequently to be noticed anchored among the bare ripple-furrows of the sand expanses. Now these egg-masses of *Scoloplos* are hardly to be distinguished in colour from the muddy sands, the surface of the cocoons becoming so coated with mud that the brownish contents—themselves only a little darker than the sands—do not show through.

Family.—MALDANIDÆ.

\* *Nicomache lumbricalis*, (Fabr.).

Hab: 10.

Three of the hindmost segments together with the characteristic equally lobed anal funnel, were dredged off



Holy Island, Anglesey, from 16 fathoms. Colour, rosy pink. The two ante-anal segments are without setæ.

\**Ariotheca catenata*, Malmgren.

Hab: L.

Immense numbers live in the muddy, evil-smelling sands stretching out from Bangor into the Menai Straits. Cunningham and Ramage aptly remark on the similitude of the projecting ends of their numberless tubes to a miniature forest. A similar ragged appearance on a larger scale is given to the Egremont and New Brighton shore by the exposed ends of *Lanice conchilega* especially when a storm has removed some of the surface sand. Tubes 5—7 inches long and 1—1½ mm. broad. The anal funnel is distinguished from that of the preceding species by the fact that the processes are of unequal length, there being about seven long tapering ones, each separated from its neighbour by from one to three short ones, and instead of two ante-anal segments being without setæ four are naked in the present species.

Family.—AMMOCHARIDÆ.

*Owenia filiformis*, Del. Chiaje.

Hab: 12, 13, 5, S, L.

Is plentiful at all these stations; but most numerous in the deep water. It ranges from extreme low water mark to 21 fathoms. It is the *Ammochæres ottonis* of Grube; and is the worm described by Carrington under the name of *Ops digitata*.

Family.—ARICIDÆ.

\**Scoloplos armiger*, (Müller).

Hab: 1, 2, 6, E, NB, Mp.

A common species in sand from mid-tide mark to 6 fms.

From observations made in the beginning of March, 1890, and April, 1891, upon the egg-cocoons of this worm,

I confirm Cunningham and Ramage's statements and deductions (*loc. cit.*). Max Schültze\* certainly described the eggs and cocoons of *S. armiger* in error for those of *Arenicola marina*. His figures, if we remember them to represent *S. armiger*, are accurate and beautiful. For details of early embryology see notes under *Arenicola marina*, page 249.

Family.—CIRRATULIDÆ.

\**Cirratulus tentaculatus*, (Montagu).

Attains to a large size at Puffin Island, where it is commonly found under stones partly buried in mud near low water mark.

*Cirratulus cirratus*, (Müller).

Hab: P, M.

During Easter, 1890, I collected a large number of small specimens—about  $\frac{3}{4}$ —1 in. in length—from narrow clefts in the schist rocks of Port Erin Bay, Isle of Man. The colour varied; very beautiful were a few where the entire body and long branchial filaments were intense black, relieved by the tentacular filaments of the anterior end being milk white.

This species can be distinguished from *C. tentaculatus* among other characteristics by (*a*) having a transverse series of tentacular filaments on the 1st setigerous somite and not on the 5th and 6th as in *C. tentaculatus*, (*b*) the lateral filaments are fewer and usually originate at a distance from the bases of the notopodia; in the other form they are more numerous and arise close to bases of notopodia; (*c*) annulations are much finer on buccal somite in *C. tentaculatus*.

Mr. Gibson enumerates, in this district two species of this family, viz:—*C. borealis*, Lamarck, and *C. cirratus*,

\* Entwick, von *Arenicola piscatorum*, 1856.

O. F. M. In fact, these two names are now accepted by all authorities as synonyms.

\**Chatozone setosa*, Malmgren.

Hab: Egremont, in clay between tide-marks.

Specimens found February 21st, 1891, contained ova quite ripe. An egg mass found on the same spot with these I believe belongs to this species. It was about the size and shape of a pea, of a faint green colour, and was anchored in the sand by means of a cylindrical stalk. The embryos which I was unfortunately unable to examine in detail appeared to be cephalotrochs approaching closely in form to those of *Arenicola*.

Family.—SPIONIDÆ.

Carrington (*loc. cit.*) mentions three species from Southport, viz:—*Spio seticornis*, (Fabricius), *Spio quadricornis*, Lamarck, and *Nerine coniocephala*, Johnston (= *N. foliosa*, Sars), and catalogues *N. vulgaris* as doubtful. I have not had the good fortune to find the second or the third of these, but on the other hand I have procured a number of specimens of *N. cirratulus* which previously has been but once recorded as British (Firth of Forth). I am also able to say with certainty that *N. vulgaris* is included in our local fauna.

*Spio seticornis*, (Fabr.).

Very abundant on the Mersey shore between Egremont and New Brighton—chiefly about or a little above mid-tide level. As half-an-inch of their fragile sand-tubes projects from the surface, their multitude gives some patches of sand quite a ragged appearance.

\**Nerine cirratulus*, (D. Chiaje).

Hab: Egremont (common between tide-marks).

Specimens found 1st March, 1890, were full of elliptical ova exhibiting the peculiar and characteristically marked vitelline membrane described by Claparede (*Chét. du Golfe*

*de Naples*, 1868). This is so sculptured as to present the appearance of a network of hexagonal meshes, each mesh being a concavity.

Diagnosis:—the first setigerous somite bears no branchiæ. The lamina extends, at most, little more than half-way along the branchial process. In *N. coniocephala* the lamina extends to the tip of the branchia in the anterior somites.

*Nerine (Scolecolepis) vulgaris*, Johnston.

Hab: Port Erin and Southport.

Plentiful in mud, under stones, at the former locality. On none of the branchial filaments does the lamina extend to the tip. The first setigerous somite bears branchiæ, thus differing from *N. cirratulus*. There appears to me no sufficient reason for excluding this species from the genus *Nerine* as Malmgren has done. I revert to Johnston's nomenclature.

*Leucodore ciliata*, Johnston.

Hab: Port Erin and Southport.

A few were found living in narrow clefts in schist rock near low water mark. Also in old shells.

Family.—MAGELONIDÆ (Cunningham and Ramage).

*Magelona papillicornis*, Fr. Müller.

Hab: New Brighton and Southport.

Found not uncommonly in sand between tide-marks. The *Maa mirabilis* of Johnston and Carrington.

Family.—CHÆTOPTERIDÆ.

*Chætopterus insignis*, Baird.

Hab: Beaumaris (low water); and Turbot Hole off Puffin Island (14 fms.).

An excellent illustration, together with figures of the various kinds of setæ, is given in a paper by Mr. J. Williams, published in vol. xviii of the Proc. of the Lit. and Phil. Soc. of Liverpool, 1864. A number of Mr.

Williams' specimens gathered from extreme low water at Beaumaris are now in the British Museum. Examination of the large specimen of "*Spiochætopterus typicus*, Sars," described by Mr. R. J. H. Gibson (*loc. cit.*) as obtained at Beaumaris shows it to be in reality an example of *C. insignis*.

*Nychia cirrosa* and *Polynoë glabra*—one or other—are usually present in the tubes as commensals; *N. cirrosa* more frequently of the two in this district; *P. glabra* (*H. malmgreni* of Ray Lankester) in the Channel Islands.\*

Our local species is identical with specimens from Herm, Channel Islands. The species differs from Quatrefages' *C. valencinii* procured from St. Malo, in that the latter shows a bundle of black bristles on the 4th and 5th pairs of feet, whereas the Herm and the Beaumaris specimens have these on the 4th pairs of feet only. Quatrefages' species has also a larger number of segments in the posterior section of the body. A Herm specimen procured for me by Mr. Sinel of Jersey had about 21 segments in this part.

Family.—CHLORHEMIDÆ.

\**Trophonia plumosa*, (Müller).

Hab: 6, 9, P. A few small specimens from 5 fathoms off Puffin Island; numbers from the deep water (45—57 fathoms) between Anglesey and the Isle of Man.

Parasitic thecate infusoria are occasionally to be seen on the head tuft of bristles and also much minute filamentous matter similar to that clogging the dorsal bristles and the fimbriæ of the elytra of *Lepidonotus squamatus*.

*Siphonostoma diplochaitos*, Otto.

Hab: H, P, 6, 7, 9.

The *S. gelatinosum* of Mr. Gibson's previous local list. It is more frequently taken on the littoral than *Trophonia*

\* On some new British Polynoina, 1866.

*plumosa*, indeed it is fairly common at low water at Puffin Island. After careful examination of specimens of the undoubted *S. diplochaïtos* obtained from the Naples Zoological Station and home specimens of *Flabelligera affinis*, Sars, I cannot but conclude that specifically they are identical. The slight differences there are, are amply accounted for by the varying states of contraction consequent upon divergent preservative agents and to the considerable difference in latitude between the two habitats. Quatrefages could certainly never have seen a specimen of the Naples *S. diplochaïtos* else he would not have defined the genus *Siphonostoma* as destitute of hairs or glandular papillæ.

Family.—TEREBELLIDÆ.

\**Amphitrite figulus*, (Dalyell).

Hab: Puffin Island and Egremont.

The *A. Johnstoni* of Malmgren according to Marenzeller. The presence of 24 pairs of notopodial fascicles of capillary setæ is characteristic of this species. Tube of mud, the corrugated end projecting about an inch above the surface of the mud-flat where it is found.

*Terebella nebulosa*, Montagu.

Dredged off Port Erin.

*Lanice conchilega*, (Pallas).

Abundant on the littoral, and taken frequently in the dredge.

*Thelepus cincinnatus*, (Fabr.)

Hab: 4, 8, 10, 13, 14, P. Littoral to 22 fms.

Shares with *Lanice conchilega* the honour of being the characteristic species of Terebellidæ of this district. It however has not so high a littoral range as the latter, but, on the other hand, it is, of the two, much the more frequently found in deep water.

Since Malmgren's time the name has continually been

spelled wrongly "*circinnata*." As Marenzeller points out (*loc. cit.*) Fabricius called the branchiæ "cincinnati" (locks of crisped hair) hence the species "*cincinnati*." It is the *Venusia punctata* of Johnston.

\**Nicolea venustula*, (Montagu).

Hab: 12, 13, 14, i.e, the central area of the Irish Sea.

Dredgings in deep water (20—22 fms.) usually yield specimens of this worm—the *N. zostericola* of Malmgren.

The species seems subject to frequent variation in the number of bristle tufts and of branchiæ. Malmgren defines it as having 2 pairs of branchiæ and 15 pairs of bristle-bundles; Tauber (*Ann. danica*) gives 16—17 pairs of the latter and 3 pairs of the former. Again, R. Leuckart's *T. parvula* (= *N. venustula*, Mont.) is endowed with 15 pairs of bristle bundles and 3 pairs of branchiæ, while Marenzeller who first pointed out the agreement of *N. zostericola*, Malmgren, with the *Terebella venustula*, Mont., diagnoses the same species, from specimens gathered both at St. Malo and in the Adriatic as possessing 17 bristle-bearing fascicles and 2 pairs of branchiæ.\* Finally all of the individuals I have examined from the Irish Sea have had the characters as given by the last named author, with the exception of two half-grown ones which differed in having 15 pairs of fascicles.

Family.— AMPHARETIDÆ.

\**Ampharete grubei*, Malmgren.

Hab: Station 14. A single specimen.

Two species of the genus *Ampharete* have previously been reported as British, viz :—*A. gracilis*, and *A. arctica*. The former is characterized according to Malmgren—by elongated filiform branchiæ and apex of palmular setæ much attenuated; the latter by stout short branchiæ, the palmular setæ having a mucronate apex. The present

\* Zur Kenntniss der Adriat. Anneliden.

species (recorded now for the first time as British) has short branchiæ and apices of palmular setæ very much drawn out.

Family: AMPHICTENIDÆ.

This is a family wherein Malmgren has introduced much unnecessary sub-division. For instance, take his two genera *Amphictene* and *Pectinaria*, the former containing *P. auricoma*, the latter, *P. belgica*. His generic definitions for the two are nearly word for word the same, almost the only divergence being that he states that in *Amphictene* the margin of the post palmular area is cirate-dentate whereas in *Pectinaria* the same region is entire. Again, the former constructs a curved tube—the latter a straight one—all which, while they may be good specific distinctions, seem to me altogether too trivial to possess generic value. Again, Malmgren erects the genus *Lagis* to contain species possessing 15 and 12 pairs of capillary and uncinigerous setæ respectively in contradistinction to *Amphictene* and *Pectinaria* with 17 and 13 pairs. This division is apparently founded upon an error as both *P. (Amphictene) auricoma* and *P. belgica* possess only 15 and 12 pairs. If Malmgren's *Lagis* really possesses the number of bristle bundles stated by him, then *Lagis* as a genus must cease to exist and must be merged into *Pectinaria*.

*Pectinaria (Amphictene) auricoma*, (Müller).

Hab: 12, 13.

Dredged from 20—22 fathoms in company with *P. belgica*, which they generally surpass in size. Not found at any time in great number. Malmgren gives the number of fascicles of capillary bristles as 17 pairs, and the uncinigerous rows as 13 pairs, but careful examination of all the specimens available showed but 15 pairs of the former and 12 pairs of the latter.



*Pectinaria belgica*, (Pallas).

Hab: 1, 2, 4, 12, 13, E. NB.

Immense numbers people the far-stretching sandbanks skirting the Lancashire and Cheshire coasts. The animals live head downwards in the sand, and range from mid-tide mark (exceptional) to a depth of 21 fathoms.

As in the preceding species there are 15 pairs of capillary fascicles and 12 pairs of uncinigerous rows, not 17 and 13 as stated by Malmgren, nor 15 and 11 pairs respectively as amended by Cunningham and Ramage.

Family.—HERMELLIDÆ.

*Sabellaria alveolata*, Linn.

Hab: S, E, NB, H.

Enormous encrusting masses attaining in favourable situations a thickness of quite two feet, occur at the tide-swept end of Hilbre Island. As the geological formation of the Island is soft Red Triassic sandstone liable to rapid denudation, these incrustations have an important retarding effect, as has been pointed out by Prof. Herdman.\* Damage wrought by storms on the brittle sand constructed tubes is very rapidly righted by the gregarious occupants. A species of mite is frequently found parasitic upon this species.

\* *Sabellaria spinulosa*, R. Leuckart.

Hab: 5, 8, 9, 10, 12, 13, 10—50 fms.

This animal is met with everywhere in deep water in our area often in considerable abundance, and is without doubt one of the commonest worms. It is brought up both in broken masses and also singly upon valves of dead shells. It appears to be confined pretty straitly to the depths of the sea and not to trench on the shallow water and littoral range of *S. alveolata*.

\*Proc. L'pool Biol Soc. vol. II. p. 39.

## Family.—SERPULIDÆ.

## 1. Sub-family.—SABELLINÆ.

*Sabella pavonia*, Savigny.

Hab: 4, 7, 8, E, H, M.

I have found considerable variation in this species, both in size and in the colouration of the branchial filaments. In this district it ranges from some feet above low water level to 16 fathoms, but specimens which are ever left uncovered by the tide never attain to the largest size.

*Sabella pavonia*, var. *bicoronata*, n.

Hab: Rock pools at extreme low water at Hilbre Id.

This variety is found in considerable numbers as above. From the type it differs in *nothing* save the arrangement of the branchiæ. These are in two unequal tufts forming two closely superposed circles of filaments when expanded—nearly 4 in. in diameter in large specimens.

Of the two fully grown specimens obtained one had 61 filaments in one tuft, and 30 in the other. The second had 55 and 37 respectively. The smaller tuft usually forms more than half a circle, the larger meets this on one side and forms the remainder of the outer circle and then curves inwards to make a more or less complete inner circle. The anterior part has 8—13 segments. At first I was inclined to form a new species for this animal and to place it in the genus *Spirographis* but for the present I incline to count it merely a variety. Numbers of normal *S. pavonia* are found associated. Probably many of the species of *Spirographis* described in various works will in time be eliminated and found to be varieties of different species of *Sabella*. In *Dasychone herdmani*, mentioned next a specimen is noted having unequal tufts after the same manner.

\**Dasychone herdmani*, n. sp. (Pl. XV, figs. 1—9.)

Hab: Puffin Island and off the coast of Anglesey, from low water to 18 fms. Stations 5, 6, 10, P.

The body is short and thick, composed of about 60 segments. The anterior or thoracic region is about as broad as long, having 8 bristle-bearing segments. The dorsal edges of the cephalic collar incline towards each other and nearly touch. Thence the collar is continued as a slightly everted rim of even height, terminating in two boldly everted lappets on each side of the median ventral line. A shallow notch separates the lappets from the rest of the collar laterally. The branchiæ are in two equal tufts of 15—20 filaments each. Apex of each radiole is naked, rather stout or digitate. The distal pinnae rapidly diminish and end as mere bud-like eminences at the base of apex. At equal distances on the rachis are disposed paired eye-spots. Between each two pairs of eye-spots is a pair of dorsal appendages; usually the position is just behind one of the pairs, but in some specimens it is nearly midway between the two. In shape they are ample, long, and *broadly spathulate, the margin of the broad apex being puckered and indented*. There are in general 20—22 pairs of these processes on each filament and an equal number of eye-spots. The tentacula are two in number, channelled on the opposing faces, acuminate, about a third as long as the filaments.

Colour. Body of dark yellowish or brownish red; a dark brown spot below each tuft of capillary setæ in the thoracic region, but above each tuft in the posterior or abdominal portion of the body. Collar pale and uncoloured as are also the tentacula. The branchiæ are white, beautifully variegated with narrow bands of intense purple, brown and yellow.

The tube is short and corrugated, dark grey in colour

and chitinous in structure. Length about 3 to 5 cm. Animal about the same length.

This species while agreeing in all other essential details with the previously known British representative of this genus, *Dasychone dalyelli*, Kölliker (the *Sabella bombyx* of Johnston) is sharply differentiated by the shape of the dorsal processes. A similar difference marks it off from the Neapolitan *D. lucullana* with which species Mr. Gibson, in the previous local list erroneously identified the present. In both *D. dalyelli* and *D. lucullana*, which I fancy will be found to be one and the same species, the dorsal appendages have the form of elongated sublinear processes slightly dilated at the apices—giving them a graceful club-like form—totally different from the broad spatulate appendages of *D. herdmani*. This latter form approaches more closely to that seen in *D. infarcta*, (Kroyer), but Kroyer's species has no eye-spots.

In one specimen I noticed with interest a similar varietal departure from the normal arrangement of the branchiæ such as I elsewhere note concerning *Sabella pavonia*. In the individual I refer to, the left tuft of branchial filaments was much larger than the right—containing 33 filaments for the other's 16.

\**Amphicora (Othonia) fabricia*, (Müller).

It is to the courtesy of Mr. C. H. H. Walker that I am indebted for having my attention directed to this tiny tube builder as an inhabitant of this district. It is fairly numerous attached to the surface of seaweed, &c. at the extremity of Egremont slip—than which no more prolific hunting-ground exists in the Mersey whenever the Ferry authorities for even a short period cease from troubling about repairs. *A. fabricia* is at times met with free—without trace of any protecting tube—crawling about among weed.

## 2. Sub-family:—SERPULINÆ.

*Filigrana implexa*, Berkeley.

Hab: N. E. coast of Anglesey and south coast of Isle of Man—Low water to 18 fms.

*Serpula vermicularis*, (Ellis).

Hab: Deep water area of Irish Sea, about 20 fms.

\* *Serpula reversa*, Montagu.

Hab:—P, 6, 12, 13.

From low water mark to 22 fathoms. The most abundant deep water Serpulid. I have seen a crab dredged up carrying two or three large ones upon its carapace; the usual situation is upon shells of dead molluscs. Probably the *Eupomatus pectinatus* of Philippi.

*Pomatoceros triqueter*, (Linn).

Hab: P, 5, 10. Common on the littoral, extending more sparingly to deep water—18 fms.

Apparently a variable species—in the colour of the branchiæ and in the shape of the operculum. Cunningham and Ramage are in error in giving *S. conica*, Johnston, as a synonym, unless indeed it be that the latter is found to be a variety *P. triqueter*. In any case Johnston's figure of the operculum of *S. conica* is not a typical form of that of *P. triqueter*, while that figured under the name of *S. armata* is perfectly characteristic, agreeing even with C. and R.'s own delineation of the operculum of the present species.

*Spirorbis borealis*, Mörch.

Hab:—On all our rocky shores and wherever it can find lodgment, characteristic of the littoral—*Fucus serratus* is its commonest host.

*Spirorbis lucidus*, (Mont), Mörch.

The characteristic *Spirorbis* of deep water. Its tiny translucent spirals frequently occur in rows along the stalk and branches of *Sertularia* dredged from various depths.

GEOGRAPHICAL and BATHYMETRICAL range of local  
POLYCHÆTOUS ANNELIDS.

NOTE.—The following abbreviations are used:—E= East coast of Great Britain; Ch = English Channel coasts; Ir = West and South coasts of Ireland; WS = West Scotland; Shet = Orkney, Shetland and Faroë region; UK = all British coasts. US = East coast N. America, south of Labrador and north of N. Carolina; Gr = Greenland and Arctic America; Sp = Spitzbergen; NZ = Nova Zembla; Sc = Scandinavian, Danish and German coasts; Med = Mediterranean Sea.

L = Littoral; O = Low water mark. (X) cast ashore by storms.

SPECIES.	Local—Irish Sea Area					RANGE in BRITISH SEA.	OTHER SEAS.	
	Central Area.	Isle of Man.	N. Wales & Anghsy.	Lancas. & Clesh.	Hilbre Island.			
<i>Aph. aculeata</i> .....	x	...	x	x	...	O—20	UK.	US, Sc, Med.
<i>Hermione hystrix</i> ...	x	x	x	...	...	15—40	Ch, Ir.	Sc, Med, C. Verde I.
<i>Lep. squamatus</i> .....	x	x	x	...	x	L—22	UK.	US, Gr, Sc, Azores.
<i>Nychia cirrosa</i> .....	...	...	x	...	...	O—18	E, Ch.	US, Gr, Sp, NZ, Sc.
<i>Polynoë imbricata</i> ...	...	x	x	...	...	L—5	UK.	US, Gr, Sp, NZ, Sc, S. Jpn, Ochotsk S, Sitcha
„ <i>halioti</i> .....	x	x	...	...	...	15	WS, Sh.	
„ <i>impar</i> .....	x	...	x	x	x	L—22	Sh, E, Ch.	US, Gr, NZ, Sc, off Gibraltar, Med (probably)
„ <i>estenuata</i> .....	...	x	x	...	...	L	...	Med.
„ <i>propinqua</i> .....	x	x	x	x	...	L—57	E, Shet.	US, Sc, Madeira.
„ <i>setosissima</i> .....	...	x	...	...	...	O	E, Ch.	Sc, Med (probably).
„ <i>castanea</i> .....	x	x	x	...	...	20—22	Shet, Ir, Ch.	
„ <i>flaccida</i> .....	...	x	...	...	...	L	E, Ch.	
„ <i>huxulata</i> .....	...	...	...	(x)	deepw		UK.	Med.
„ <i>gohastoni</i> .....	...	...	x	...	12—20	Sh, WS, Ch.	Ir	Sc. La Rochelle.
<i>Acholoë astericola</i> .	x	...	(x)	...	14		Ir	Med
<i>Hul. gelatinosa</i> .....	...	x	...	...	O	E, WS, Ch.	Sc.	

<i>Hermadion assimile</i>	x	x	...	...	10—21	E. Ir, Ch.	off C. de Gatte (M'D).
„ <i>pellucidum</i>	x	...	...	...	16—22	E, WS.	Med.
<i>Sthenelais boa</i> ...	x	x	...	...	L	UK.	Sc.
„ <i>limicola</i>	(?)	x	...	...	20—22	Shet, E.	US.
„ <i>zelandica</i> (?)	x	...	...	...	20	Shet.	
<i>Pholoe minuta</i> .....	x	x	...	...		E, Ch.	US, Gr, Sp, NZ, Sc.
<i>Spinther miscooides</i> ..	x	...	...	...	17	WS, & Blfast	Sc.
<i>Eunice harassii</i> .....	x	...	...	...	20—22	Ch.	
<i>Onuphis conchilega</i> ..	x	...	...	...	20—22	UK.	US, Gr, Sp, NZ, Sc, Portugal.
<i>Lumbr. fragilis</i> .....	x	x	x		20—22	E, Shet.	US, Gr, Sp, NZ, Sc.
<i>Nereis pelagica</i> .....	x	x	x	x	L—20	UK.	US, Gr, Sp, NZ, Sc, Japan.
„ <i>diversicolor</i>			x		L	UK.	Gr, Sc, Med, Japan.
„ <i>dumerilii</i> ...	x	x	x		L—16	UK.	US, Sc, Med, Madeira, C. Verde Ids. & Japan.
„ <i>virens</i> .....			x		L	E, WS.	US, Sc.
„ <i>fucata</i> .....	x	x	x		L—18	E, Ch.	US, Sc.
<i>Nephtys ceca</i> .....	x				18	E, WS, Ch.	US, Gr, Sc.
„ <i>homberti</i> .....	x	x	x	...	L—20	E, WS.	US, Gr, NZ, Sc.
<i>Goniada maculata</i> ....			x		L	E.	US, Sc.
<i>Glycera capitata</i> .....		x	x		L—17	E, WS, Ch.	US, Gr, Sp, NZ, Sc, Portugal and Azores.
„ <i>nigripes</i> .....			x		5	E.	
„ <i>dubia</i> .....			Stomachs of Cod			E, WS, Ch.	
„ <i>goësi</i> .....			x			E.	Sc.
<i>Syllis tubitex</i> .....	x	x			3—21	E, WS, Ch.	N. Scotia, Madeira, Sc.
„ <i>armillaris</i> .....					O	E, Ch.	Sc.
<i>Autolytus alexandri</i> ..	To w-	x	netted	...	...	...	US, Gr.
„ <i>prolifer</i> .....			x			E.	Sc.
<i>Ephesia gracilis</i> .....	x	x	x		O—25	UK.	Gr, Sp, NZ, Sc.
<i>Psammathe fusc.</i> .....			x		L	E, Ch.	
<i>Castalia punctata</i> ....			x		18	E.	Sc, Iceland.
<i>Phyll. maculata</i> .....			x	x	O—18	E.	Iceland.
„ <i>luminosa</i> .....	x	x			O	E, Ch.	Med.
<i>Eulalia viridis</i> .....	x	x			L	E, Ch.	Gr. Sc.
<i>Tomopt. onisciformis</i>	x	x	To w-	netted		E, Ch, Shet.	?
<i>Ophelia limacina</i> .....	x				18	E.	Gr, Sp, NZ, Sc, US.
<i>Annot. aulogaster</i> ...	x	x			3—21	E, WS.	Gr, Sp, NZ, Sc.
<i>Capitella capitata</i> ...	x	x			L	E, WS.	Gr, Sp, NZ, Sc, Med.
<i>Arenicola marina</i> ....	x	x	x	x	L	UK.	US, Gr, Sp, Sc, Med.
<i>Nic. lumbricalis</i> .....			x			E.	US, Gr, Sp, NZ, Sc.
<i>Aziothea catenata</i> ....			x		O	E, Shet.	US, Gr, Sp.
<i>Owenia filiformis</i> ..	x	x	x		O—22	E.	Gr, Med.
<i>Scoloplos armiger</i> ...	x	x	x		L—6	Sh, E, Ch.	US, Gr, Sp, NZ, Sc.
<i>Cirratulus cirratus</i> ...	x	x			O	UK.	US, Gr, NZ, Sc.
„ <i>tentaculatus</i>	x	x			L	E, Ch.	Med.
<i>Chaetozone setosa</i> ....			x		L	E.	US, Sp, NZ, Sc.
<i>Spio seticornis</i> .....			x		L	E, Ch.	Gr, Sc.
<i>Nerine cirratulus</i> ....			x		L	E.	Med.
„ <i>vulgaris</i> .....	x	x			L	E, Ch.	Sc.
<i>Leucodre ciliatu</i> ....	x	x			L	E, Ch.	Iceland, Sc, Philippns & Australia (Haswell).
<i>Mag. papillicornis</i> ...			x		L	E.	
<i>Chaetopterus insignis</i>			x		O—14	WS, Ch.	
<i>Trophonid plumosa</i> ...	x	x			O—57	Sh, E, Ch.	Gr, Sp, NZ, Sc.
<i>Siphon. diplochaëtos</i>	x	x	x		L—18	WS, E, Ch.	US, Gr, Sp, NZ, Sc Med
<i>Amphitrite figulus</i> ...	x	x	x		L	E.	US, Sc.
<i>Terebella nebulosa</i> ...	x				14	UK.	Sc, Med.

<i>Lanice conchilega</i> ....	x	x	x	x	x	L-22	E, Ch.	Cattegat, Belgium, Med, and Madeira.
<i>Thelepus cincinnatus</i>	x		x			L-22	UK.	US, Gr, Sp, NZ, Se Med
<i>Nicola venustula</i> ....	x					20-24	Sh, E, Ch.	Gr, Sc, Med.
<i>Ampharete grubei</i> ....	x						...	Gr, Sp, NZ, Se.
<i>Pectin. auricoma</i> ....	x					20-22	E, WS.	Sc, Med.
„ <i>belgica</i> .....	x	x	x			O-22	UK.	Se.
<i>Sabellaria alveolata</i> .			x	x		L	E, Ch.	Med.
<i>Sabellaria spinulosa</i>	x		x			10-50	E, Ch.	Se.
<i>Sabella pavonia</i> .....		x	x	x	x	M-16	E, Sh, ChWS	US, Se.
<i>Dasychone herdmani</i>			x			O-18	...	
<i>Amphicora fabricia</i> ..			x			O	E, Ch, WS.	Gr, Sc,
<i>Filigrana implexa</i> ....	x	x				O-18	E, Ch.	US, Sc.
<i>Serpula vermicularis</i>	x					20	UK.	Se, La Rochelle
„ <i>reversa</i> .....	x		x			O-22	E, Ch, Ir.	
„ <i>triquetra</i> ....			x			L-18	E, Ch.	Se, Med.
<i>Spirorbis borealis</i> ....		x	x	x	x		Litt.	US, Gr, Se.
„ <i>lucidus</i> ....	x	x	x			10-20	E.	US, Gr, NZ.

## EXPLANATION OF PLATES.

## PLATE XIII.

- Fig. 1. Notopodial seta of *Polynoë propinqua*,  $\times 250$ .  
 Fig. 2. „ „ „ „ *imbricata*,  $\times 250$ .  
 Fig. 3. „ „ „ „ *impar*,  $\times 250$ .  
 Fig. 4. „ „ „ „ *extenuata*,  $\times 250$ .  
 Fig. 5. „ „ „ „ *haliæti*, var. *hyænæ*,  $\times 250$ .

(These figures show the minute but constant relative differences in the degree of serration exhibited by the bristles of the respective species.)

- Fig. 6. *Polynoë impar*. Portion of scale showing single large pear-shaped papilla,  $\times 130$ .  
 Fig. 7. *Polynoë propinqua*. One of the large sub-globular margin processes,  $\times 190$ .  
 Fig. 8. *Polynoë extenuata*. Entire scale,  $\times 44$ .  
 Fig. 9. *Polynoë propinqua*. Parapodium,  $\times 20$ .  
 Fig. 10. *Eunice harassii*. Parapodium and branchia from the 21st setigerous somite,  $\times 20$ .



## PLATE XIV.

- Fig. 1. Egg capsule of *Scoloplos armiger*, nat. size.  
Fig. 2. Ovum separated from capsule,  $\times 80$ .  
Fig. 3. Extrusion of polar bodies,  $\times 80$ .  
Figs. 4—11. Stages in segmentation of an ovum,  $\times 80$ .  
*p.b.* polar bodies; *mic.* micromeres; *mac.* macromeres.  
Fig. 11. Shows macromeres entirely enclosed by micromeres except at the blastopore.  
Fig. 12. Egg capsule of *Arenicola marina*, nat. size.  
Figs. 13—18. Stages in the larval development of same,  $\times 225$ . *e.g.* eye-spots; *z.* zonar band of cilia; *a.* anterior tuft of cilia; *m.* mouth; *v.* ventral band of cilia; *c.* first segmental constriction of larval body.  
Figs. 17, 18 are diagrams to show the ciliary arrangement.  
Fig. 19. Appearance of zonar cilia as seen from above while the embryo is whirling rapidly,  $\times 225$ .  
Figs. 20, 21. Most advanced embryos observed; *c.* first segmental constriction,  $\times 400$ .

## PLATE XV.

*Dasychone herdmani*, n. sp.

- Fig. 1. Entire animal, dorsal view,  $\times 3$ .  
Fig. 2. Lateral view of anterior portion of body,  $\times 4\frac{1}{2}$ .  
Fig. 3. Ventral view of same,  $\times 4\frac{1}{2}$ .  
Fig. 4. Part of a branchial filament,  $\times 44$ . *a.* dorsal processes; *b.* eye-spots; *p.* pinnæ.  
Fig. 5. Extremity of a radiole,  $\times 44$ .  
Fig. 6. Dorsal process from a different specimen to Fig. 4; here the margin is less puckered,  $\times 60$ .  
Figs. 7, 8. Capillary setæ. 7, superior; 8, inferior,  $\times 250$ .  
Fig. 9. Uncinus,  $\times 250$ .



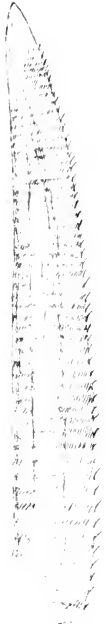


Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.

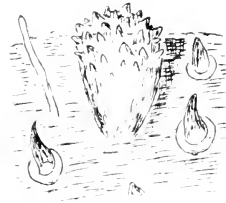


Fig. 6.

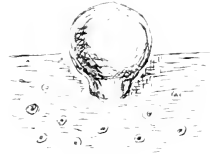


Fig. 7.

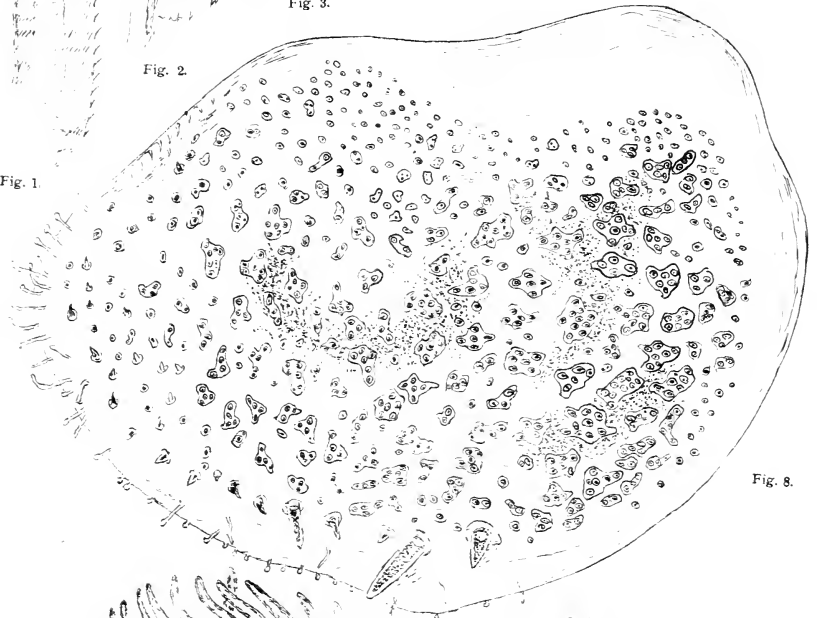


Fig. 8.

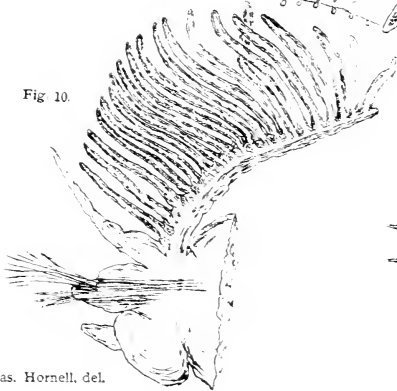


Fig. 10.

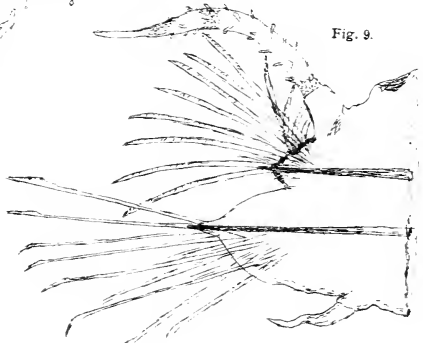
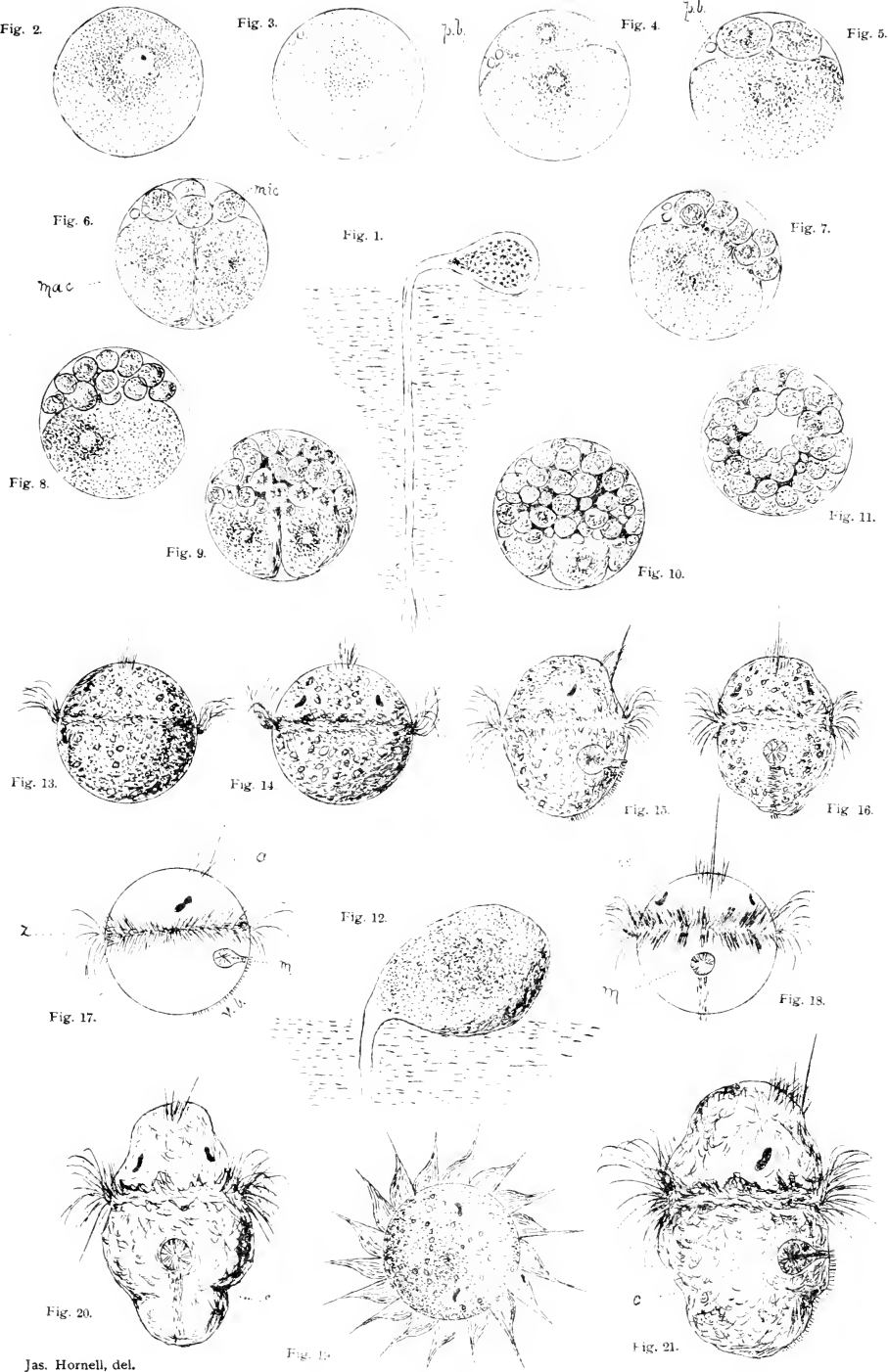


Fig. 9.

Jas. Hornell, del.





Jas. Hornell, del.

EMBRYOLOGY OF SCOLOPLOS ARMIGER.  
AND ARENICOLA MARINA



Fig. 1.



Fig. 7.

Fig. 8.



Fig. 5.



Fig. 4.

Fig. 6.



Fig. 2.

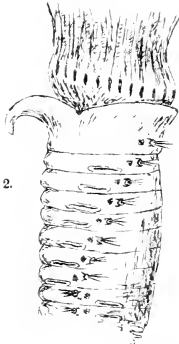


Fig. 9.

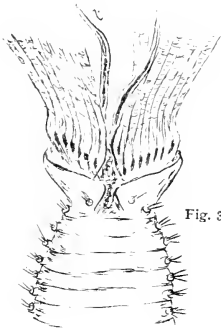


Fig. 3.

Jas. Hornell, del.





[From Trans. Biol. Soc., L'pool. Vol. V.]

FIFTH ANNUAL REPORT of the LIVERPOOL  
MARINE BIOLOGICAL STATION now on  
PUFFIN ISLAND.

BY W. A. HERDMAN, D.Sc., F.L.S., F.R.S.E.,

DERBY PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE,  
LIVERPOOL; CHAIRMAN OF THE LIVERPOOL MARINE BIOLOGY  
COMMITTEE, AND DIRECTOR OF THE PUFFIN  
ISLAND STATION.

[Read 11th December, 1891.]

THE YEAR.

THE past year has been a most unfortunate one for marine biological work on account of the storms during the summer and autumn which interfered with our usual dredging expeditions in Liverpool Bay, and did great damage to the boats at Puffin Island. Still work has been carried on continuously at Puffin Island and in other parts of the district, and as a result not a few additions to knowledge, and advances along lines of investigation previously started, claim record in this annual report.

The Biological Station was not closed during last winter, and will be kept open during the present winter also. The keeper, Thomas Jarrett, and his wife are still in charge. At the end of autumn (October 31st, 1890) the old sailing boat, "Bonnie Doon," which had for some time been leaking badly and required frequent patching and caulking, was taken up to Cadnant (Menai Straits) and beached for the winter. A thorough examination of her in the spring showed that she was really past work. Some of her planks were so rotten that they would not bear further caulking, when a leak was stopped in one place it broke out in another, and the boat did not seem worth

the very extensive repairs which would be necessary in order to render her safe in the strong winds and heavy seas which come upon us with very short warning in the neighbourhood of Puffin Island. So the executive of the committee after full consideration reluctantly decided that the "Bonnie Doon" must be condemned and sold for what she would bring.

A new sailing boat to take her place at the island was now necessary, and a timely donation towards that purpose from Mrs. C. W. Jones encouraged the Treasurer to provide the amount required for the purchase of the "Morning Star," a second-hand, but almost new, 4 ton cutter, 21 ft. in length, which was in first rate condition and bore an excellent character at Beaumaris. She has been in constant use during the summer and autumn and has proved perfectly satisfactory.

Unfortunately during the severe gales which commenced on October 13th and continued for some time, the "Morning Star," like so many other small yachts in the neighbourhood, was sunk at her moorings, and had to be left at the bottom until the gales were over and boats and men could be got down from Bangor to raise her. After several attempts she was got up on November 24th, brought in to low water mark, bailed out, floated, and afterwards taken up to Beaumaris where she has been hauled up for the remainder of the winter. Fortunately her hull has received no damage, but several of her spars are broken or lost and the sails and rigging are destroyed and will have to be replaced in spring. To finish the record of the disasters to our boats, the old black rowing boat "Ascidian" was smashed to pieces on the beach during one of the storms; and the small blue punt was, on another occasion, sunk between tide marks, but was afterwards recovered. She has

suffered no damage to speak of, and is still in fairly serviceable condition, though showing signs of wear.

## STATION RECORD.

The Journal at the Laboratory records that the following naturalists have been working at the Biological Station for longer or shorter periods during the present summer:

DATE.	NAME.	WORK.
1891.		
<i>February.</i>	I. C. Thompson, F.L.S., Liverpool ... ..	Copepoda.
—	Alfred Leicester, Southport ... ..	Land Mollusca.
—	W. A. Herdman, Univ. Coll., Liverpool ... ..	Nudibranchs, &c.
<i>April.</i>	Dr. R. Hanitsch, Univ. Coll., Liverpool ... ..	Sponges.
—	I. C. Thompson... ..	Copepoda.
—	W. A. Herdman ... ..	Nudibranchs.
<i>June.</i>	W. Thornely .. ..	Zoophytes and
—	F. V. Milward ... ..	Polyzoa.
<i>July.</i>	Dr. G. S. Brady, F.R.S. ....	Copepoda.
—	I. C. Thompson... ..	Copepoda.
—	R. J. H. Gibson, Univ. Coll., Liverpool ... ..	Alge.
—	Rev. T. Shankland, Univ. Coll., Bangor ... ..	Land Mollusca.
<i>August.</i>	Miss A. E. Warham, B.Sc., U.C.L'pool. ... ..	Ascidians.
—	Miss L. Buckley, B.Sc., U.C.L'pool. ... ..	General.
—	Alfred Leicester, Southport ... ..	Land Mollusca.
—	Miss J. Leicester ... ..	„
—	J. Coventry, Liverpool ... ..	General.
—	Rev. T. Shankland ... ..	Land Mollusca.
<i>October.</i>	I. C. Thompson... ..	Copepoda.
—	W. A. Herdman ... ..	Nudibranchs, &c.

This list contains rather fewer entries than the corresponding ones for the last two years, but that may probably be accounted for by the miserable weather during the greater part of the season. Several parties which were organised to visit the Station had to be broken up, and on one occasion several of our local biologists got as far as Beaumaris on their way to Puffin Island in very bad weather, and after waiting there for a few days had to return.

It is experiences such as these, during a summer like the one we have just encountered, which unpleasantly emphasize the inconvenience of having the biological station at a somewhat inaccessible spot; and which are causing the Committee to consider the advisability, now that we have had five years work at Puffin Island, of moving the centre of operations to some suitable spot nearer home. Although a marine fauna seems practically inexhaustible, still we have certainly now found and recorded the great majority of the animals and plants of the Menai Straits, and have investigated to some extent the more characteristic and interesting forms of life, and some of the problems they present to us for solution. So it might well be found more profitable to break ground in some new part of our area, and if a suitable local habitation could be obtained somewhere in the neighbourhood of Hoylake, West Kirby, or Hilbre, although the fauna would not be so rich and varied as at Puffin, still the proximity to Liverpool would greatly facilitate work. Then again, with our biological station near a fishing centre like Hoylake, we would also be able to carry on investigations with a practical bearing which might be of importance to the fishermen, and so help our friends on the Sea Fisheries Committee of the County Council in their most necessary and valuable work for the benefit of the local fisheries. Several of the lines of investigation started by our L.M.B. Committee during the last few years—such as the distribution and composition of the surface life of the sea and its relation to the food of fishes, statistics in regard to the life-history of shrimps, and habits, growth, &c., of young mussels—have opened up avenues leading to practical results, and which ought to be pursued further; while many other problems and lines of inquiry of equal biological interest and economic importance still await investigation.

On the other hand it is possible that all such purely local work might be adequately undertaken in connection with the College Laboratories, and that the L.M.B.C. Station should be regarded as a means of investigating more outlying areas; and therefore several of the Committee are strongly of opinion that if we leave Puffin Island the station should be established at Port Erin, near the south end of the Isle of Man, for a few years, in order that the rich marine fauna of that neighbourhood may be more fully investigated.



Fig. 1.—Map of the L.M.B.C. District.

#### PUBLICATIONS.

It is proposed to issue the third volume of reports on the Fauna and Flora of Liverpool Bay during the coming season. Most of the sheets and plates for it have been printed off and stored, but as it is desired to include also those papers on the marine biology of the district which

will be laid before the Biological Society during the present session, and especially the revised reports upon the Copepoda (by Mr. Thompson), the Mollusca (by Mr. Archer), and the Pycnogonida (by Dr. Hurst and Mr. Walker), the volume will probably not be in the hands of the public until early summer.

The various L.M.B.C. papers which were announced in last year's Report as being nearly ready for publication were communicated in due course to the Biological Society and printed in the fifth volume of Transactions. The two most important of these are:—an extensive report by Mr. Harvey Gibson on the Marine Algæ, including records of 256 species of which 66 are additions to our list; and a report on the Polychætous Annelids, by Mr. J. Hornell, in which 88 species (one new to science) and two new varieties are given, three of the species being new to British waters and 39 additions to our local fauna. Mr. Moore's long promised report upon the Fishes is not yet ready. This is the more to be regretted as in view of the ever increasing attention which is being directed towards fishes, the formation of a Fisheries Committee of the County Council, the establishment of a Sea Fisheries District in our neighbourhood and the appointment of a superintendent (Mr. R. A. Dawson), with a steamer at his service and a staff of assistants, it is most desirable that we should publish a report upon the local fishes without further delay. It is hoped that Mr. Moore's improved health will permit him now to make more rapid progress with the work.

#### DREDGING EXPEDITIONS.

For the first time in the history of these annual reports we have no "Hyæna" expedition to record. The Salvage Association, with their usual kindness, permitted us to

organize an expedition during Whit-week, but most unfortunately at the last moment when our party was assembled ready to embark for a 4 or 5 days cruise it was found to be so rough outside the river, and the telegraphic reports from Holyhead were so bad, that the captain and the officials of the Salvage Association reluctantly decided that it was not fit for the "Hyæna" to go, so the expedition was postponed for a few weeks. The decision, although disappointing at the moment, was a wise one, as it blew hard for the next three days, and even if the "Hyæna" had succeeded in reaching the north coast of Anglesey, our proposed destination, it was clear from the weather reports that we could have done no work there. A few of our party from other towns, who were to join us at Beaumaris, unfortunately did not hear of the change of plan in time and reached the Menai Straits next day by train, and spent a day or two there dredging in sheltered waters.

A second time, a few weeks later, the party was organized and all arrangements made, when a couple of days before the proposed start a disastrous collision occurred in the Mersey, a steamer was sunk, and the "Hyæna" was consequently called off to her ordinary salvage duties. The Salvage Association most kindly offered to let us have the boat later in the summer, but we were unable to take advantage of it then, and must look forward to better luck and less boisterous weather next spring.

Early in June the Sea Fisheries Committee, through their superintendent, Mr. R. A. Dawson, invited us along with some of the Southport Biologists to organize a single day dredging trip in their new Fisheries steamer "The Mavis." On this occasion (June 20th) we had beautiful weather, and did a good deal of dredging and tow-netting in the neighbourhood of Southport. The party consisted

of Mr. Fell, Mr. Muspratt, Mr. Ascroft, and Mr. Dawson of the Fisheries Committee, Dr. Chaster and several others of the Southport Natural Science Society, and Mr. Thompson, Mr. Leicester, Mr. Comber, Mr. W. J. Stewart, the Mayor of Bootle, and others of our own Committee. Although many specimens were obtained on this occasion none, so far as yet determined, were specially noteworthy or new to our records, except some fine typical specimens of the Foraminifer *Vaginulina linearis* obtained from 20 fms., about 23 miles out from Southport. Later in the summer a few of the Southport biologists went out again for a day's dredging in the "Mavis." They report having found good ground and got good hauls (Ascidians, &c.). Unfortunately our Committee were not able to take part in that expedition, and the specimens were not preserved nor recorded.

On September 26th we chartered the tug "Spindrift" for the day, and a considerable party left the Landing Stage in the morning, hoping to have some dredging in that central area, half-way to the Isle of Man, which seems so difficult to reach on our expeditions. With our usual luck we found on getting out of the river that there was a heavy sea, and although we persevered for some hours it was getting worse all the time, and so about one o'clock we turned back and had some hauls of the trawl in the afternoon in the Rock Channel where we got Starfishes, Zoophytes, Polyzoa, and other common things, none of them new to the locality.

#### SURFACE FAUNA.

Mr. Thompson, who has been receiving and examining the tow-nettings taken by the keeper at Puffin Island throughout the year and also those collected on the few expeditions, says that although valuable for statistical



purposes there is comparatively little that is specially worthy of note. January (1891) was remarkable for the enormous profusion of *Sagitta* in all the tow-nettings from the neighbourhood of Puffin Island. From later in the spring on to July the gatherings from the same region were characterised by the abundance of Diatoms and a slimy *Conferva*.

In a ten-fathom dredging taken by Mr. A. O. Walker off the Little Orme, near Colwyn Bay, on May 6th, one species of Copepod occurred which is new to the district, viz., *Thalestris peltata*, Boeck. It has apparently only once been taken before in British Seas, as Brady says in regard to it "One specimen only was found in dredged material from a depth of 40 fms. off St. Agnes, Scilly Is." The material from this same dredging off the Little Orme contained also several other rare species, viz., *Artotrogus magniceps*, *Zaus goodsiri*, *Thalestris hibernica*, and *Thalestris helgolandica*, the last named being also new to our district. On the "Mavis" expedition of June 20th *Anomalocera patersonii* and *Pontella wollastoni*, both notable species, were taken in the tow-nettings about 20 miles off Southport (see also p. 20).

Mr. A. O. Walker gives me the following additional list of Higher Crustacea taken in our district since his last report dealing with the subject:—Schizopoda, *Nyctiphanes norvegica*, M. Sars (off Puffin I.), *Leptomysis lingourea*, G.O. Sars (Colwyn Bay), *Siriella armata*, M. Edw. (off Puffin I.); Cumacea, *Cumopsis goodsiri*, v. Ben. (off Puffin I.), *Eudorella truncatula*, Bate (off Puffin I.); Amphipoda, *Hyperoche lütkeni* Bovall. (tow-net on D. buoy near Puffin I.), *Gitana sarsi*, Boeck (off Little Orme), *Ptilocheirus pectinatus*, Norman (Menai Straits, "Hyæna" cruise, 1890), *Podocerus cumbrensis*, S. and R. (Menai Str. and Colwyn B.), *Erichthonius difformis*, M.

Edw. (I. of Man, "Hyæna," electric light, 1888), *Siphonacetes typicus*, Kr. (Little Orme), and *Guernea coalita*, Norman (off Great Orme).

#### LAND MOLLUSCA.

In several previous reports Mr. A. Leicester's work on the Land Mollusca at Puffin Island has been alluded to. During the last year he has made two special expeditions to the island, and has been indefatigable in his search, exploring the bushes, tufts of grass, and rock crannies high and low from unconscionably early hours before breakfast till dark night, and leaving literally not a stone unturned in his track. He is now supported in his labours by the Rev. T. Shankland, formerly of the University College of Bangor, now at Mold, who made three or four trips to Puffin Island during July and August for the purpose of comparing the molluscan fauna with that of Anglesey and North Wales, and for the purpose of introducing certain species not found on the island. Altogether they have found during the year 22 species of land Mollusca on Puffin Island, of which 5 are new records (including *Amalia marginata*, *A. gagates*, and *Vertigo pygmæa*).

Mr. Shankland has drawn up comparative lists showing which of the British genera of Pulmonata have been found (1) at Puffin Island, (2) on Penmon Point, Anglesey, and (3) on the Great Ormes Head, as follows :—

<i>Testacella</i> .....	not found at all.
<i>Arion</i> .....	Penmon.....Great Orme.
<i>Amalia</i> .....	Puffin.....Penmon.....Great Orme.
<i>Limax</i> .....	Puffin..... Penmon.....Great Orme.
<i>Succinea</i> .....	Penmon.....Great Orme.
<i>Vitrina</i> .....	Puffin.....Penmon.....Great Orme.
<i>Zonites</i> .....	Puffin.....Penmon.....Great Orme.
<i>Helix</i> .....	Puffin.....Penmon.....Great Orme.

<i>Bulimus</i> .....	Puffin.....	Penmon.....	Great Orme.
<i>Pupa</i> .....	Puffin.....	Penmon.....	Great Orme.
<i>Vertigo</i> .....	Puffin.....	Penmon.....	Great Orme.
<i>Balea</i> .....			...not found at all.
<i>Clausilia</i> .....	Puffin.....	Penmon.....	Great Orme.
<i>Cochlicopa</i> .....	Puffin.....	Penmon.....	Great Orme.
<i>Achatina</i> .....			...not found at all.
<i>Carychium</i> .....			...not found at all.
<i>Aeme</i> .....			...not found at all.
[ <i>Cyclostoma</i> .....			Great Orme.]

As was to be expected, this list shows a close similarity between the three districts. Mr. Shankland also investigated and arranged the varieties of *Helix nemoralis* on the island. He found 14 distinct band-varieties, several of them very rare ones, and he remarks in regard to this species "I have never met with such a variety and richness of colour." On August 19th and 20th Mr. Leicester and Mr. Shankland were occupied in planting in appropriate spots (all duly recorded in the journal at the laboratory) batches of the following species, which ought to do well on the island, and which they had brought over in considerable quantity from the mainland, viz., *Arion ater*, *Arion hortensis*, *Arion subfuscus*, *Arion bourguignati*, *Limax flavus*, *Limax maximus*, *Amalia marginata*, *Helix aspersa*, *Helix rufescens*, *Cochlicopa tridens*, and *Carychium minimum*.

#### FAUNISTIC WORK AT PUFFIN.

Our first visit in this year to Puffin Island was at the end of February, when three members of the Committee went down to the Biological Station for a few days, partly for the purpose of collecting animals on the shore, and partly to examine into the condition of the boats, the fresh water cistern, the rain gutters on the roof, &c., and give directions to the keeper.

After sailing down from the port of Bangor, taking surface gatherings on the way, we reached the island in good time for the evening low tide, and spent the hours till dark collecting amongst the reefs and boulders of the South Spit. One of the first objects found on the shore was a rather interesting specimen. It was an example of the common limpet (*Patella vulgata*), which, in place of being attached to a rock, was sticking firmly to the rounded surface of a piece of iron bar from a wreck. The limpet was moulded to the surface. Its lower part was strongly concave, and the edge of the shell was curved up in the middle on each side, and down at each end, so as to be able to embrace about half the circumference of the cylindrical bar. The animal had evidently grown so as to stick closely and tightly to the surface. Now, this would not be at all surprising in a coral or an ascidian, or any animal which remained adhering to one spot all its adult life; but it is remarkable in a case like the limpet, which, it is generally supposed, does not remain rooted to one spot, but wanders about in search of food.

Although when we notice limpets on rocks between tide marks they are generally fixed and motionless, still Prof. J. R. A. Davis has shown that they can loosen their hold and crawl over the rocks for some distance. It is noticed, however, that when the rock is not very hard, as, for example, in the case of the limestone blocks at Puffin Island, each limpet occupies a well-marked depression exactly its own shape. From this it is clear that the animals are not on mere temporary resting places, but are in their own "roosts" or homes, to which, if they leave them, they return regularly, and which they have themselves excavated to a considerable depth and with the precise shape of the outline of their own shells. So much so that they have to place themselves with the

head always facing the one way in order that they may fit into the depressions.

It is not yet known by what sense the limpets are able to find their way back to their roosts when they leave them in search of food. It is certainly not by sight, as the eyes are very simple and imperfect. It has been proved by experiment that it is not by smell; while taste, and feel can scarcely help. There may be a sense of direction different from anything we know of in our own experience; but what the exact method is by which the limpet finds its way about, can go back the way it has come, and can recognise its own roost amongst a number of similar neighbouring depressions, has still to be discovered.

Now for the interest of the present specimen. It is so closely moulded to the iron bar that I am of opinion that it could not have been in the habit of leaving its home and prowling about. In the first place, the bar was short, and was loose, and free to roll about, and it would be very difficult for a crawling snail-like animal such as the limpet to cross from the bar to the rocks even if its support was stationary, but if, as seems likely, the bar was being rolled about by the waves, one does not see that it would be possible for the limpet to re-find its roost, if it ever left it. Possibly, however, as some think, the limpet never loosens its hold when covered by the tide. This would remove the difficulty partly but not wholly. Then, in the second place, the shape of the shell in this specimen is such that I do not see that the animal could crawl over the rocks, or could occupy any position other than that on the bar in which we found it.

After examining this specimen, I looked carefully at the limpets scattered over the rocks, and found several in which the animal was situated at the bottom of a deep pit, from which it would be very difficult, if possible

at all, for it to extricate itself; and one in which the shell was so jammed in between projecting points of rock round which it was moulded, that I was not able even with the careful use of a strong knife-blade to get the shell out entire. Whether the limpet is sometimes able to obtain sufficient food by raising slightly the edges of its shell I cannot say, but certainly the last few cases mentioned seem to prove that individuals now and then fix themselves in positions which after a time they cannot leave on account of the growth of their shells.

For the rest, our programme at Puffin Island was much as usual. We bathed about 7.30 a.m., and collected specimens on the rocks at low tide for an hour or so before breakfast; Mr. Thompson took tow-nettings from the punt round the shore, and Mr. Leicester searched the cliffs and the bushes for land mollusca. We examined into the condition of the boats, the rain gutters on the roof, and the water cistern, and made arrangements for the necessary repairs. Finally, we gave instructions to the new keeper in regard to the tinned meats and other stores to be laid in, and the best way of providing meals for the biologists who might be going down to work at the station during the Easter vacation.

One noticeable feature of the shore at this time was that the specimens of *Littorina rudis*, which are so very abundant in summer and autumn on the rocks above high water mark, were now almost entirely absent. The only ones left were a few odd individuals down at bottom of deep clefts and crevices, perhaps unable to get out.

On April 8th, Dr. Hanitsch went down to Puffin Island to work at Sponges. He obtained *Tethya lynceurium* and *Raspailia ventilabrum* which had not been found on the island before and also three other species new to the dis-

trict, all from the walls of the sponge caves on the north side.

On April 11th, Mr. Thompson and I went to join Dr. Hanitsch for a few days in his sponge hunting. We thought we had experienced all possible methods of reaching St. Seiriol's Isle, except, perhaps, by means of a balloon or a submarine tunnel, but this occasion showed that our resources were not yet quite exhausted. When we arrived at Garth Ferry we found a rough sea, with a strong head wind, and our man in a small ten-foot punt, while the large boat we had expected to meet us was delayed further up the straits, and could not be brought down for some hours. No other boat of sufficient size was obtainable, and the boatmen and pilots at the ferry declared that there was a big sea running beyond Beaumaris, and that it would be impossible for anyone to reach Puffin for some hours at least, until the tide had ebbed, and the sea and wind had fallen considerably. But as we had determined to be at the island, and make various preparations before the low tide, our prospects looked rather blank, and we were just on the point of starting off overland through Anglesey to Penmon, in the hope of being able to get a boat there, and approach our destination from the opposite side, when we fortunately caught sight of a small steamer out in the channel with steam up, and in process of weighing anchor. To jump, all three of us, into our punt with our bags and collecting bottles and other impedimenta, and start in pursuit of the steamer was the work of an instant, and apparently caused no little amusement to the assembled natives on the pier. We pulled furiously, shouting as we went, and waving our handkerchiefs, but our hearts sank as the anchor appeared above the water, the screw began to revolve, and the steamer moved rapidly away from us. Our final yell, however, reached its des-

tinuation, and with joy we saw the burly captain on the bridge turn round, look at us for a moment, and then apply his mouth to the speaking tube, and we fancied we almost heard the obvious "stop her," which enabled us two minutes later to dash alongside the steamship *St. Seiriol* (most appropriately named), and, fastening our painter round her rail, clamber on board, state our case, and claim the protection and help of our patron saint with such success that Captain Hughes most kindly welcomed us, and agreed to tow our little punt down to somewhere near Puffin Island. The *St. Seiriol* was bound to Dingwall with a cargo of slates. A good little boat she is, with a worthy captain, and we had half a mind to go the whole round in her. However, business is business, and the lowest spring tide of the year was awaiting us, so after photographing Captain Hughes and the crew with our Kodaks, we were cast off in the little punt in the middle of the stormy channel, through which the tide runs with great force, between Anglesey and Puffin, and so we made our way to the shore, to the great astonishment of Dr. Hanitsch, who did not expect to see us till some hours later.

During the remainder of our stay the weather was perfect. In fact, on the second day it was so calm that in the evening at low tide we were able to row into the wonderful "sponge caves" on the north side (which can only be entered at the lowest of tides and on a calm day, and then only in a small boat), and inspect their treasures. The two large caves are close together, and have been hollowed by the sea out of the bases of the high limestone cliffs. Their mouths face seawards towards the Irish coast, and on entering the boat has to be pushed (it is too narrow to row) through a long tunnel-like passage, with vertical walls, to the inner end, with its small piece of sloping gravel



beach, where one can land—in the dark. On striking a match it is seen that the sides of the cave are closely encrusted with various kinds of colonial and sessile animals, especially with sponges, the characteristic feature of the place. Here Dr. Hanitsch revels in *Pachymatisma johnstoni*, *Dercitus bucklandi*, *Plumohalichondria atosanguinea*, and other many-hued slimy-looking Tetractinellids and Monoactinellids. Here he first found, a few years ago, the rare new genus which has been named "*Sciriola*," in honour of our sainted predecessor on the isle (probably a good biologist according to the lights of his day and generation), who lived, as the naturalist always loves to do, beside the sea, the rocks, and the Puffins, and who possibly shoved his coracle on a calm evening into the sponge caves and saw in the dim light those curious white masses on the rock which some thirteen centuries after were dedicated to his memory.

The calm weather also enabled us to land upon the Beacon rocks and explore their recesses and fissures. By the way, why has this beacon, standing on a dangerous rock surrounded by strong currents and eddies, in a channel frequented by fishing boats, flats, and other small coasting craft, not got any means by which a man reaching its base might cling on for a time or even climb to the top? A close-fitting iron ladder and a few rings and hooks would probably offer but little opposition to the flow of water over the smooth rounded masonry, and might at any time be the saving of the occupants of a boat carried against the rocks or upset in the immediate neighbourhood of the beacon.

While suggesting improvements, I may be allowed to point out the excellent opportunity which the walls of our biological station would offer to an art teacher, and say half a dozen students, for the planning and carrying out

of schemes of decoration. Some simple artistic designs, applied in co-operation, under the direction of the teacher, might convert our wide expanses of whitewashed walls in the rooms, and the broad yellow planks between and around our sleeping bunks, into things of beauty, which would be a joy for ever to the sojourning biologists, and a constant reminder that there is something else in the world besides science, and another side to nature from the one they are especially observing in the field and in the laboratory. We have made a feeble beginning by cutting our initials on the front of the bunks we usually occupy, and by labelling the head planks with their official designations, such as "hon. treasurer's bunk;" but there is still abundant opportunity for further decoration.

One of the most interesting animals obtained this time was the sea slug *Dendronotus arborescens* of which a specimen was dredged in the channel about a quarter of a mile off the south-west end of the island. This animal is not uncommon at many places round our coast, but the special interest of this particular one is as follows:—Until lately *Dendronotus* has not been found anywhere near Puffin. Five years careful shore-collecting and dredging in the neighbourhood failed to turn up a single specimen. At Hilbre Island, on the other hand, this magnificent sea slug is abundant, and forms one of the most characteristic features of the fauna. With the view of introducing this, which is certainly the finest of our British nudibranchs, at Puffin two separate batches were taken down alive from Hilbre in September, 1888, and were set free at low tide on the South Spit. They had disappeared before the next tide, and all further search for them or their progeny, both by sea and shore, during the following two years was fruitless, and we were beginning to think that the experiment had failed. During the "Hlyæna" cruise of last

summer, however, when dredging in the straits between Puffin and Beaumaris, we brought up one very young specimen of *Dendronotus*, which, if it had any connection with the specimens from Hilbre, was only one of their descendants, and now we have found another *Dendronotus* of much larger size, but still not quite full grown, close to Puffin Island. These are, perhaps, too slender grounds for drawing any definite conclusion from, but it is at least quite possible that these specimens may be descended from those set free in September, 1888, and if so, the species is probably now established in the neighbourhood of Puffin Island, and may be expected to turn up frequently in our future operations.

We collected altogether on this occasion 13 species of Nudibranchs, including the rare *Eolis landsburgi*; also a very remarkable sponge belonging to the genus *Suberites*, and another sponge of a dark orange colour—one of the Desmacidonidæ—which was found by Dr. Hanitsch in one of the caves. This will probably turn out to be a very rare and interesting sponge as it is in symbiosis with a Zoophyte. The hydrorhiza of the Zoophyte permeates the sponge in all directions and replaces to a certain extent the missing spongin fibres. The spicules of the sponge are found echinating the hydrorhiza of the Zoophyte. The only other notable sponges obtained from Puffin during the year were an undetermined species of *Desmacidon* from the caves, and a *Chalinopsis* found washed up, by the keeper, in February.

The first Puffin was seen by the keeper on the island on April 9th, Dr. Hanitsch saw 2 or 3 on April 10th, and we all saw several pairs on April 12th.

At the end of June and beginning of July Mr. W. Thornely and Mr. F. V. Milward from Cambridge were at the station collecting Zoophytes and Polyzoa. Of the

former group they obtained 24 species, of which 4 (including *Eudendrium rameum*) were new to Puffin Island. Of Polyzoa 19 species and 2 varieties were found, and of these 1 species (*Schizoporella unicornis*, only found previously in our district at the Isle of Man) and 1 variety (*Pedicellina cernua*, var. *glabra*) were new to Puffin.

The visit of Dr. G. S. Brady and Mr. I. C. Thompson to Puffin in July for the purpose of studying the Copepoda resulted in the capture of 2 species of Copepods new to the district, dredged from a depth of 10 fms., off the north side of the island, viz., *Pontella acuta*, Dana, and *Misophria pallida*, the first being new to Britain and not before recorded north of the Indian Ocean. The same dredging contained 2 specimens of another rare species *Cyclopicera lata*, Brady.

Early in August two former students of the Biological department of University College, Liverpool, and graduates in Science of Victoria University, Miss Amy Warham and Miss Lucy Buckley, went to Puffin for the purpose of collecting compound Ascidians and making some observations upon them in the living state. I extract the following from their record in the journal as a sample:—

“Aug. 5th. Morning, collecting on shore under house. After breakfast went dredging with flood tide along north side of island towards Conway Bay—dredge full of Ascidians, Zoophytes, Hermit-crabs and Sea-urchins. Arrived back at 4 p.m. After tea, shore-collecting on spit—most beautiful sunset. Examining and sorting the material dredged, in evening. Station very comfortable and clean.”

“Aug. 6th. Left by morning tide and intend having a haul of the dredge in the straits.”

## FAUNISTIC WORK AT HILBRE.

As usual members of the Committee and others have tried to go to Hilbre Island at the very low tides as often as possible during the year. On a visit in April Mr. Christophers, a student of the Biological department of the College, found a species of sponge (*Raspailia* sp.) which is at least new to the district. We also on that occasion obtained various Nudibranchs, some of them spawning. The starfishes were very abundant on the rocks, and seem to be yearly increasing in number. Young mussels were also at this time very plentiful all over the rocks. Later in the year we found that the mussels had entirely disappeared. To some extent no doubt they are eaten by the starfishes and other animals, but we have reason to believe that their disappearance as they get large is chiefly due to the fact that on account of the layer of fine mud which covers all the rocks at Hilbre they are unable to attach themselves firmly to any solid support and merely cling together by the interlacing of their byssus fibres, so that when they come to be of appreciable size and offer resistance to the sweep of the waves, they are readily detached from the surface of the rock in large sheets a yard or two in length. We have seen this process going on on more than one occasion—the sheets of half-grown mussels being rolled up by the waves, and then washed about the sands.

On November 14th some of us went to Hilbre Island with Professor Howes (S. Kensington), Mr. Garstang and Mr. Bles (Owens College) and some others, when we found 8 species of Nudibranchs, *Garveia nutans*, a *Siphonostomum*, the Nemertean *Amphiporus lactifloreus*, and other interesting forms.

The amount of Zoophytes and Polyzoa found cast up by the recent gales was most astonishing. A few hand-

fuls of these brought home have been examined by Miss L. R. Thornely who finds in them 18 species of Polyzoa, of which 3 (*Cellaria fistulosa*, *Cellepora avicularis* and *Bowerbankia pustulosa*) have not been previously recorded from Hilbre; and 22 species of Zoophytes of which 8 are new to the locality.

#### THE SHRIMP ENQUIRY.

The collection of statistics in regard to the life-history and habits of the common shrimp (*Crangon vulgaris*) in this neighbourhood has been continued for a second year. The circulars asking a few simple questions such as a shrimper could readily answer were taken charge of at the five fishing centres by the same gentlemen who kindly helped me in the matter last year, viz., Mr. T. Comber, F.L.S., and Mr. Comber, Junr. (Parkgate), Mr. R. L. Ascroft (Lytham), Mr. A. Leicester and Dr. Chaster (Southport), Mr. A. G. Haywood (Crosby), and Mr. Henry Isaacs (Hoylake); and most of the circulars have been returned to me, duly filled up, with regularity throughout the twelve months. I wish to express my acknowledgments to all those friends for their hearty co-operation. I know a few of them have had some difficulty and trouble in collecting the information—for example, one of my correspondents writes to me that he could not get continued replies to the enquiries “because a tory canvasser spread the report that I had a political purpose in view.”

The questions asked for each month were:—“(1) Have shrimps been plentiful this month; what was the average catch per boat? (2) Were they of large size? (3) Were any young or immature ones seen? (4) Had any of them eggs? (5) In what locality were they caught? (6) In what depth of water, and on what bottom? (7) What

were the shrimps feeding on? (8) Did you see anything eating the shrimps? (9) What has been the general weather and state of sea this month? (10) Have you any other remarks to make?"

Last year I reduced the reports to a tabular form\* showing the answers to each question in each month at each locality. There is no need to construct a similar table this year as on the whole the answers are the same as before, I shall therefore refer readers to last year's table and mention merely the few points of difference or of special interest which these reports present.

In January, in all localities, the shrimps were smaller than in the previous year: the weather was colder, frosty. Mr. Ascroft writes from Lytham in February that there are "a great number of *Crangon allmani* amongst the shrimps."

The prawners are reported as finding lumps of the sand tubes built up by the gregarious annelids *Sabellaria alveolata* to be full of prawns. This year again there is much evidence that few shrimps are to be obtained in cold and in unsettled weather. The food matters generally attributed to the shrimps are:—worms, shore worms, long fine green worms, dead fish, sweet cockles and lug-worms, stones and shells, and finally "suction." One correspondent mentions that sometimes the anterior end of the shrimp is coloured green by the green worms it has eaten. Some of these matters require investigation.

By universal consent the worst enemies of the shrimp are crabs (*Carcinus moenas* and *Polybius henslowi*) and fishes, especially whiting, young haddock, small cod, skates, and flukes. Mr. Ascroft mentions in February having taken a quart of shrimps out of a skate's stomach. It is reported from Parkgate that in the summer time the

\* See Trans. L'pool Biol. Soc., vol. v., p. 32, 1890.

hand or push nets kill great numbers of young shrimps in the shallows; and there certainly seems abundant evidence that a great destruction of immature flat fish (soles and flukes) is caused by the shrimpers generally. It is worth consideration and experiment whether it would be possible to construct in the tail end of the net some form of metal sieve with narrow elongated meshes of such a size and form as would allow small soles and flukes to wriggle through while retaining at least the larger shrimps. This would be in constant action while the net was being worked, and would take the place of the apparently inadequate operation of sifting, which is performed in the boat after the net has been emptied and which is probably too late to save the lives of many of the young fishes. Mr. R. A. Dawson has just informed me that a few years ago he experimented with a shank trawl which had the lower edge of the net fixed to a bar set a little way off the ground so that only the shrimps, which spring well upwards when disturbed, were captured and most of the young fishes were passed over. Mr. Dawson intends to have another net of this kind made, and to give it a fair trial during the fishery investigations he is now carrying on.

If, as seems likely, it will be soon found necessary in the interests of the young flat fish to restrict somewhat the operations of the shrimpers in space or time, or in both, a compensating addition to the supply of shrimps might, I think, be obtained by artificial cultivation. Some parts of our sandy estuaries might be enclosed as shrimp preserves to be stocked, supplied with food, and carefully attended to. The shrimps breed practically all the year round, are hardy and prolific, and if supplied with plenty of food and protected from their enemies would probably increase greatly in numbers in a very short time.



In discussing this matter lately with Mr. A. O. Walker, he suggested that without going so far as a definite scheme of artificial cultivation, a good deal might be effected by selecting as breeding grounds certain portions of the coast, say one mile in length and extending from the shore out to a depth of a few fathoms, on which large stones should be put down a hundred yards or so apart in order to prevent any trawler from working on those areas. This would be a very inexpensive method of making what would probably form an admirable and safe breeding ground for both shrimps and fish.

#### OTHER INVESTIGATIONS.

Mr. Chopin of Manchester did some collecting work at the south end of Isle of Man in August, and succeeded in finding *Lucernaria* which had not previously been recorded in our district. He also made a collection of sponges which Dr. Hanitsch, who is examining them, reports will probably be found to contain 2 or 3 species new to the neighbourhood.

Mr. G. Swainson of St. Anne's has been indefatigable in tow-netting at night from the end of the pier, and has been rewarded by the capture of a number of interesting forms of surface life, including the Tunicata *Fritillaria furcata*, not previously recorded, and a form of *Oikopleura* with a remarkable investing test or "Haus" on which Mr. Swainson read a paper at the Cardiff meeting of the British Association.

Specimens collected at Puffin Island and elsewhere have, as usual, been distributed to our specialists, and have afforded material for a number of investigations which have been or will be shortly laid before the Biological Society. A small collection of typical marine Invertebrata has also been sold to the Yorkshire College,

Leeds, for laboratory use. The Committee would be glad to add to the income of the Station in this way in the future. Most ordinary marine types for laboratory work can be supplied either fresh or preserved in spirit.

The usual balance sheet is appended, by the Hon. Treas., along with a list of the subscriptions and donations to the L.M.B.C. funds received during the last year.

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Applications\* to be allowed to work at the Biological Station, or for specimens (living or preserved) for Museums, Laboratory work, and Aquaria, should be addressed to Professor Herdman, University College, Liverpool.

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Subscriptions and Donations should be sent to Mr. I. C. Thompson, F.L.S., 19, Waverley Road, Liverpool.

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The L.M.B. Committee are publishing their Reports upon the Fauna and Flora of Liverpool Bay in a series of 8vo. volumes at intervals of about three years. Of these two have appeared:—vol. I. containing 372 pp. and 12 plates, price 8/6, was issued in 1886; vol. II. containing 240 pp. and 12 plates, price 7/6, was issued in 1889. Vol. III. is nearly ready and will be issued in the summer of 1892. Copies of these may be ordered from the Liverpool Marine Biology Committee, University College, Liverpool, or the Hon. Treas., 4, Lord Street, Liverpool.

\*Subscribers of a guinea or upwards to the funds are entitled to work at the Station, when there is room, free of charge (except the keeper's weekly account for food) College Students of Biology are offered lodging (not including food) and the use of the laboratory at the Station at the rate of ten shillings per week, payable to the Hon. Treasurer. All visiting the Station, including Members of the Committee, Subscribers, and Students, pay the keeper daily or weekly for their food. Four simple meals (breakfast, dinner, tea, and supper) are provided at about cost price, averaging three shillings a day.

## APPENDIX.

## SUBSCRIPTIONS and DONATIONS.

	Subscriptions.			Donations.		
	£	s.	d.	£	s.	d.
Archer, Francis, B.A., 21, Mulgrave-street	1	1	0	—		
Banks, Prof. W. Mitchell, 28, Rodney-st.	2	2	0	—		
Bickersteth, Dr., 2, Rodney-street... ..	2	2	0	—		
Brook, George, 19, Greenhill-gardens, Edinburgh ... ..	1	1	0	—		
Brown, Prof. J. Campbell, University College, Liverpool ... ..	1	1	0	—		
Brown, J. Harvie, Dunipace House, Larbert, N.B. ... ..	0	10	0	—		
Bulley, Arthur K., West Kirby ... ..	1	0	0	—		
Burton, Major, Fryars, Beaumaris... ..	2	2	0	2	2	0
Caine, Nath., 10, Orange-court, Castle-street	1	1	0	—		
Caton, Dr. 31, Rodney-street ... ..	—			1	1	0
Comber, Thomas, Leighton, Parkgate ... ..	1	1	0	—		
Coventry, Joseph, 34, Linnet Lane ... ..	1	1	0	—		
Davidson, Dr., 2, Gambier-terrace... ..	1	1	0	—		
Denny, Prof., Firth College, Sheffield ... ..	1	1	0	—		
Derby, Earl of, Knowsley ... ..	5	0	0	—		
Drysdale, Dr., 36A, Rodney-street... ..	1	1	0	—		
Gair, H. W., Smithdown-road, Wavertree... ..	2	2	0	—		
Gamble, Col. David, C.B., Windlehurst St. Helens ... ..	2	0	0	—		
Gaskell, Holbrook, J.P., Woolton Wood, Much Woolton ... ..	1	1	0	1	0	0
Gibson, R. J. Harvey, 41, Sydenham-avenue	1	1	0	—		
Gifford, J., Whitehouse-terrace, Edinburgh	1	0	0	—		
Glynn, Dr., 62, Rodney-street ... ..	1	1	0	—		

Halls, W. J, 35, Lord-street	...	...	1	1	0	—
Henderson, W. G., Liverpool Union Bank			1	1	0	—
Herdman, Prof., University College, L'pool.			2	2	0	—
Higgin, Thos. (the late), Ethersall, Roby...			1	1	0	—
Holder, Thos., 1, Clarendon-buildings Tithe-						
barn-street	...	...	1	1	0	—
Holland, Walter, Mossley Hill-road			2	2	0	—
Holt, George, J.P. Sudley, Mossley Hill			1	0	0	—
Johnstone, Rev. Geo., M.A., 41, Bentley-rd.			0	5	0	—
Jones, Chas. W., Field House, Wavertree			5	0	0	—
Jones, Mrs. Chas. W., Field House, Waver-						
tree	...	...	—	5	0	0
Jones, J. Birdsall, 10, St. George's-crescent			1	1	0	
Leicester, Alfred, 24, Aughton-rd, Birkdale			1	1	0	—
Lomas, J., 23, Avondale-road	...	...	0	10	6	—
Macfie, Robert, Airds	...	...	1	0	0	—
Marshall, Prof. A. Milnes, Owens College						
Manchester	...	...	1	1	0	—
McMillan, W. S., 17, Temple-street			2	2	0	—
Meade-King, R. R., 4, Oldhall-street			0	10	0	—
Meade-King, H. W., Sandfield Park, West						
Derby	...	...	1	0	0	—
Melly, George, 90, Chatham-street...			1	0	0	—
Melly, W. R., 90, Chatham-street...			1	0	0	—
Miall, Prof., Yorkshire College, Leeds			1	1	0	—
Monks, F. W., Brooklands, Warrington			1	1	0	—
Muspratt, E. K., Seaforth Hall			5	0	0	—
Phillips, Prof. R. W., Univ. College, Bangor			1	1	0	—
Poole, Sir James, Tower Buildings			2	2	0	—
Rathbone, R. R., Glan-y-Menai, Anglesey			2	2	0	—
Rathbone, S. G., Croxteth-drive, Sefton-park			2	2	0	—
Rathbone, Theo., (the late,) Backwood,						
Neston	...	...	2	2	0	—
Rathbone, W., M.P., Greenbank, Allerton			2	2	0	—
Roberts, Isaac, F.R.S., Tunbridge-wells			1	1	0	—
Shankland, Rev. Thos., Wheat-villa, Rhyl			0	10	6	—

Shepherd, T., Kingsley Lodge, Chester ...	1	1	0	—
Simpson, J. Hope, Annandale, Aigburgh- drive ... ..	2	2	0	—
Smart, Rev. E. H., Kirby-in-Cleveland, Northallerton ... ..	1	1	0	—
Stewart, W. J., City Magistrates Office ...	1	1	0	—
Tate, A. Norman, 9, Hackin's-hey... ..	1	1	0	—
Thompson, Isaac C., 19, Waverley-road Sefton-park ... ..	2	2	0	—
Thornely, James, Baycliff, Woolton ...	1	1	0	—
Thornely, The Misses, Baycliff, Woolton ...	1	0	0	—
Toll, J. M., 340, Walton Breck-road ...	1	1	0	—
Vicars, John, 8, St. Alban's-square, Bootle	2	2	0	—
Walker, Alfred O., Nant-y-glyn Colwyn Bay	3	3	0	—
Walker, Horace, South Lodge, Princes-park	1	1	0	—
Watson, A. T., Tapton-crescent, Sheffield	1	1	0	—
Westminster, Duke of, Eaton Hall ...	5	0	0	—
Wiglesworth, Dr., Rainhill ... ..	1	0	0	—
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	100	10	0	9 3 0
Royal Society Grant, per Professor Herdman	...			<hr/> <hr/> 50 0 0

# LIVERPOOL MARINE BIOLOGY COMMITTEE.

Dr.

IN ACCOUNT WITH ISAAC C. THOMPSON, HON. TREASURER.

Cr.

	£	s.	d.		£	s.	d.
1891.				1891.			
To Balance due Treasurer, 1890 .....	3	13	8	By Subscriptions and Donations .....	£107	1	0
„ Salary of Keeper .....	52	0	0	Of which £25 is towards Endowment and placed to Investment Account.	25	0	0
„ Station Repairs .....	3	13	1	„ Grant from Royal Society .....	—	—	—
„ Repairs to Boats, Ropes, Chains, &c. ....	6	1	5	„ Dividend, British Workman's Public House Co., Ltd., Shares .....	4	10	0
„ Cutter, "Morning Star" .....	20	0	0	„ Sale of Marine Specimens .....	1	8	0
„ Steam Tugs, and Dredging Expenses .....	25	6	11	„ Reports .....	0	10	6
„ Postages, Carriage of Apparatus, Specimens, &c. ...	3	17	4	„ Amount collected on S.S. "Mavis" .....	3	13	6
„ Paraffine Oil and Coals .....	7	19	0	„ Balance due Treasurer .....	—	—	—
„ Printing and Stationery .....	20	2	6		£145	3	6
„ Sundries .....	2	9	7				
	£145	3	6	Endowment Fund Investment, British Workman's Public House Co.'s Shares.	80	0	0
				Funds pending Investment.....	25	0	0
By Balance due Treasurer .....	3	0	6		£105	0	0

ISAAC C. THOMPSON,

HON. TREASURER.

LIVERPOOL, 31st December, 1891.

*Audited and found correct,*

ALFRED LEICESTER.

[From Trans. Biol. Soc., Liverpool. Vol. VI.]

## NOTES on the STRUCTURE of OIKOPLEURA.

By W. A. HERDMAN, D.Sc., F.L.S.,

PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, LIVERPOOL.

With Plates I—IV.

[Read 12th February, 1892.]

For several years, as opportunity offered, I have been making occasional observations on the structure of Appendicularians, living and preserved, from Puffin Island and other parts of Liverpool Bay. Mr. G. Swainson, F.L.S., of St. Annes-on-the-Sea, Lancashire, who has been successful in capturing several curious forms of Appendiculariidaë, lately sent me for examination a very good specimen of an *Oikopleura* (probably *O. flabellum*, J. Müll.) which he had caught in his surface net from St. Anne's pier in August, and had preserved in graduated alcohols from 30% to absolute, and which had been imbedded in paraffine, stained with Babes' safranin solution and sectionised by Dr. E. C. Bousfield with the Caldwell automatic microtome. My thanks are due to Mr. Swainson and Dr. Bousfield for their kindness in enabling me to examine this form. As their specimen seems to have been in excellent condition, and shows some interesting points rather well, I have made it the basis of the following observations (in which the substance of my former notes is incorporated) and have drawn in the accompanying plates the more important of the sections, enough of them, I think, to form a guide to the complete structure of the animal. I have also given in figure 9 on plate IV. a lateral view of the animal, reconstructed from the serial sections, which may be useful in interpreting the individual

sections, and also as an approximately true-to-nature diagram of the typical structure of the group. The structure of various Appendiculariidae examined whole as transparent objects has been described and figured by Huxley, Gegenbaur, Fol, Eisen, Sanders, Moss, Chun and others, but the method of serial sections has not apparently been applied before to this group, and I do not think any figures of sections have yet been published.

The size of the specimen was:—length of the body 1.5 mm., and length of the “tail” 4–5 mm. On commencing at the rounded posterior end of the body (see Pl. IV. fig. 9) it is found that the first few sections consist of ovary alone surrounded by a delicate membrane, the ectoderm. There is no trace of cuticular test on this part of the surface. Then, after a few sections, a small crescentic or lenticular piece of testis begins to appear on each side of the ovary and gradually increases in size as it is traced forwards. Consequently in some sections near the posterior end (see Pl. I. fig. 1) the ovary seems to be a single median organ placed between a pair of lateral testes. In a few sections considerably further forward, however, (Pl. II. fig. 2) we find two lateral pieces of ovarian tissue, while the testis is a single organ. The fact is both are single, but lobed: the ovary being slightly bifurcated at its anterior end and having an overhanging dorsal lobe near its posterior extremity (see Pl. IV. fig. 9, *ov*), while the testis consists of two great posterior lateral lobes connected anteriorly and ventrally (Pl. II. fig. 3, *sp.*).

The outlines of the ova are not distinct, but the germinal vesicles and germinal spots are very conspicuous even under a low power (Pl. I. figs. 1, 2, &c.), while a higher magnification shows them as represented in Plate I. fig. 4. The spermatic tissue in the testis shows merely a number of fine rounded dots in a faintly stained protoplasm, the



dots being evidently the deeply stained nuclei of the small spermatic cells (see Pl. I. figs. 3 and 5).

After about 20 sections from the posterior end the lateral lobes of testis are found to be encroaching upon the ovary in its centre so as to divide off a smaller dorsal lobe from the ventrally placed main mass (Pl. I. fig. 2). In this region is found the apparently single genital duct. The dorsal ectoderm bends down in section 24 to form a slender epithelial tube which seems to join the wall of the ovary (Pl. IV. fig. 9, *o.d.*). The testis lobes come in contact dorsally at this point and may possibly join (Pl. I. fig. 3), so the tube might be vas deferens, or act both as oviduct and vas deferens. The dorsal lobe then dies out after a few sections, and the ovary is then represented by a nearly flat ventral plate which can be traced forwards to about the 90th section (counting from the posterior end). Figure 3 on Plate I. shows the typical arrangement in a number of sections, say numbers 25 to 45, where the ventral ovary and the two lateral testis lobes enclose a small triangular area, which will be occupied a little further forward by the alimentary canal. The whole is still surrounded by a delicate ectoderm with no trace of a distinct test.

The next figure (Pl. I. fig 6) shows, in the 48th section, the most posteriorly placed part of the alimentary canal. It is a short dorsal diverticulum from the point where the œsophagus joins the stomach, and can be traced forwards through the sections into the œsophagus and then the pharynx or branchial sac. In about the 50th section we come upon the first trace of the test in the form of a thin layer of cuticle dorsally placed and co-terminous with an area of rather larger ectoderm cells. As one traces the sections forwards these ectoderm cells get larger, and the layer of test over them becomes thicker (see Pl. I. figs. 7

and 8). Inside the ectoderm on this dorsal aspect a very thin layer of connective tissue (parietal mesoderm) can now be recognised (fig. 8, *mes*).

We now come upon the posterior end of the stomach. This organ is of large size and complicated shape, it extends from about the 50th to the 160th section. There are two great laterally placed posterior lobes which join anteriorly. Into one of these lobes, the left, the œsophagus opens, while the intestine emerges from the other, on the right side. They may be conveniently referred to as the cardiac (left) and the pyloric (right) sacs respectively. These lateral posterior parts of the stomach are of considerable dorso-ventral extent (see Pl. II. fig. 1, *st*, *st'*), while the anterior or median part of the stomach where the cardiac and pyloric sacs join is low, but very wide from side to side (Pl. II. fig. 5). The greater part of the alimentary canal is richly ciliated (Pl. I. fig. 10). I have, however, not been able to find any trace of cilia in the cardiac sac which is very much more glandular, especially in its ventral end (Pl. II. fig. 1, *gl*) than any other part of the stomach.

The pyloric sac extends a little further posteriorly than the rest of the stomach, and is seen in fig 7, Pl. I. with the flattened diverticulum from the œsophagus lying dorsally. In the next figure (Pl. I. fig. 9), which shows the 61st section, the cardiac sac is just beginning to appear below the œsophagus, and ten sections further forward (Pl. I. fig. 10) the two are found to communicate, the œsophagus having turned ventrally with a slight undulation. The pyloric sac is now large and lies with its long axis dorso-ventrally. Its interior, and that of the œsophagus, is ciliated while the cardiac sac shows glandular cells at its ventral end (Pl. I. fig. 10, *gl*).

The last three figures show the gradual reduction in

size of the lateral testis lobes which now no longer invade the dorsal part of the body; these figures (Pl. I. figs. 7, 9, 10) also show the increase of the dorsal cap of large ectoderm cells and of test both in thickness and in superficial extent. About the 70th section (Pl. I. fig. 10) it may be noticed that the test is becoming thinner in the medio-dorsal line and thicker in its lateral parts. The most posterior (curved) part of the nerve cord (myelon) is seen in figs. 9 and 10. Its two ends diverge, the one (*n.s.*) dorsally and to the right to become continuous anteriorly with the cerebral ganglion, and the other (*n.*) ventrally and to the left to join the caudal ganglion and nerve (compare Pl. IV. fig. 9, *n.*).

Ten sections further forward (Pl. II. fig. 1) the cardiac and pyloric sacs are found to join at their dorsal ends, and from this point forward to its anterior extremity, in section 163 or so, the stomach is seen as a single cavity which gradually diminishes in its vertical and increases in its horizontal (lateral) extent. The œsophagus is still seen running forwards over the stomach dorsally, and the cilia and gland cells are distributed as before. After another ten sections we find that the two lateral testis lobes become connected by a median band immediately above the much reduced ovary which now bifurcates (Pl. II. fig. 2) and then dies away. This last figure shows the constriction marking the separation of the intestine (*i*) off from the pyloric sac.

We now come to the point where the œsophagus passes into the pharynx or branchial sac, and in section 103 (Pl. II. fig 3, *ph.*) it is seen that the lumen of this dorsal cavity has become distinctly triangular with a medio-dorsal groove which is the posterior end of the well marked epipharyngeal groove corresponding to the dorsal lamina of Ascidiæ. The stomach and testis are much as before,

and the intestine is now seen to be completely separated off from the pyloric sac, while the cæcal extremity of a new tube—a diverticulum running posteriorly and to the left from the rectum is seen in the middle line between the stomach and the intestine. In the next section figured (Pl. II. fig. 4), which is just ten further forward, this diverticulum is seen as a large distinct tube lying near the centre of the body and between stomach and intestine. It can be traced alongside the latter (see Pl. II. fig. 5) for about 20 sections when (Pl. II. fig. 6) the two tubes communicate, and finally after another 20 sections the two have completely coalesced to form a single medio-ventral tube, the rectum. Pl. II. fig. 6 (section 134) shows the two tubes communicating by a narrow passage provided with long cilia; Pl. II. fig. 7 (section 151) shows the tubes almost completely joined there being only a small chink left to represent the intestine, the greater part of the lumen being derived from the diverticulum; finally Pl. III. fig. 1 (section 155) shows the median rectum, still a little unsymmetrical in shape. It results from this arrangement seen in the last 50 sections that there must be only a very narrow slit-like opening from the intestine into the point of junction of the rectum and its cæcum.

These sections (103 to 155) show also the gradual but marked growth of the pharynx in size and differentiation as it is traced forwards. Figures 4 and 5 on Pl. II. and fig. 1 on Pl. III. show the triangular shape, the broad ventral base, the thin lateral walls, and the formation of ciliated tracts dorsally and ventrally, the dorsal being a pair of prominent pads which bound the epipharyngeal groove (see Pl. II. fig. 5, *ep.p.*), while the ventral is a flat hypopharyngeal plate (*hy.p.*) which can be traced forwards to near the endostyle. Section 113 (Pl. II. fig. 4) shows the anterior bifurcation of the testis (*sp.*) which dies out

a few sections further forward, thus bringing us to the anterior end of the very extensive hermaphrodite reproductive system (compare Pl. IV. fig. 9).

The gradual increase of the dorsal area of large ectoderm cells, and of the thickened test covering it, is very noticeable, and the point where ectoderm and test join and thin off into a delicate membrane ( $\times$  in Pl. II. fig. 5) can be seen to advance further and further down the wall of the body until in section 155 (Pl. III. fig. 1) it has almost reached the ventral surface. We are now approaching the anterior end of the stomach. This extensive cavity has been gradually changing its shape in the sections from a vertical bilobed to a single horizontal space lying across the middle of the body (see Pl. III. fig. 1) between the dorsal branchial sac and the ventral rectum. In the next few sections the walls are found encroaching irregularly upon the lumen, and in section 163 (Pl. III. fig. 2) the lumen has completely disappeared, and a couple of sections further forward (Pl. III. fig. 3) no trace of the wall of the stomach is left.

Just before we finally leave the stomach behind we come upon the posterior end (really the morphological anterior part) of the great ventral appendage or "tail" (Pl. III. fig. 1, *app.*). Consequently the tail joins the body just about on a level with the anterior end of the stomach. No trace of the tail is visible in section 125 (Pl. II. fig. 5,) while it is seen just completely separated off from the ventral body-wall in section 155 (Pl. III. fig. 1). It first appears a few sections behind this, and it is the lateral edges of the tail which first become free, and lastly the median part lying between the notochord and the rectum separates off from the ventral wall of the body. From this point the tail is present in all the sections forward to the front or oral end of the body, and even for a considerable

distance beyond that. It contains in its centre the notochord (or urochord, *n. ch.*) and on the left side of that the nerve or myelon (*n.*). In section 155 (Pl. III. fig. 1) we see the latter greatly enlarged to form the caudal ganglion at the base of the tail. The heart is placed just above the base of the tail (Pl. IV. fig. 9, *h.*). We see a part of it between the stomach and the rectum in Pl. II. fig. 5, at *h.*

We now come to the important region, about section 170, where the branchial sac or pharynx communicates with the exterior by a pair of ventral tubular ciliated openings or stigmata. The series of sections represented by figures 3 to 6 on Pl. III show the structure of these openings and the passages leading to them. The first change as one approaches the stigmata is seen at *a* on the right hand side of fig. 3, (section 165) where the lateral edge of the branchial sac bends down ventrally while at the same time the ectoderm on the surface of the body over this region is invaginated, so that only a narrow bridge of tissue is left between the two cavities. The next stage is seen a couple of sections further forward at *b* in fig. 4, where a few large cells appear in the bridge of tissue and then become arranged, as at *c*, in two regular rows. These rows of cells draw apart (see *d*, fig. 5), then additional rows appear till there are in all 4 series of cells with narrow slits between the rows (*e*. fig. 3). [On account of a slight obliquity in the sections or because of one of the stigmata being slightly further forward than the other, the two sides of the body show different conditions in the same section, consequently these four sections figured show us eight or nine different stages (*a* to *i*, figs. 3 to 6)]. The middle cells of each row then die out as we trace the sections forwards (see *f*. fig. 4) leaving merely a set of four pyramidal richly ciliated cells (*g*. fig. 5) on each wall of the tubular passage which places

each side of the branchial sac in free communication with the external world. For some few sections from No. 170 forwards this is the state of affairs, and these sections are evidently cut through the middle of the stigmata. It is clear then that we are dealing with four horizontal rings of ciliated cells encircling the middle of the passage.

Then these passages begin, about section 180, to be closed in by the ectoderm growing across the external aperture, outside the ciliated cells. It is the most ventral extension of the area of large test-producing ectoderm cells which effects this change. In fig. 3 it is seen that the conspicuous ectoderm has exactly reached the lateral angles of the triangular body, immediately external to the openings (atrial) of the stigmata; in fig. 5 a little thickened ectoderm is seen on the ventral surface just internal to these openings; while in fig. 6, at *h* on the right side, the ectoderm is seen to have grown across the opening in the form of a fold from each side; and finally at *i*, on the left side of the same figure, the folds have completely united and there is now a wide bridge of tissue, both covered and lined by ectoderm, separating the remains of the stigma from the exterior. The ciliated cells now die away a few sections further forward leaving the lateral edges of the branchial sac very much as they were immediately posterior to the stigmata (see right side of fig. 3 and fig. 7). This series of sections in which the stigmata are present shows also the rectum changing from a triangular (fig. 3) to a circular lumen (fig. 6), and then opening to the exterior at the anal aperture. Fig. 7 (section 190) is immediately in front of the anus, so the rectum is no longer present.

The ectoderm cells on the lateral walls of the body are becoming still larger and more conspicuous (fig. 7), and they now extend well on to the ventral surface from each

side, leaving only its middle third uncovered. In the dorsal part of the branchial sac the two ciliated pads which further back lay one at each side of the narrow epipharyngeal groove are now seen to have moved further ventrally, and they continue as traced forwards to run obliquely down the lateral walls of the branchial sac (see figs. 7 and 8), being now in fact the peripharyngeal ciliated bands of ordinary ascidians, till finally they meet in the ventral median line in the region of the endostyle. In the middle of the lateral surface of the body (fig. 8) the ectoderm is more than one layer deep. There are large columnar cells,\* in each of which several nuclei are present, while at the bases of these there are smaller triangular cells with their apices running in between the adjacent columnar ones (Pl. III. fig. 10).

The tail in the last few sections while remaining of about the same width from side to side has become a good deal thicker dorso-ventrally, and the dorsal and ventral surfaces in the middle third have become covered by a thicker layer of ectoderm, while inside that and co-terminous with it is a well marked layer of muscle fibres (see Pl. III. figs. 8 and 9). In the centre of the tail and occupying all the extent between the two muscle layers is the notochord with its usual undulating outline, and on its left side the delicate nerve cord (see Pl. III. fig. 7). The tail retains this structure through all the sections forwards to and in front of the oral end of the body proper.

The next section figured, No. 216 (Pl. III. fig. 8), shows the body becoming rapidly smaller, while the ectoderm cells on the lateral walls have become enormous, and

\* It is probably these cells which Sanders (Mon. Micros. Jour., Ap. 1874, p. 141) mistook for stigmata in his *Oikopleura* from Torquay. Possibly the supposed gill-slits in Moss's remarkable appendicularian (Linn. Trans. XXVII, p. 299.) may have been either large ectoderm cells or large glandular cells of the endostyle.



show distinctly the arrangement in more than one layer noted above (see fig. 10). The entire ventral surface is now covered with large ectoderm cells, and there is a continuous layer of test all over the body. With the exception of the small dorsal nerve cord (*n.s.*), the branchial sac or pharynx is the only organ inside the ectoderm. It is roughly of triangular form with a ciliated pad projecting inwards from each of its sides. The two lateral pads are the peripharyngeal bands and the third is a median ventral ridge (the hypopharyngeal) which shortly becomes converted into a ciliated groove leading forward to the endostyle. Six or seven sections further on (Pl. IV. fig. 1) this ventral ciliated area is seen as a shallow groove, two sections in front of that (Pl. IV. fig. 2) it has become a deeper, narrower groove, and in another couple of sections it forms, along with the peripharyngeal grooves (*p.p.*) which have now moved down ventrally and coalesced with it, the sloping lateral edges of the aperture of the endostyle into the branchial sac (Pl. IV. fig. 3).

The posterior end of the endostyle is found about section 220. Pl. IV. fig. 1, *en.*, shows its appearance in section 223 where it is composed of a mass of glandular cells lying half-way between the ventral surface of the branchial sac and the ectoderm, and having no connection with the pharynx. In section 225 (Pl. IV. fig. 2) the endostyle is larger and has a central lumen around which the glandular cells are placed; it has now nearly come into connection with the deep hypopharyngeal groove. In another couple of sections we find this connection established as is shown in section 228 (Pl. IV. fig. 3) where the endostyle has a considerable cavity opening by a narrow slit into the ventral part of the pharynx. The glandular cells are not equally developed around the whole wall of the endostyle but are arranged in four definite longitudinal tracts. After

a few sections the endostyle becomes again shut off from the pharynx, so that the opening between the two is very small and the greater part of the endostyle is not a canal as in most Tunicata, but a closed in tube (compare Pl. IV. fig. 9, *en.*). Its close resemblance both in transverse (Pl. IV. fig. 3) and in longitudinal (fig. 9) section to its homologue the thyroid involution in the larval lamprey is more marked in this form, I think, than in any Tunicate yet figured. This endostyle differs considerably from that of *Vexillaria speciosa* as figured by Eisen.

Twenty sections further forward (Pl. IV. fig. 4) we find the body greatly reduced in size, as we are now not far from the anterior end; while the tail is still very large. The branchial sac or pharynx is small and is transversely elongated. Above it we find the nervous system now becoming of considerable size, and ventrally is the closed endostyle composed of large glandular cells arranged below a small circular lumen. Six sections further forward (Pl. IV. fig. 5) we find the body and the branchial sac still smaller, the endostyle large but with no lumen now, and the nervous system larger than before with the otocyst attached to it, on the left side. On each side of the branchial sac is seen a large glandular mass which is the posterior end of an elongated cylindrical or sausage shaped closed gland lying at the side of the mouth (Pl. IV. fig. 5).

This section shows also the very large ciliated infundibulum (fig. 5, *d.t.*) which opens into the dorsal edge of the branchial sac, on the right side, and which probably corresponds to the opening of the hypophysial duct on the dorsal tubercle of an Ascidian. A few sections further forward, in No. 257, we see this organ still better, and the middle portion of this section is shown more highly magnified ( $\times 600$ ) in Pl. IV. fig. 6. The pharynx is thin walled and irregular in shape with the ciliated funnel opening into the

right hand end of its dorsal surface. The cells near the aperture of the funnel are very large and distinct while the cilia they bear are long and numerous and lie directed upwards towards the inner end of the funnel. That caecal end is supplied by a nerve. The central nervous system is here at its largest. It shows large granular nerve cells, and the otocyst (Pl. IV. fig. 6, *o.c.*). The endostyle and the lateral oral glands are very much as before.

Ten sections further forward, No. 266 (Pl. IV. fig. 7) we find the body still smaller. It is now close to the anterior end, and this is the last section we figure. The pharynx is now small and will shortly terminate in the oral aperture. The two large glands lie alongside it, but the endostyle is no longer visible ventrally, we are in front of its anterior end. Dorsally the nervous system is seen attached to the inner surface of the ectoderm, where it extends outwards into two lateral processes. Figure 8 shows this region more highly magnified ( $\times 600$ ). The ectoderm is here distinctly two layers thick, and is covered by a cuticle or test which can be traced as a distinct though thin layer completely round the body in this region.

The nervous system, then, when traced through the whole series of sections is seen to be connected anteriorly with the dorsal ectoderm close to the mouth; then it becomes free from the ectoderm and expands to form the large ganglionic mass or brain placed above the front of the pharynx (see Pl. IV. fig. 9, *n.s.*) and having two sense organs, the ciliated funnel and the otocyst, connected with it. The ganglion then tapers posteriorly to form a slender nerve cord, the myelon, which runs backwards over the pharynx, rather on the right side of the medio-dorsal line (Pl. III. fig. 3), until it reaches the oesophagus where it turns ventrally and runs down between the pyloric sac

and the right lateral lobe of the testis until it reaches the ventral surface between the stomach and the anterior end of the ovary (Pl. I. fig. 9). It now turns forwards, reaches the base of the tail, enlarges to form the caudal ganglion, and then continues onwards through the length of the tail lying on the left side of the notochord.

I have not discussed specially those detailed points in which the preceding account differs from those of Fol, Eisen and other authors. The new method of investigation, serial sections in place of transparent objects, might be naturally expected to yield some new results in matters of detail: besides I cannot be certain that my form is specifically identical with any of those previously described. I may mention, however, as perhaps the most interesting points shown in my figures:—the condition of the endostyle as a diverticulum to a great extent shut off from the branchial sac, the presence of a genital duct, the distribution of the enlarged ectoderm cells and the cuticular test, the exact course of the nerve cord through the posterior part of the body, and finally the shapes and relative positions of the alimentary and reproductive viscera.

#### EXPLANATION OF THE PLATES.

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All the figures with the exception of fig. 9 on Pl. IV. were drawn from the sections, which were placed so that right and left sides of the figure represent right and left sides of the animal. With the exceptions of figs. 4, 5, and 8 on Pl. I. figs. 9 and 10 on Pl. III. and figs. 6 and 8 on Pl. IV. which show more highly magnified details, all the figures were drawn under a moderate magnification, about 115 diameters. The following abbreviations are used:—

*a.* anus, *app.* appendage or tail, *d.t.* dorsal ciliated funnel, *ec.* ectoderm, *ep.p.* epipharyngeal ciliated groove, *en.* endostyle, *gl.* glandular cells in left side (cardiac sac) of stomach, *h.* heart, *hy.p.* hypopharyngeal ciliated ridge or groove, *i.* intestine, *m.* mouth, *mes.* connective tissue, *n.* caudal nerve (posterior part of myelon), *n.ch.* notochord (urochord). *n.s.* nervous system (cerebral ganglion and anterior part of myelon, *æs.* œsophagus, *ov.* ovary, *o.g.* oral glands, *o.c.* otocyst, *o.d.* oviduct, *ph.* pharynx, (branchial sac), *p.p.* peripharyngeal ciliated bands, *r.* rectum, *st.* pyloric sac of stomach, *st'.* cardiac sac, *sp.* lobes of testis, *t.* test, *sg.* stigma leading to atrial pore.

## PLATE I.

- Fig. 1. Section 8 (from posterior end) showing ovary and lobes of testis.
- Fig. 2. Section 22, showing separation off of dorsal lobe of ovary.
- Fig. 3. Section 35, immediately behind the alimentary canal.
- Fig. 4. Small part of ovary from last section more highly magnified ( $\times 600$ ).
- Fig. 5. Small part of testis from last section highly magnified ( $\times 600$ ).
- Fig. 6. Section 48, showing posterior end of stomach.
- Fig. 7. Section 54, showing stomach and œsophagus.
- Fig. 8. A part of surface of section 54 more highly magnified ( $\times 600$ ).
- Fig. 9. Section 61, showing parts of alimentary canal, and nerves.
- Fig. 10. Section 71, showing œsophagus opening into stomach.

## PLATE II.

- Fig. 1. Section 81, showing cardiac and pyloric sacs of stomach, &c.
- Fig. 2. Section 95, showing junction of lobes of testis.
- Fig. 3. Section 103, showing intestine leaving stomach.
- Fig. 4. Section 113, showing diverticulum of rectum, &c.
- Fig. 5. Section 125, showing branchial sac, heart, &c.
- Fig. 6. Section 134, ) showing the narrow opening of the
- Fig. 7. Section 151, ) intestine into the rectum.

## PLATE III.

- Fig. 1. Section 155, showing the beginning of the tail.
- Fig. 2. Section, 163, showing the anterior end of the stomach,
- Fig. 3. Section 165, )
- Fig. 4. Section 167, ) showing the structure of the stig-
- Fig. 5. Section 169, ) mata.
- Fig. 6. Section 183, )
- Fig. 7. Section 190, showing the branchial sac in front of the stigmata.
- Fig. 8. Section 216, showing the large lateral ectoderm cells.
- Fig. 9. Part of tail from last section more highly magnified ( $\times 600$ ).
- Fig. 10. Ectoderm cells from about section 200, highly magnified.

## PLATE IV.

- Fig. 1. Section 223, )
- Fig. 2. Section 225, ) showing the relation of the endo-
- Fig. 3. Section 228, ) style to the branchial sac.
- Fig. 4. Section 248, showing anterior caecal part of endostyle, &c.



Fig. 1.



Fig. 2.

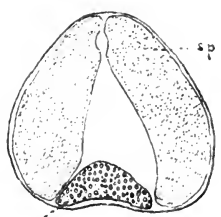


Fig. 3.

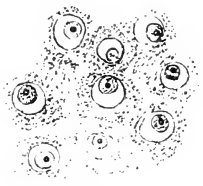


Fig. 4.



Fig. 5.

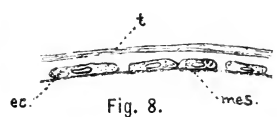


Fig. 8.

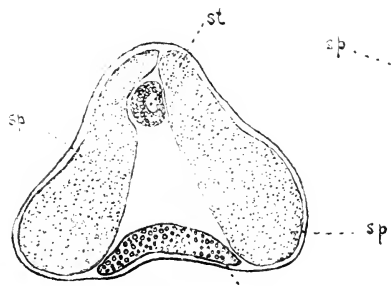


Fig. 6.

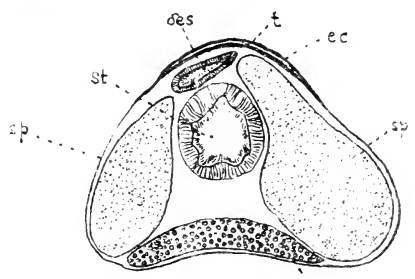


Fig. 7.

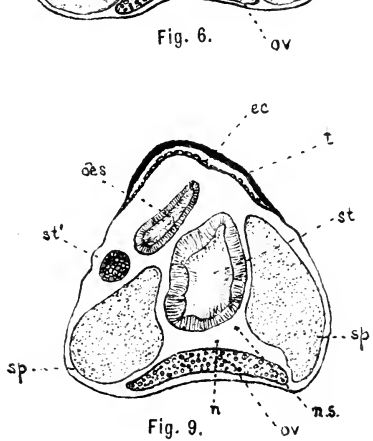


Fig. 9.

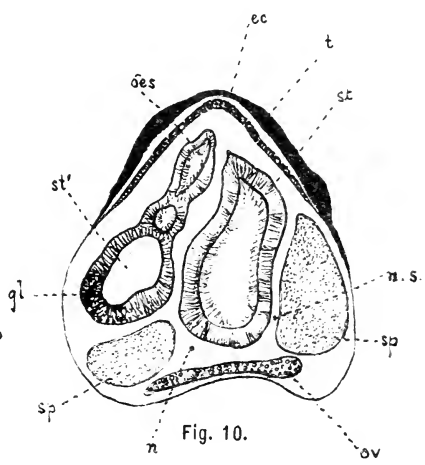


Fig. 10.





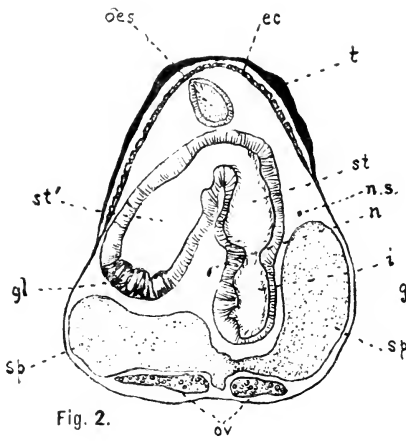


Fig. 2.

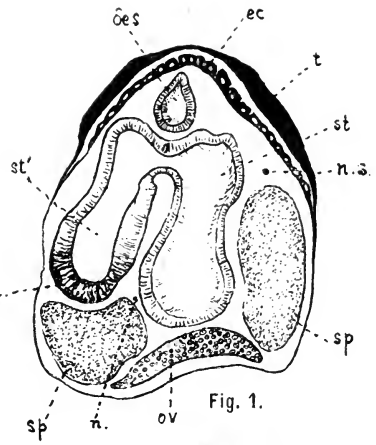


Fig. 1.

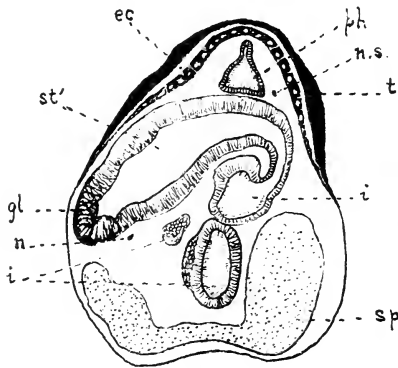


Fig. 3.

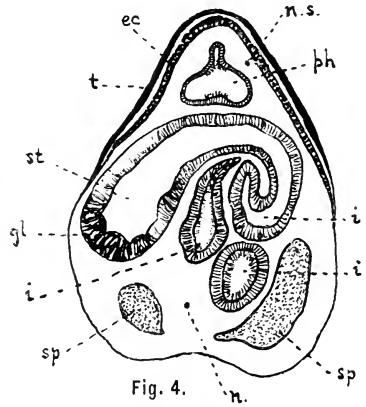


Fig. 4.

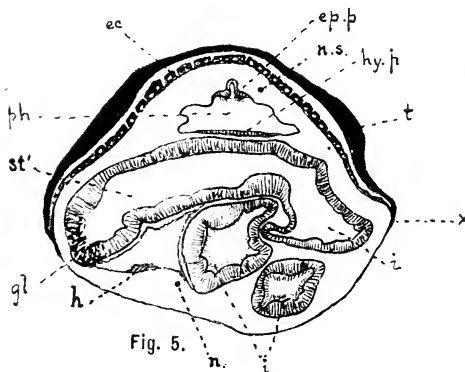


Fig. 5.



Fig. 6.



Fig. 7.

W.A.H. del.

OIKOPLEURA.



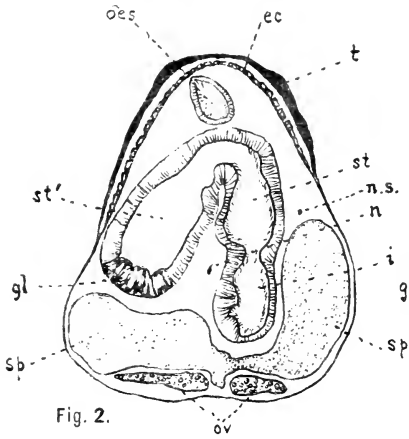


Fig. 2.

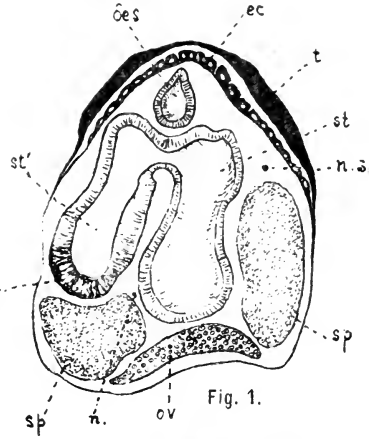


Fig. 1.

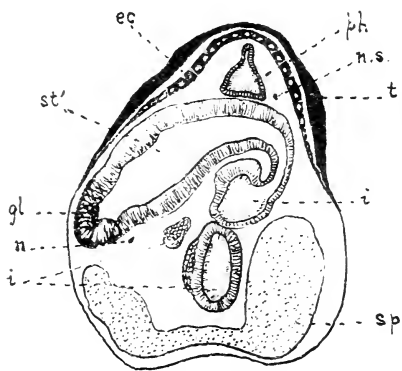


Fig. 3.

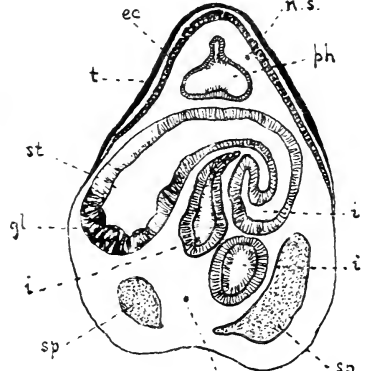


Fig. 4.

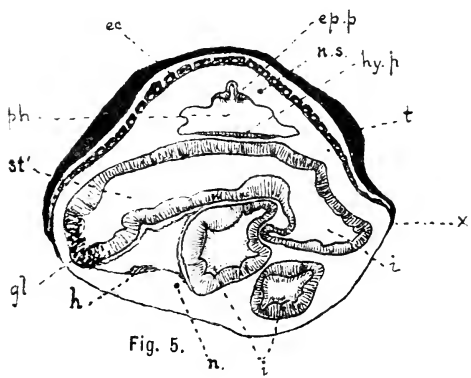


Fig. 5.

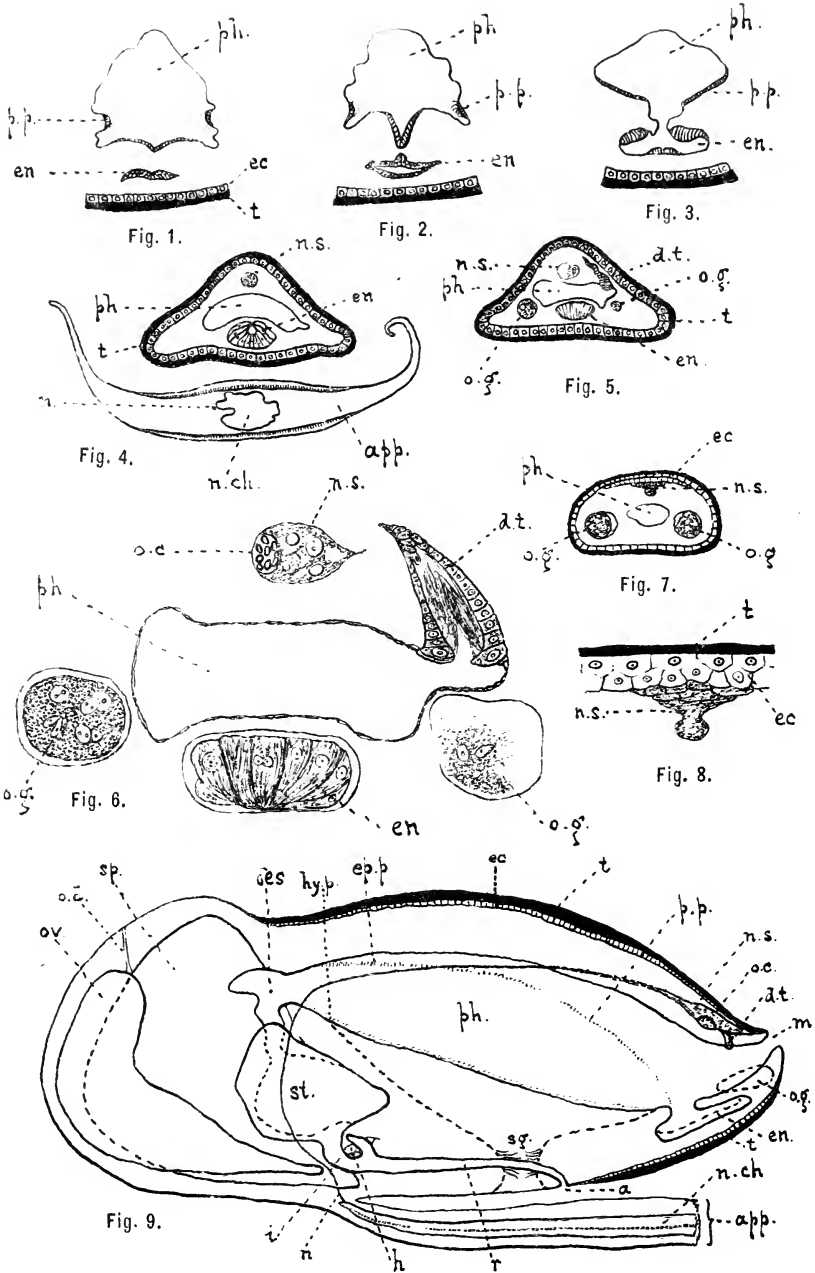


Fig. 6.



Fig. 7.





W.A.H. del.

OIKOPLEURA,



- Fig. 5. Section 254, nervous system, sense organs, &c.  
 Fig. 6. Section 257, part of the centre, showing nervous system, &c., highly magnified ( $\times 600$ ).  
 Fig. 7. Section 266, showing anterior end of nervous system, oral glands, &c.  
 Fig. 8. Dorsal part of last section more highly magnified ( $\times 600$ ).  
 Fig. 9. Diagrammatic reconstruction of the animal from the sections, seen from the right hand side, showing the extent of the thickened ectoderm and test dorsally and ventrally, the course of the nerve cord, and the shapes, sizes and relative positions of the other organs, about 60 times natural size.

POST-SCRIPT.—March 1;—Mr. W. Garstang, who was present when this paper was read, has kindly written to me since stating that in some sections of *Oikopleura* (? *dioica*) which he has made the endostyle is an open canal in the greater part of its extent. On the other hand Dr. Bousfield has very kindly sent me three additional series of sections of the same species of *Oikopleura* as before (? *flabellum*), and in these I find as in the one described above that the cavity of the endostyle is shut off from the pharynx above for more than half of its length. The actual numbers of sections involved in these new series are:—

- |      |                  |    |         |      |     |        |          |     |
|------|------------------|----|---------|------|-----|--------|----------|-----|
| I.   | closed posterior | 7  | sects., | open | 14, | closed | anterior | 12. |
| II.  | „                | 6  | „       | 14,  | „   | 11.    |          |     |
| III. | „                | 10 | „       | 18,  | „   | 19.    |          |     |

[From Trans. Biol. Soc., L'pool. Vol. VI.]

RECORD of Additional HYDROIDA from the  
ISLE OF MAN.

By G. W. WOOD, F.I.C.

[Read April 8th, 1892.]

I HAVE much pleasure in submitting to the Biological Society a list of some Hydroida from the Isle of Man, which have not been previously recorded.\* I have made numerous dredgings there during the last few years, chiefly in moderately deep water (20—30 fathoms). The forms belonging to other groups which I have preserved may be reported upon on some future occasion.

Hydroida have also been procured for me by some of the Manx trawlers, and parcels continue to be forwarded from time to time, so that the present list is likely to be extended. I have confined my attention to the fauna of the N.W. and N.E. coasts, the south end of the Island having already been investigated during the L.M.B.C. dredgings, and those of Prof. Herdman, as recorded in the first volume of the Fauna of Liverpool Bay.

Although the area represented by the Isle of Man is comparatively small, the habitats of some of the species are somewhat sharply defined. Some of the species found by the L.M.B.C. in the S. and other species reported from the N. are altogether absent from the N.E. and N.W. and *vice versa*. *Diphasia pinaster*, a species not hitherto reported from the N. or S., is quite common in the N.W. but absent again in the N.E. Another species, *Sertularia*

\* [The Report upon the Hydroida of the L.M.B.C. District will be found in Vol. I. of the "Fauna of Liverpool Bay," p. 95.—Ed.]



*argentea*, which is abundant (in the young state) in the N.E. is represented in the N.W. by only two or three small fragments, and only "several *very* small pieces" were obtained by the L.M.B.C. in the S. Of the rare *Thuiaria articulata* I have found several good specimens in the N.W., none on the other side. I have also dredged fine specimens of *Aglaophenia myriophyllum* in plenty off the Dhoon, but one small colony only has appeared in the N.W. Neither of the two last-named species has, I believe, been reported from the Isle of Man since the time of Forbes.

As a summary of my results up to the present time I have the gratification to record 12 Hydroida not hitherto reported from the Isle of Man, of which 5 are new to the district of Liverpool Bay. They are as follows:—

New to Isle of Man only.

*Tubularia coronata*, Abildg. From the N.W.

*Obelia geniculata*, Linn. From the N.W. and N.E.

*Obelia longissima*, Pallas. From the N.W.

*Diphasia attenuata*, Hincks. From the N.W. & N.E.

*Diphasia pinaster*, Ellis and Sol. From the N.W.

*Diphasia tamarisca*, Linn. From the N.W.

*Sertularia cupressina*, Linn. From the N.W.

New to the Isle of Man and L.M.B.C. district.

*Tubularia attenuata*, Allman. From the N.W.

*Campanularia (?) raridentata*, Alder. From the N.W.

*Halecium muricatum*, Ellis and Sol. From the N.E.

*Halecium tenellum*, Hincks. From the N.E.

*Sertularella tenella*, Alder. From the N.W. and N.E. (abundant).

[From Trans. Biol. Soc., L'pool. Vol. VI.]

REVISION of the PODOPHTHALMATA and  
CUMACEA of LIVERPOOL BAY to May, 1892.

BY ALFRED O. WALKER, F.L.S.

[Read May 13th, 1892.]

THE following list comprises all the Podophthalmata and Cumacea recorded from Liverpool Bay up to date. The Edriophthalmata will follow, but it is considered advisable to delay these until the completion of Prof. G. O. Sars' fine work on the Amphipoda of Norway so that our species may be named in accordance with it.

In the references to the Reports previously published it may be well to mention that Rep. I, is contained in the first volume of the Reports of the Liverpool Marine Biological Committee, (1886) pp. 221—226; Report II and III, are in the second vol. of the above (1889) pp. 171—181 and App. pp. 68—86; Rep. II, is also published in the Proceedings Liverpool Biological Society, Vol. II, 1887—8, pp. 171—181; Rep. III, in Vol. III, 1888—9, pp. 195—213; and Rep. IV, in Vol. IV, 1889—90, pp. 239—51.

PODOPHTHALMATA,

BRACHYURA.

*Gonoplax angulata*, Fabr. (Rep. I, 225).

One specimen said to have occurred at Southport (C. H. Brown). A Mediterranean species.

*Pinnotheres pisum*, Penn. (Rep. I, 225).

In Mussels as a commensal.—Dawpool; Conway;  
Coast of I. of Man.

*Corystes cassivelaunus*, Herbst (Rep. I, 225.)

Not uncommon on sandy ground at various depths and between tidemarks throughout the district.

*Thia polita*, Leach. (Rep. I, 224).

Constable Bank, "Hyæna," 1885, 10 to 17 miles N.W. of Mersey Bar; "Spindrift," 1890.

*Atelecyclus septemdentatus*, Mont. = *A. heteroden*, Leach.

Off Fleswick Bay, Station I, 20 fath., 2 specimens, and Station III, 30 to 33 fath. 1 specimen, June 5, '92.

*Platyonychus latipes*, Penn., *Portumnus variegatus*, Leach. (Rep. I. 225. II, 180).

Between tidemarks on sand in which it buries itself. Penmaenmawr. Colwyn Bay.

*Carcinus mænas*, Baster (Rep. I, 225).

Very abundant in the Dee and Mersey. Not so common at Colwyn Bay.

*Portunus puber*, Linn. (Rep. I, 225, III, 69).

Point of Ayr, 1875. Bull Bay, Anglesey.

*Portunus depurator*, Linn. (Rep. I, 225).

Abundant everywhere: generally on stony ground 3 to 7 fath.

*Portunus arcuatus*, Leach. (Rep. I, 225).

Mouth of the Dee. Colwyn Bay. Not common.

*Portunus holsatus*, Fabr. (Rep. II, 180).

Garth Ferry, Menai Straits—10 fath. (H. C. Chadwick)

*Portunus pusillus*, Leach. (Rep. I, 225, IV, 243).

Port Erin, I. of Man; Dulas Bay, Anglesey.

*Pilumnus hirtellus*, Penn. (Rep. I, 225, II, 180).

Orme's Heads; Puffin Island; Bar of Dee. Shore to 15 fathoms.

*Xantho rivulosus*, Risso, and var. *tuberculatus*, Couch (Rep. II, 180, III, 69, IV, 244).

Baumaris, shore (Chadwick). Port Erin. 16 miles N. of Holyhead 40 to 60 fath. "Spindrift," 20/7/89.

*Cancer pagurus*, Linn. (Rep. I, 226).

Rhos and Colwyn Bays : Common but small.

*Eurynome aspera*, Penn. (Rep. I, 226, II, 180).

Puffin Island, 15 fath. S. end of I. of Man. Between  
Liverpool and I. of Man, 20 and 30 fath.

*Hyas araneus*, Linn. (Rep. I, 226).

Off the Little Orme; Puffin Island, &c., in stony  
places 2 to 10 fath. : not so common as the next species.

*Hyas coarctatus*, Leach. (Rep. I, 226).

Stony places, shore to 10 fath. Common.

*Inachus dorsettensis*, Penn. (Rep. I, 226, II, 180).

Off Port Erin; between Liverpool and I. of Man,  
"Weathercock," 28/8/86.

*Stenorhynchus rostratus*, Linn. (Rep. I, 226).

Common in stony places.

*Ebalia tuberosa*, Penn., *E. pennantii*, Leach (Rep. I, 224,  
II, 180, IV, 243).

S. end of I. of Man; Dulas Bay; between Liverpool  
and I. of Man "Weathercock," 28/8/86, 20 to 30 fath.

*Ebalia tumefacta*, Penn., *E. bryerii*, Leach (Rep. I, 224,  
II, 180, IV, 243).

S. end of I. of Man; "Weathercock," 28/8/86; Dulas  
Bay, 20 to 30 fath.; Penrhos Bay, May, 1890; 10 to  
17 m. N.W. of Mersey Bar, Sept., 1890.

It is remarkable that the two last species, if they be  
distinct, should have been taken together in every case.

#### ANOMURA.

*Eupagurus bernhardus*, Fabr.

Abundant everywhere.

*E. prideauxii*, Leach (Rep. I, p. 223).

Off Port St. Mary, Isle of Man (Herdman).

*E. pubescens*, Kröyer (Rep. III, p. 69).

Dredged W. of Calf of Man, May, 1888, "Hyæna."

*Eupagurus cuanensis*, Thompson (Rep. I, 224, II, 179).

Off S. end of I. of Man, 1885. Between Liverpool and Isle of Man, 20 to 30 fath., Aug., 1886.

*Spiropagurus levis*, Thomp. (Rep. II, 180).

One specimen, Douglas, I. of Man, 1886.

*Porcellana platycheles*, Pennant (Rep. I, 224).

Under stones at low tide. Colwyn Bay; Hilbre Island; Puffin Island. Sometimes abundant, especially in spring.

*P. longicornis*, Penn. (Rep. I, 224).

Common everywhere under stones.

*Galathea nexa*, Embleton (Rep. IV, 243, 244).

Off Anglesey Coast, June, 1889; about 16 miles N. of Holyhead in 40 to 60 fath., July, 20th, 1889; several.

*G. dispersa*, Bate, (Rep. III, 69, IV, 244).

Off I. of Man, May, 1888, about 16 miles N. of Holyhead, 40 to 60 fath., July 20th, 1889. One specimen taken off Calf of Man, April, 1889, had the 3rd maxillipedes as figured by Henderson, "Anomoura of Challenger Expedition," Pl. XII, fig. 6a.

*G. intermedia*, Lilljeborg, *G. andrewsii*, Kinahan (Rep. I, 223, II, 179).

Menai Straits; Hibre Swash; Port Erin; between Liverpool and I. of Man, 20 to 30 fath.; coast of I. of Man; rather common.

*G. squamifera*, Leach (Rep. I, 223).

Off S. end of Isle of Man.

*Munida banffica*, Penn. (Rep. III, 70).

Off S. end of I. of Man, May, 1888.

#### MACRURA.

*Palinurus vulgaris*, Latreille.

Anglesey Coast near Valley; Isle of Man.

*Homarus vulgaris*, M. Edw. (Rep. I, 223).

Rhos Bay; Puffin Island; Anglesey Coast; Hilbre Island.

*Nephrops norvegicus*, Linn. (Rep. I, 223).

Said to have been taken at Holyhead (Bell's Brit. Crust. p. 254).

CARIDA.

*Crangon vulgaris*, Linn.

Common; sandy shores.

*Crangon allmanni*, Kinahan (Rep. II, 179, IV, 243).

Between Liverpool and Isle of Man, 20 to 30 fath., August, 1886, three miles off Dulas Bay, Anglesey, June, 1889; Little Orme.

*C. trispinosus*, Hailstone (Rep. I, 222, II, 179).

Turbot Hole; Puffin Island; Colwyn Bay low tide.

*C. fasciatus*, Risso. (Rep. I, 222, II, 179).

Turbot Hole; Colwyn Bay.

*C. sculptus*, Bell (Rep. I, 222).

Off S. end of Isle of Man.

*C. nanus*, Kröyer = *C. bispinosus*, Westwood, (Rep. IV, 243,) Turbot Hole, 2 females with ova.

*Pasiphæa sivado*, M. Edw. (Rep. I, 221).

Mouths of the Dee and Mersey, scarce.

*Virbius varians*, Leach (Rep. I, 222).

Common in tidal pools and down to 15 fathoms.

*Hippolyte spinus*, Sowerby (Rep. IV, 224).

One specimen 16 m. N. of Holyhead, 40—60 fath., "Spindrift," July 20, 1889.

*H. cranchii*, Leach (Rep. II, 179).

Turbot Hole and Puffin Island, low water; Colwyn Bay; Towyn, Anglesey, 5 fath.

*H. pusiola*, Kröyer (Rep. II, 179).

Turbot Hole, between Orme's Head and I. of Man, 30 fath.; off Porthwen Bay, Anglesey, 21 fath.; Towyn, Anglesea, 5 fath.; Amlwch Bay; Little Orme, 8 to 10 fath.

*Caridion gordonii*, Bate (Rep. III, 70).

One female with ova, between Calf of Man and Port Erin, May, 1888.

*Pandalus annulicornis*, Leach (Rep. I, 222).

Abundant everywhere on stony ground.

*P. brevirostris*, Rathke = *Hippolyte Thompsoni*, Bell. (Rep. I, 222, II, 179, III, 70).

Turbot Hole; between Ormes Head and I. of Man, 30 fath.; S. end of I. of Man, 21 fath.; 16 m. N. of Holyhead, off Red Wharf Bay, 20 fath.; Towyn, Anglesea, 5 fath.

*Palæmon serratus*, Penn. (Rep. I, 221).

Stony ground; not abundant.

*Palæmon squilla*, Leach. (Rep. II, 179).

One specimen in tidal pool at Beaumaris (Chadwick).

*Palæmonetes varians*, Leach.

In brackish water. Wallasey Pool, Birkenhead (W. J. Halls).

#### SCHIZOPODA.

*Nyctiphanes norvegica*, M. Sars.

Tow-net, about 1½ m. N. of Puffin Island, 6.30 a.m., November 30, 1890.

*Leptomysis lingouira*, G. O. Sars.

Colwyn Bay, 2½ fath., Sept. 15, 1890; Port Erin Harbour, 2 to 5 fath., June 4, 1892.

*Siriella norvegica*, G. O. Sars (Rep. IV, 241, 244-5).

Port Erin, April 20, 1889, Electric Light and tow-net on surface.

*Siriella armata*, M. Edw.

Puffin Island, tow-net, 1890.

*Gastrosaccus spinifer*, Goes. (Rep. IV, 241-2).

Colwyn Bay, 2½ fath., October 2, 1889; Port Erin, Electric Light, April 20, 1889.

*Mysis flexuosa*, Müller (Rep. I, 221).

Dee, off Flint; tidal pools, Rhos Bay, April and May; Puffin Island, S. side.

*M. neglecta*, G. O. Sars (Rep. IV, 242-245).

Rhos Bay, low tide, June, 1889, July, 1890.

Distinguishable from the last species by the anterior tarsal joints having 5 joints and the posterior 4, instead of 6 and 5 respectively. The antennal scale is also shorter and proportionately wider in this species.

*M. inermis*, Rathke (Rep. IV, 242).

Colwyn Bay, low tide, Sept., 1889; Puffin Island, off Dinmor Point, April, 1890 (I. C. T.); Douglas, I. of Man, August, 1886; Dulas Bay,

*M. spiritus*, Norman, tow-net.

Puffin Island, 1890 (I. C. T.)

In Report I, p. 221, for *M. spiritus*, Norman, read *M. kervillei*, Sars.

*M. ornata*, G. O. Sars (Rep. IV, 242-3, 245).

Colwyn Bay, May, 1887; off Lighthouse, Puffin Island, 1888; Little Orme, 8 fath., August, 1889.

*M. kervillei*, G. O. Sars, (Bull. de la Soc. des Amis des Sciences Nat. de Rouen, 1885, p. 92, Pl. V. Hoek, Tijdschrift der Nederlandsche Dierkundige Vereen, 1887, p. 11, Pl. VII.)

Little Orme, 8 fath., August, 1889 (with *M. ornata*); 12 to 17 m. N. of Mersey Bar, Sept., 1890; Colwyn Bay, Jan., 1890 and 1891.

I have called the specimens with 5 tarsal joints (excluding the nail) *M. ornata*, and those with 6 joints *M. kervillei*. I am unable to see any other constant difference between the 2 species. I have specimens with 6-jointed tarsi which have the cleft of the telson and the position of the spine of the antennal scale (which are the parts relied upon by the author for the specific difference in addition



to the tarsal joints), exactly the same as other specimens which have only 5-jointed tarsi.\* Generally the spine is nearer to the apex of the antennal scale than to the base. The colour of *M. kervillei* is greyish-white, thorax spotted with dark red or brown, one dorsal and two lateral (one on each side) spots on each abdominal segment; proximal fourth of telson also dark red, succeeded by a white arborescent patch.

*M. lamornæ*, Couch (Rep. II, 178).

Colwyn Bay, May, 1887, 3 fath.; Little Orme, August, 1889, 8 fath.

*M. vulgaris*, Thompson (Rep. II, 178).

Mouth of the Alt, in brackish water.

#### CUMACEA.

*Cuma scorpioides*, Montagu = *C. edwardsii*, Goodsir (Rep. III, 70; IV, 242-3, 246).

Off Great and Little Ormes, 5 to 10 fath.; Ramsey at Electric Light and Port Erin, males and females, 3 fath. below surface; Dulas Bay and Porth Dafarch, Anglesey; Puffin Island; Hilbre Swash; Menai Straits. For remarks on the identity of *C. scorpioides* and *C. edwardsii* see Rep. IV, 246.

*Iphinœ trispinosa*, Goodsir = *I. gracilis*, Sp. Bate and Sars, Middelhavets Cumaceer p. 36, Pl. 10—14. *Iphinœ serrata*—Norman—under Plates (Rep. III, 71, IV, 242.)

Port Erin at Electric Light, very abundant; Colwyn Bay 2½ fath. dredged; Puffin I. 5 fath.; Porth Dafarch, Anglesey.

The females only have a row of spines on the dorsal surface of the cephalothorax. An old male measured 11½ mm., colour bright red.

\* I have also an adult male with the cleft of the telson and antennal scale as figured for *M. kervillei* but with 7-jointed tarsi.

*Cumopsis goodsiri*, Van Beneden = *Bodotria goodsiri*, Van Ben. Recherches sur la Faune littorale de la Belgique, p. 77, Pl. XIII = *Cumopsis goodsiri*, Van Ben.—G. O. Sars, Middelhavets Cumaceer p. 52, Pl. XIX to XXI.

One female in tow-net off Puffin I. Nov. or Dec. '90; several young dredged off Puffin I. in 10 fath., July '91 (I.C.T.).

*Lamprops fasciata*, G. O. Sars. Om den aberrante Krebsdyrgruppe Cumacea, Christ. Vid.—Selsk. Forhandl. 1864—(Rep. IV, 242/3, 247.) Colwyn Bay, 2½ fath.; 3 miles off Dulas Bay, 20 fath.; Little Orme 8 fath.; Puffin I. 5 fath.

*Eudorella truncatula*, Sp. Bate = *Eudora truncatula*, Sp. Bate, Ann. & Mag. Nat. Hist. Ser. 2, Vol. 17, p. 457, Pl. XIV. Off S.W. end of Puffin I. 5 fath. May '90, Colwyn Bay, 1 young male, colour pure white.

*Diastylis rathkei*, Kröyer, (Rep. IV, 249), Little Orme—two immature males; Puffin I. 5 fath., off S.W. end, two females.

*Diastylis spinosa*, Norman (Rep. II, 178, Pl. XIII, f. 10 Rep. IV, 242, 247). Male = *D. Bradyi*, Norman, female.

Colwyn Bay—females and young abundant, males scarce; Puffin I. 5 fath. S.W. end, two females; Towyn 5 fath.

For remarks on the identity of the above species see Rep. IV, 247.

*Pseudocuma cercaria*, Van Beneden, (Rep. III, 71, IV, 242, 248.)

Port Erin at Electric Light—males only, abundant; Colwyn Bay, abundant; Puffin I. 5 fath.

[From Trans. Biol. Soc., L'pool. Vol. VI.]

SUPPLEMENTARY REPORT upon the  
TESTACEOUS MOLLUSCA of the  
L.M.B.C. DISTRICT.

BY THE LATE FRANCIS ARCHER, B.A.

[Read 13th May, 1892.]

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EDITORIAL NOTE.

It is well known to members of the Biological Society that for some years past the late Mr. F. Archer has had charge of the Mollusca obtained in the dredging and other collecting expeditions, and has been accumulating material for a report supplementary to that given by Mr. R. D. Darbishire in the first volume of the "Fauna of Liverpool Bay."

During last winter Mr. Archer decided that his records and notes were sufficiently complete to permit of publication this session, so the title of the report was printed on the Society's circular for reading at the March meeting. After his sudden death in February, and in consultation with his brother Surgeon-Colonel S. Archer, it was decided that the report (the materials for which were found very carefully and systematically recorded in five large note books) should be edited and published with as little delay as possible, in order that it might be incorporated in the forthcoming volume III of the "Fauna" as originally intended. At Surgeon-Colonel Archer's suggestion I wrote to his brother's friend Mr. Brockton Tomlin, of

Chester, and asked him to undertake the responsible work of putting the notes and records in proper form for the printer. This Mr. Tomlin kindly consented to do, and the following report has accordingly been arranged and corrected by him. I wish as editor of these L.M.B.C. reports to thank Mr. Tomlin, and express the satisfaction of the Committee, that one so eminently qualified both as a conchologist and also from his knowledge of Mr. Archer's collections and notes and methods should have been found willing to undertake this work, and carry it out without delay. The following introduction is by Mr. Tomlin.

W. A. H.

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#### INTRODUCTION.

This Report is strictly supplementary, and must be read entirely by the side of that in vol. I of the "Fauna," pp. 232—266. Nor must it be supposed that *all* new records are included, especially in the case of the commoner species, the aim being primarily to record extensions in the habitat or apparent habitat of the species, but not to publish all the occurrences of dead specimens, while our knowledge of the district is so imperfect and the collecting disconnected. It will be noticed that the chief centres of thorough exploration since last report have been Port Erin in the Isle of Man and the N. and E. coasts of Anglesea, all worked by the late F. Archer: the Southport neighbourhood by Dr. G. W. Chaster: Fleetwood by W. H. Heathcote and others: and the central area by means of several dredging expeditions, the details of which will be found in the successive annual reports upon the work of the L.M.B.C.

To the list of 1886 we are enabled to add 37 species (marked by asterisks in the following pages), of which the *Spirula* is a pelagic cephalopod, accidentally drifted to our shores. The 9 species enclosed in square brackets are for various reasons doubtful. Five of them, viz., *Pinna rudis*, *Trochus lineatus*, *Odostomia conoidea*, *O. pusilla*, and *Cerithiopsis tubercularis*, may quite possibly occur but require confirmation: *Donax trunculus* is a certain error in Rep. I and should be expunged, the specimens being referable to *D. vittatus*: *Aplysia depilans* is an almost equally certain error: *Fusus islandicus* of Forbes and C. H. Brown = *F. gracilis*, DaC.; while there is much reason to believe that *Cardium echinatum* was mistaken for *C. aculeatum* by Forbes in his "Malacologia Monensis."

The following should be added to the bibliographical references on p. 247 of Rep. I.

Forbes and Hanley's "History of Brit. Mollusca" (1853).

Dr. J. G. Jeffrey's "Brit. Conchology" 5 vols. (1863).

Thos. Pennant's "Brit. Zoology" vol. IV (1777).

Chas. H. Brown's Mollusca in Dr. Nichol's "Southport," 3rd edition (1883).

Rev. Carleton Greene's "Marine Moll. of N. Wales" in "The Conchologist" vol. I, No. 1.

B. Tomlin's "Notes on N. Wales Mollusca" in "Quarterly Journal of Conchology," vol. VII, No. 1 (Jany., 1892), also containing some corrections of Rev. C. Greene's paper.

Dr. G. W. Chaster's "Mollusca of Southport and District" in Rep. I of Southport Soc. Nat. Sc. (1892).

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## BRACHIOPODA.

\**Crania anomala*, Müll., omitted in Rep. I.

A single specimen dredged off Ballaugh in 1834 by Forbes (Mal. Mon.).

## MOLLUSCA.

## LAMELLIBRANCHIATA.

*Anomia ephippium*, L.

The vars. *squamula*, *aculeata*, *cylindrica* are all recorded from the I. of Man. General throughout the district but characteristically dwarfed.

*Anomia patelliformis*, L.

Common at Port Erin (F.A.): var. *striata* common on shells in deep water (Forbes; Mal. Mon.).

*Ostrea edulis*, L.

Recorded by Forbes as plentiful off N. and E. coasts of I. of Man, a bank existing off Laxey (Mal. Mon.); two beds known to exist off Bull Bay, Anglesea: occasionally brought in alive to Southport (C.H.B.): beds used to exist on Penmon side of Redwharf Bay, at Pwll Buchan, and at Dulas Bay.

*Pecten varius*, L.

common living, 5 m. outside Fleetwood, especially a white var.

*Pecten opercularis*, L.

A bed outside Port Erin and smaller patches nearer shore, especially off Bradda Head (F.A.).

*Pecten tigrinus*, Müll.

Occasionally living, Port Erin (F.A.): Birkdale, valves rare (G.W.C.).

\**Pecten striatus*, Müll., omitted in Rep. I.

Isle of Man (Jeff. B.C. II, 70).

\* The additions to the former list are marked by an asterisk.

*Pecten similis*, Laskey.

Valves only from dredgings off Puffin I. ("Hyæna"), Southport, Bay Fine (common), and in Central area.

*Lima loscombii*, Sow. see Rep. I. since taken alive.

Two living at Bull Bay in 20 fms. (F.A.): also alive off Bradda Head and Bay Fine (F.A.).

[*Pinna rudis*, L.

The keeper of the cave on the Gt. Orme's Head shows a large specimen said to have been dredged 7 or 8 miles off shore. Query—British at all?]

*Mytilus modiolus*, L.

Many dredged living 5 miles off Fleetwood: living off Port Erin (F.A.).

*Mytilus barbatus*, L.

Many off Fleetwood with the last.

*Modiolaria marmorata*, Forb.

Common near Southport in tests of Ascidians and in *Alcyonium digitatum* (G.W.C.): also in Ascidians off Fleetwood.

*Modiolaria discors*, L.

Abundant in rockpools, Moelfre Bay, and occasional at Bull Bay (F.A.): Southport, rare in *Alcyonium* (C.H.B.).

*Nucula nucleus* var. *radiata*, F. and H.

Commoner than type at Port Erin (F.A.): fairly c. alive in central area: Bull Bay, occasional (F.A.).

*Nucula nitida*, Sow.

Has now occurred commonly alive at Tynyngogl, Bull Bay (F.A.), Carnarvon Bay ("Hyæna," 1890), and in central area: rare alive Birkdale (G.W.C.): Port Erin occasional (F.A.).

*Leda minuta*, Müll.

Carnarvon Bay, alive ("Hyæna," 1890): abundant, living off Amlwch (F.A.): occas. living in central area.

*Lepton squamosum*, Mont.

One perfect but dead, 20 m. W. of Southport (G.W.C.).

\**Lepton nitidum*, Turton.

New to the district: 5 specimens in dredgings from central area and several in the same from Port Erin (F.A.).

*Montacuta substriata*, Mont.

Common in central area on *Spatangus purpureus*.

*Montacuta bidentata*, Mont.

Now very common, dead on Birkdale shore (G.W.C.), cf Rep. I: dead also in most localities.

\**Lucina spinifera*, Mont.

New to district: several dead off Bay Fine (F.A.).

*Lucina borealis*, L.

Dead shells and valves common off Port Erin (F.A.).

*Cyamium minutum*, Fab.

Common alive in weed at Bay-ny-Carrickey, and at Porthwen, Anglesea (F.A.).

[*Cardium aculeatum*, L.

Point of Air, Isle of Man, dead only (Forbes Mal. Mon.) but an extremely doubtful record and should almost certainly be referred to *C. echinatum*: cf. Jeff. B.C. II, 269.]

*Cardium echinatum*, L.

An immense quantity thrown up at Southport in January, 1891, many alive (G.W.C.): living but generally young off Port Erin, Bull Bay, Tynygongl (F.A.) and in central area.

\**Cardium nodosum*, Turton.

New to district: common alive off Bay Fine and Bradda Head (F.A.): central area and Bull Bay (F.A.) valves only.

*Cardium norvegicum*, Sp.

Very large and living off Morecambe (W.H.H.): valves only, of general occurrence.



*Astarte sulcata*, DaC.

Frequent alive in Carnarvon Bay ("Hyæna," 1890): sparingly off Bradda (F.A.): rare alive on Birkdale shore (G.W.C.).

var. *scotica*, M. and R. Isle of Man, N., rare in deep water (Mal. Mon.).

\**Venus chione*, L., omitted from Rep. I.

Carnarvon Bay in 12 fms. (McAndrew), cf. Jeff. B.C. II, 333: valves in same loc. (Forbes and F.A.). This is the northern limit of the species on our coasts.

*Venus fasciata*, DaC.

Common alive at Beaumaris (R.D.D.), off Port Erin (F.A.), at Llandudno, in 1878 (B.T.), and in Carnarvon Bay ("Hyæna," 1890): records numerous.

*Venus ovata*, Penn.

Frequent alive at Port Erin (F.A.), and in Carnarvon Bay ("Hyæna," 1890).

*Tapes virgineus*, L.

Very abundant at Port Erin and quite the characteristic shell though by far the greater number were fresh dead shells (F.A.): also Bull Bay and Tynyngogl (F.A.), Birkdale (G.W.C.), dead only.

*Lucinopsis undata*, Penn.

One small living specimen in central area, valves common: valves at Port Erin, Tynyngogl (F.A.), Southport (G.W.C.).

*Tellina fabula*, Gron.

Port Erin c. dredged and on shore (F.A.).

\**Tellina squalida*, Pult.

Between Southport and Blackpool (W.H.H.), valves only.

*Tellina donacina*, Don.

c. in central area, young shells alive, adults dead; valves recorded *passim*.

Can any of these "young shells" possibly be *T. pusilla*?

*Psammobia tellinella*, Lam.

Abundant in one haul off Bradda Head (F.A.).

[*Donax trunculus*, L.

An undoubted error in Rep. I, p. 252 for *D. vittatus*, DaC. or a variety: the true *D. trunculus* is a mediterranean species of which 2 specimens have occurred on the S. coast of Devon. The mistake must have originated from Forbes' nomenclature, as in his time all British authors called our common species *trunculus*. cf. Jeff. B.C. II, 405.]

*Scrobicularia prismatica*, Mont.

Occasionally living, more frequent dead at Bull Bay with *S. alba* (F.A.): Port Erin, living (F.A.): very rare at Southport, dead (G.W.C.).

*Solen pellucidus*, Penn.

Abundantly, living in several parts of central area, and at 4—10 miles W. of Southport: more sparingly at Bull Bay (F.A.).

\**Pandora inaequivallis*, L., omitted from Rep. I.

Isle of Man in 20 fms., and N. Wales in 12 fms. (Forbes, as *P. obtusa*): Carnarvon Bay ("Hyæna," 1890): Port Erin and central area (F.A.): Llandudno (F.A.) all living: one dead specimen at Birkdale (G.W.C.).

*Lyonsia norvegica*, Chem.

Alive in 20 fms., Isle of Man (Forbes): one fine specimen alive off Bay Fine (F.A.): one dead in central area with valves united.

*Corbula gibba*, Ol.

Living *passim*, usually frequent.

*Mya binghami*, Turton.

Moelfre Bay and Bull Bay (F.A.).

*Saxicava rugosa*, L.

Abundant in many places, living: the var. *arctica*, L. also occurs.

\**Teredo navalis*, L.

Southport, once in driftwood (G.W.C.): one valve in sand (W.H.H.). New to district.

SCAPHOPODA.

*Dentalium entale*, L.

Colwyn Bay (F.A.), and once abundantly in central area—living: dead at Bull Bay and Tynyngongl (F.A.).

*Dentalium tarentinum*, Lam.

Central area, 25 m. N.W. of Bar Lightship, 2 or 3 dead shells ("Spindrift"); several 20 m. W. of Southport (G.W.C.).

POLYPLACOPHORA.

*Chiton fascicularis*, L.

Scarce living at Porthwen (F.A.) and Llandudno (B.T.).

GASTROPODA.

*Tectura testudinalis*, Müll.

Now abundant at Fleetwood (W.H.H.): dredged living but small at Port Erin, and one littoral specimen at Llandrillo (F.A.): one fresh shell, Carnarvon Bay ("Hyæna," 1890).

*Tectura virginea*, Müll.

Common at roots of *Laminaria* on Puffin Is. (A. Leicester): rare living at Llandudno (B.T.): abundant alive off Port Erin (F.A.).

\**Puncturella noachina*, L.

New to district. 2 dead in central area dredgings ("Spindrift").

*Emarginula fissura*, L.

Dead shells of general occurrence. The same applies to *Fissurella græca*, L.

\**Cyclostrema serpuloides*, Mont.

Isle of Man in 20 fms. (Forbes, as *Skeneca divisa*, Fleming): abundant living on seaweeds at low water in Fleshwick Bay (F.A.).

[*Trochus lineatus*, DaC.

Anglesea (Donovan) in Jeff. B.C. III, 318. This certainly requires confirmation as Forbes (Brit. Assoc. Rep. 1850, p. 255) says that the range of this species ceases in Cardigan Bay or a little higher up, the latter expression probably referring to the S. coast of Carnarvonshire where it does occur.]

*Trochus montacuti*, Wood.

Frequent living at Port Erin with *T. tumidus* (F.A.).

*Trochus millegranus*, Phil.

2 or 3 small ones living at Port Erin (F.A.).

*Trochus granulatus*, Born.

Alive off Morecambe (W.H.H.): occasionally thrown up dead on Lancashire coast.

*Trochus zizyphinus*, L.

Large and abundant at very low-water, Rhos Point near Colwyn (B.T.).

var. *lyonsii*, Leach. c. alive off Pt. Lynas (Forbes); living at Bull Bay and dead off Tynyngongl and in Carnarvon Bay (F.A.).

var. *lavigata*, Sow. Menai Straits and Bull Bay in Anglesea: littoral and dredged at Port Erin (F.A.): Rhos Point (B.T.).

A specimen of the monstrosity mentioned by Jeffreys was dredged in the Menai Straits by Rev. A. H. Cooke.

*Lacuna crassior*, Mont.

Several alive 5 m. outside Fleetwood, in Sept., 1891.

*Lacuna divaricata*, Fab.

Young c. in seaweed at Porthwen and Fleshwick Bay (F.A.): abundant on *Laminaria* beyond the pier at Llandudno and of very large size (B.T.).

\**Lacuna puteolus*, Turton.

New to the district: Douglas Bay, among sand (Mal. Mon.): small living at Bull Bay, and several off Port Erin (F.A.): one living with *L. divaricata* at Llandudno (B.T.).

*Lacuna pallidula*, DaC.

Common alive at Moelfre Bay and Porthwen (F.A.), and at Llandudno with the last 2 species (B.T.), where both green and orange forms occur of all sizes.

\**Rissoa cancellata*, DaC.

One broken specimen from deep water off the Isle of Man, N. coast (Forbes in Jeff. B.C. IV, 10), omitted from Rep. I.

\**Rissoa calathus*, F. and H., omitted from Rep. I.

Isle of Man (Packe in Jeff. l.c. 11).

*Rissoa punctura*, Mont.

Dredged off Fleetwood (W.H.H.).

*Rissoa costata*, Ad.

Dead in Bull Bay (F.A.), one at Rhyl (B.T.).

*Rissoa parva*, DaC.

Abundant, living at Porthwen, Llandrillo, Llandulas Point, and Port Erin district (F.A.): do. at Llandudno (B.T.): Puffin Is. (A. Leicester).

Forbes (Mal. Mon.) says that var. *interrupta* is abundant in Isle of Man, N. but rare at S. and E. where it is replaced by *R. cingillus*.

*Rissoa striata*, Ad.

Living at Moelfre Bay, Porthwen and Bull Bay (F.A.): at low water on Puffin Is. (A. Leicester.): Fleetwood (W.H.H.).

*Rissoa vitrea*, Mont.

One in central area: rare in drift at Southport (G.W.C. and C.H.B.).

\**Rissoa soluta*, Phil.

Very rare at Southport (G.W.C.).

\**Rissoa semistriata*, Mont.

This and the last are new to district: seaweeds at low water, Puffin Is. (A. Leicester): Fleetwood (W.H.H.).

*Rissoa cingillus*, Mont.

Dead from Bull Bay, Porthwen (F.A.): abundant above Laminarian zone at Port Erin and Bay-ny-Carrickey (F.A.).

\**Hydrobia ventrosa*, Mont.

var. *ovata*, Jeff. Débris at h.w. mark near the border of Pilling Marsh (W.H.H.).

\**Jeffreysia diaphana*, Alder.

Abundant on weed at low water at Porthwen (F.A.): one at Bull Bay (F.A.) and one at Puffin Is. (A.L.).

*Skenea planorbis*, Fab.

Porthwen at low water, and abundant near Pt. Erin (F.A.), always on seaweed.

*Homologyra atomus*, Ph.

Sparingly near Port Erin and at Porthwen (F.A.): among *Laminaria* roots at Puffin (G.W.C.).

\**Cæcum glabrum*, Mont.

Rare at Southport (C.H.B. and G.W.C.).

\**Aclis unica*, Mont.\**Aclis ascaris*, Turton.

} both rare at Southport (G.W.C.).

*Aclis supranitida*, S. Wood.

Dead records also from Bull Bay (F.A.); Crosby (A. Reade); central area, 2 specimens.

\**Odostomia rissoides*, Hanley.

Abundant living at Puffin under stones and at *Laminaria* roots (A. Leicester): var. *dubia*, Jeff. (teste Jeffreys) Southport drift (C.H.B.).

\**Odostomia pallida*, Mont.

One from Puffin Is. (G.W.C.).

[*Odostomia conoidea*, Broc.

“Isle of Man (Forbes, as *O. plicata* apparently)”  
Jeff. B.C IV, 128. An undetermined species dredged  
alive and dead in central area is probably to be referred  
here (F.A.).]

\**Odostomia conspicua*, Alder., omitted in Rep. I.

“Douglas, I.M. (Alder)”—Jeff. l.c. 133, F. and H.  
III, 263.

\**Odostomia dolioliformis*, Jeff.

Southport (W.H.H.).

\**Odostomia decussata*, Mont.

One dredged at Port Erin (F.A.).

\**Odostomia indistincta*, Mont.

Southport drift (C.H.B.), teste Jeffreys: do. frequent  
(G.W.C.).

var. *brevior*, Jeff. Southport (W.H.H.).

*Odostomia rufa*, Ph.

“Anglesea (McAndrew)” Jeff. l.c. 163.

var. *fulvocincta*, Thompson, c. dead in central area.

[*Odostomia pusilla*, Ph.

Douglas Bay, scarce in sand (Mal. Mon.): Southport,  
v. rare (C.H.B.). Looking at the published localities  
of this critical species, I am of opinion that these  
records require confirmation: it is so easily confused  
with *O. lactea* which is widely diffused in our district.]

\**Odostomia scillæ*, Scacchi.

Central area, living and dead: new to district.

*Eulima distorta*, Desh.

Dredged at Fleetwood (W.H.H.).

*Eulima subulata*, Don.

c. at Crosby (A. Reade); several in central area and

20 m. W. of Southport: one at Pt. Erin (F.A.): not yet taken alive.

\**Adeorbis subcarinatus*, Mont.

4 dredged dead at Bull Bay: one in central area ("Spindrift," 1890).

*Velutina laevigata*, Penn.

One dredged dead at Bull Bay, and young on seaweed at Porthwen (F.A.).

[*Cerithiopsis tubercularis*, Mont. "*C. tuberculata*" by error in Rep. I, p. 261.

Mr. Archer records 2 worn specimens, from the "Spindrift," 1890, as apparently belonging to this species. It therefore requires confirmation ]

*Purpura lapillus*, L.

A narrow elongated form occurs rarely at Llandudno (B.T.): an instructive comparison is to be drawn between the ordinary clean, well-coloured *Purpuras* so common at Llandudno by the pier, and a very large solid, muddy-looking form which occurs at extreme low water on the "Conway shore" (so-called) along the Morfa. By the pier shells of a rather unusual colour, pinkish mauve, are not uncommon.

var. *imbricata*, Lam. In the McAndrew Coll. (Camb. Univ. Mus. of Comp. Anatomy) may be seen a magnificent suite of some 40 specimens of this var., beautifully frilled. They were dredged in Rhoscolyn Bay, Anglesea, in 4—7 fms.

\**Lachesis minima*, Mont.

Prestatyn, N. Wales (Grosvenor Mus., Chester).

*Trophon truncatus*, Ström.

c. young living in Bull Bay (F.A.): many dead off Tynyngogl and in central area (F.A.).

[*Fusus islandicus*, Chem.

Of Forbes (Mal. Mon.) and C. H. Brown is of course



not the true *islandicus*,—a very rare species,—but = *gracilis*, DaC. The confusion has been general, cf. Jeff. B.C. IV, 334, sqq.]

*Fusus gracilis*, DaC.

Is found to be generally distributed in a live state: common in winter at Port Erin on the crab-pots (F.A.).

*Fusus propinquus*, Alder.

Llandulas Pt. (F.A.), Birkdale (G.W.C.), rare and dead only.

*Nassa incrassata*, Ström.

c. alive at Port Erin (F.A.).

*Defrancia linearis*, Mont.

One alive and several dead at Port Erin (F.A.).

\**Pleurotoma costata*, Don., omitted from Rep. I.

Dead in 15—20 fms., N. Wales (Forbes).

*Pleurotoma nebula*, Mont.

Dead at Tynygongl and Bull Bay (F.A.), and at Southport extremely rare (G.W.C.).

*Pleurotoma turricula*, Mont.

Has now been dredged alive as follows:—central area: Bull Bay and Colwyn Bay (F.A.): c. 23 m. W. of Southport (G.W.C.).

\**Utriculus truncatulus*, Brug., new to district.

Fleetwood (W.H.H.): Puffin Is., small specimens (G.W.C.).

*Utriculus obtusus*, Mort.

6 living at W. Kirby (F.A.), thus confirming Byerley's locality between Hilbre Is. and mainland (teste F. P. Marrat).

*Scaphander lignarius*, L.

2 living off Bradda Head, and taken also near Kitterland, Port Erin (F.A.).

\**Philine punctata*, Clark.

One from roots of *Laminaria* on Puffin Is. (A. Leicester) : new to district.

\**Philine nitida*, Jeff.

Two specimens off Southport in 12 fms. (J. T. Marshall).

*Philine aperta*, L.

Frequently dredged living near Tynygongl and in central area (F.A.) : 3 alive off Colwyn Bay (F.A.).

[*Aplysia depilans*, L.

According to Pennant, *Laplysia* (sic) *depilans* has been taken off Anglesea. Probably his species was the common *A. punctata*, Cuv.]

\**Pleurobranchus plumula*, Mont., omitted from Rep. I.

Isle of Man, F. and H. III, 561.

*Pleurobranchus membranaceus*, Mont.

A Fleetwood fisherman stated that this species is frequently fished up between Walney Is. and N. of Man especially about Easter, and that they are called "lumps of pork" : one specimen received thence by W.H.H. Shore, Bay-ny-Carrickey (W. A. Herdman).

## PULMONOBRANCHIATA.

\**Melampus bidentatus*, Mont.

One at Port Erin (F.A.).

*Otina otis*, Turton.

R.D.D. is under the impression that Dr. Alcock and he many years ago got this species on stones at the foot of the lighthouse at the entrance to Channel at Fleetwood.

## CEPHALOPODA.

\**Spirula peronii*, Lam.

One or two authentic fragments of this species were

presented to the Grosvenor Museum, Chester, by a lady, with a lot of other ordinary beach shells,—all gathered at Rhyl.

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NOTE.—The Mollusca of the future L.M.B.C. expeditions will be worked up and reported upon by Mr. Alfred Leicester, Priory Gardens, Birkdale, who will gladly receive and acknowledge records of specimens from other conchologists in the district. Ed. L.M.B.C. Reports.]









